

Cape Wind Energy Project

Draft Environmental Impact Statement
January 2008

Volume I

**CAPE WIND ENERGY PROJECT
ENVIRONMENTAL IMPACT STATEMENT**

Draft (X)

Final ()

Type of Action:

Administrative (X)

Legislative ()

Areas of Potential Impact: Offshore marine environment and the coastal counties of Barnstable County, Nantucket County, and Dukes County in Massachusetts, and Washington County, Rhode Island.

Responsible Agency: U.S. Department of the Interior
Minerals Management Service
381 Elden Street
Herndon, VA 20170-4817

Abstract:

This environmental impact statement presents the characteristics of the environment in the project area and analyzes the effects of the construction, operation and maintenance, and decommissioning of the Cape Wind Energy Project, consistent with the requirements of the Outer Continental Shelf (OCS) Lands Act, (67 Stat. 462, as amended, 43 U.S.C. §1331 et seq.) and in accordance with the National Environmental Policy Act of 1969. The proposed action is a wind energy facility with a maximum electric output of 468 megawatts (MW) in Nantucket Sound off the coast of Massachusetts that can interconnect with and deliver electricity to the New England Power Pool. In addition to the proposed action, six alternatives were evaluated in detail, including the no action alternative.

In analyzing potential impacts of the project, consideration was given to a broad range of impact producing factors that could occur either under normal conditions or during unplanned or accidental conditions during the three phases of the project: construction, O&M, and decommissioning. Environmental resource characteristics from both the marine environment and the on land portions of the proposed action were then compared to these factors in order to assess and present the potential direct, indirect, and cumulative impacts of the proposed action and the six alternatives evaluated in detail.

**For Further Information Regarding
This Statement, Contact:**

James F. Bennett
Chief, Branch of Environmental Assessment
Minerals Management Service
U.S. Department of the Interior
381 Elden Street
Mail Stop 4042
Herndon, VA 20170
Phone: 703-787-1656

**For Further Information Regarding
This Project, Contact:**

Rodney E. Cluck, Ph.D.
Project Manager
Alternative Energy Program
Minerals Management Service
U.S. Department of the Interior
381 Elden Street
Mail Stop 4080
Herndon VA 20170
Phone: 703-787-1300

EXECUTIVE SUMMARY

Purpose of the Document

The Cape Wind Energy Project developer, Cape Wind Associates, LLC (the applicant), proposes to build, operate, and eventually decommission an electric generation facility with a maximum electric output of 468 megawatts and an average output of 182.6 megawatts, in Nantucket Sound off the coast of Massachusetts (proposed action). The proposed action would generate electricity from wind energy resources on the Outer Continental Shelf. The applicant seeks to commence construction in 2009 and begin operation in 2010.

The applicant requests a lease, easement, right-of-way, and any other related approvals from the Department of the Interior, Minerals Management Service necessary to authorize construction, operation and eventual decommissioning of the proposed action. The Minerals Management Service's authority to approve, deny, or modify the Cape Wind Energy Project derives from the Energy Policy Act of 2005 (EPAAct – <http://www.mms.gov/2005EnergyPolicyAct.htm#Renewables>). Section 388 of the Act amended the Outer Continental Shelf Lands Act by adding subsection 8(p), which authorizes the Department of the Interior to grant leases, easements or right-of-ways on Outer Continental Shelf lands for activities that produce or support production, transportation, or transmission of energy from sources other than oil and gas, such as wind power.

The proposed action requires environmental review for Federal approval under Subsection 8(p) of the Outer Continental Shelf Lands Act. The National Environmental Policy Act provides the framework under which Federal agencies perform environmental review of projects for which they would be authorizing, funding, or undertaking on their own behalf. In this instance, the proposed federal action resulting in the need for environmental review under the National Environmental Policy Act is the issuance of a lease, easement or right-of-way and related approvals by the Minerals Management Service for authorizing the construction, operation and eventual decommissioning of the Cape Wind Energy Project (the proposed action).

This Draft Environmental Impact Statement provides a detailed description of the proposed action, including the construction, operation and maintenance, and decommissioning phases. An explanation of the alternative screening analysis, the locations and descriptions of the considered alternatives, as well as a comparison of impacts between the alternatives and the proposed action is also provided. The existing conditions of the affected environment are described and broken down in to the physical, biological and socioeconomic resources. A detailed analysis of the impacts on each of these resources according to construction, operation and maintenance, and decommissioning, is presented. Cumulative impacts and commitment of resources are discussed. The concept of an Environmental Management System is introduced that contains many of the mitigation measures and other commitments and requirements under which the proposed action would be constructed, operated, and decommissioned. Other important information contained in this Draft Environmental Impact Statement includes agency correspondence and coordination, and supplemental studies and reports prepared by the applicant.

Project Purpose and Need

The underlying purpose and need to which the agency is responding is to develop and operate an alternative energy facility that utilizes the unique wind resources in waters offshore of New England employing a technology that is currently available, technically feasible, and economically viable, that can interconnect with and deliver electricity to the New England Power Pool, and make a substantial contribution to enhancing the region's electrical reliability and achieving the renewable energy requirements under the Massachusetts and regional renewable portfolio standards.

The Massachusetts Energy Facility Siting Board found there was a need for at least 110 megawatts of energy resources beginning in 2007 with a much greater need within the following years (Energy Facility Siting Board, Siting Decision 2004). The Massachusetts and regional Renewable Portfolio Standards mandate that a certain amount of electricity come from renewable energy sources, such as wind. Specifically, the Massachusetts Renewable Portfolio Standard requires that all retail electricity providers in the state utilize new renewable energy sources for at least 2.5 percent of their power supply in 2006 and increasing this percentage to 4 percent by 2009 (<http://www.mass.gov/doer/rps/regs.htm>).

Proposed Action Description Overview

The proposed action entails the construction, operation and maintenance, and eventual decommissioning of an electric generating facility consisting of 130 wind turbine generators arranged in a grid pattern in the Horseshoe Shoal region of Nantucket Sound, Massachusetts (see [Figure E-1](#)). Each of the 130 wind turbine generators would generate electricity independently of each other. For this area of Nantucket Sound, the wind power density analysis conducted by the applicant determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the wind turbine generators. This alignment would position the wind turbine generators perpendicular to prevailing winds, which are generally from the northwest in the winter and from the southwest in the summer for this geographic area in Nantucket Sound.

The wind turbine generators have a stated design life span of twenty years. However, this estimate is based on experience generated from land-based machines which are subject to higher levels of turbulence and arguably experience greater wear and tear than can be expected offshore where winds are less turbulent. It is possible that the proposed action could be operational beyond the minimum design life of twenty years.

Solid dielectric submarine inner-array cables (33 kilovolt) from each wind turbine generator would interconnect within the grid and terminate on an electrical service platform. The electric service platform would serve as the common interconnection point for all of the wind turbine generators. The proposed submarine transmission cable system (115 kilovolt) is approximately 12.5 miles in length (7.6 miles within the Massachusetts 3-mile territorial line) from the electric service platform to the landfall location in Yarmouth. The submarine transmission cable system consists of two parallel cables that would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue. The proposed onshore transmission cable system route from the landfall area to its intersection with the NSTAR electric right-of-way would be located entirely along existing paved right-of-ways where other underground utilities already exist. All of the roadways within Yarmouth and Barnstable in which the proposed transmission cable system would be placed are town owned and maintained roads with the exception of Routes 6 and 28, which are owned and maintained by the Massachusetts Highway Department. A portion of the onshore transmission cable system route would also be located underground within an existing maintained NSTAR Electric right-of-way.

Installation of the proposed action components would comprise five activities: (1) installation of the foundation monopiles; (2) erection of the wind turbine generators and electric service platform; (3) installation of the inner-array cables; (4) installation of the transmission cables from the electric service platform to the Barnstable Switching Station; and (5) installation of the scour protection around the monopiles and electric service platform piles. The electric service platform design is based on a piled jacket/template design with a superstructure mounting on top. The platform jacket and superstructure would be fully fabricated on shore and delivered to the work site by barges, where it would be installed.

The proposed method of installation of the submarine cables (both the inner array cables and the submarine transmission cables) would be accomplished by the Hydroplow embedment process,

commonly referred to as jet plowing. This method involves the use of a positioned cable barge and a towed hydraulically-powered jet plow device that simultaneously lays and embeds the submarine cable in one continuous trench from wind turbine generator to wind turbine generator and then to the electric service platform, or from the electric service platform to the landfall area.

The transition of the submarine transmission cables from water to land would be accomplished through the use of Horizontal Directional Drilling. Construction of the onshore transmission cable would occur in two phases. The first phase would consist of installing the ductbanks, conduits, and vaults. The second phase would consist of the installation of the onshore transmission cables, including splices and terminations.

It is anticipated that the main operation center would be located in the Town of Yarmouth. Here would be installed the remote monitoring and command center where all decisions concerning the operation of the offshore generating facility would be made. The service and maintenance vessels, supplies and personnel would be stationed at two additional onshore locations: a New Bedford location for parts storage and larger maintenance supply vessels and Falmouth for crew transport, since it is closer to the site.

Project Chronology

In November 2001, Cape Wind Associates, LLC sought permission from the U.S. Army Corps of Engineers to construct and operate a wind-powered electrical generating facility on Horseshoe Shoal in Nantucket Sound, Massachusetts. In December 2001, the U.S. Army Corps of Engineers determined that an environmental impact statement was required for the Cape Wind Energy Project. First, a Notice of Intent to prepare the environmental impact statement was published in the Federal Register and other public notices were issued. The Notice of Intent was published on January 30, 2002. Public scoping meetings were held in Boston and West Yarmouth on March 6 and March 7, 2002, respectively. Existing relevant data was then collected and reviewed to address issues discussed during scoping. The U.S. Army Corps of Engineers Draft Environmental Impact Statement was made available for public review and comment in November 2004. The public comment period lasted 60 days, commencing with a notice of availability published in the Federal Register. Public comment meetings were held on Nantucket, Martha's Vineyard, Cape Cod, and in Boston.

Prior to the enactment of the Energy Policy Act of 2005, there was a lack of clear federal regulatory authority for alternative energy projects proposed to be sited on the Outer Continental Shelf. In the absence of such authority, prior to Energy Policy Act of 2005, the U.S. Army Corps of Engineers had been acting as the lead agency for National Environmental Policy Act evaluation of the proposed Cape Wind Energy Project. Following adoption of the Energy Policy Act, and the amendments to the Outer Continental Shelf Lands Act, the Department of the Interior was given authority for issuing leases, easements, or rights-of-way for alternative energy project activities on the Outer Continental Shelf.

During the fall of 2005, the Minerals Management Service reviewed the Cape Wind application to determine its adequacy and evaluated how to proceed with its own National Environmental Policy Act evaluation. It was determined that the regulations and requirements under which the Minerals Management Service would authorize the proposed action are substantially different than those under which the U.S. Army Corps of Engineers would have authorized the proposed action, and so it was determined that a new Draft Environmental Impact Statement would need to be prepared. To ensure there was an efficient and timely National Environmental Policy Act analysis, the Minerals Management Service considered, and borrowed where appropriate, certain portions of the U.S. Army Corps of Engineers Draft Environmental Impact Statement for the proposed action. Minerals Management Service also treated public comments on the U.S. Army Corps of Engineers Draft Environmental Impact

Statement as scoping comments in Minerals Management Service's preparation of this Draft Environmental Impact Statement. The Minerals Management Service determined that an independent contractor would need to be hired to assist in the preparation of the Draft Environmental Impact Statement. A Memorandum of Understanding was prepared and signed in the spring of 2006, between Cape Wind and the Minerals Management Service, to support the environmental impact statement preparation process using an independent contractor. The contractor was selected by the Minerals Management Service in May of 2006 and work commenced on preparing a Draft Environmental Impact Statement. On May 30, 2006, the Minerals Management Service published in the Federal Register its Notice of Intent to prepare an environmental impact statement. This Notice also served to announce the initiation of the written scoping process for the environmental impact statement, and invited other Federal, State, tribal and local governments to consider becoming cooperating agencies in the preparation of the environmental impact statement.

During the remainder of 2006 and into 2007, the contractor worked with the application materials, the U.S. Army Corps of Engineers Draft Environmental Impact Statement, and other relevant and existing information to prepare the Draft Environmental Impact Statement. During this timeframe, the applicant continued to perform studies and submit new information, as well as respond to requests for additional information that were identified by Minerals Management Service and the contractor as necessary in order to prepare the Draft Environmental Impact Statement.

Summary Description of Alternatives Assessed

In order to conduct a comprehensive evaluation of reasonable alternative locations for an offshore wind energy facility that would be capable of serving the New England region, Minerals Management Service identified and initially screened nine alternative locations (in addition to the proposed location on Horseshoe Shoal) along the coast from Maine to Rhode Island. The sites were chosen based on geographic diversity, having at least some potential in terms of wind resources, and the necessary area required for the proposed facility size. In addition, in development of the alternatives, Minerals Management Service took into account comments received as a part of the scoping process. Specifically, the Phelps Bank Alternative was selected as a result of interest expressed in this location by the Massachusetts Office of Coastal Zone Management, and Offshore Nauset Alternative was chosen as a result of public interest in a deep water alternative.

These geographically diverse sites included:

- Offshore Portland, Maine
- Offshore Cape Ann, Massachusetts
- Offshore Boston, Massachusetts
- Offshore Nauset, Massachusetts (East of Nauset Beach)
- On Monomoy Shoals (east of Monomoy, Massachusetts)
- On Nantucket Shoals (southeast of Nantucket Island, Massachusetts)
- On Phelps Bank (southeast of Nantucket Island, Massachusetts)
- South of Tuckernuck Island
- East of Block Island, Rhode Island

Of these nine sites that were chosen as geographically diverse, seven sites were not selected for further environmental analysis because of physical limitations and/or constraints due to (1) water depth (should be < approximately 100 feet [30 meters] in depth to be considered economically feasible) (TRC, 2006); (2) extreme wave height (should be less than approximately 20 feet [6.1 meters] high in 50 feet [15.2 meters] of water depth); (3) presence of bedrock or large boulders (this is problematic both for installation of the monopiles and proper burial of electrical interconnection lines); (4) distance from site

to onshore transmission system (should be less than approximately 31 miles [50 kilometers]) for an underground alternating current transmission line; high voltage direct current transmission cables have not yet been proven to be a commercially available technology for offshore wind farms); and (5) the availability of technology to develop the site (development of floating platform technology for use in water depths >150 feet [45 meters] is beyond the milestones scheduled for project development) (see Section 3.3.4).

The sites which were not assessed for further evaluation include the Portland, Maine; Cape Ann, Massachusetts; Boston, Massachusetts; Nauset, Massachusetts (East of Nauset Beach); on Nantucket Shoals (southeast of Nantucket Island, Massachusetts); on Phelps Bank (southeast of Nantucket Island, Massachusetts); and east of Block Island, Rhode Island sites. Out of the group of nine geographic sites, the alternative sites selected for further environmental analysis include Monomoy Shoals and South of Tuckernuck Island.

In addition to the sites screened above, Minerals Management Service also screened three non-geographic based alternatives to the proposed action to see if they could produce electricity at a reasonable cost range to that of the proposed action. These design alternatives included:

- Smaller Project (half the megawatt capacity of the Proposed Alternative at the same location);
- Condensed Array (same number of turbines but closer together); and
- Phased Development (two phases of 65 turbines each)

The No Action Alternative was also included in the screening process. The analysis of the No Action Alternative provides a benchmark for Minerals Management Service in which to compare the magnitude of environmental impacts of the proposed action. The No Action alternative considers other strategies for addressing the demand for electricity in New England if the proposed action were not constructed, and the viability of those strategies and or impacts associated with those other strategies. This includes an assessment of energy efficiency, and the assessment of other energy options including fossil fuel technologies, and other alternative energy technologies.

Figure 3.3.5-1 shows the locations of the proposed alternatives that passed the first phase of screening and were therefore subject to an environmental resource and impact assessment. They include the proposed action, No Action, South of Tuckernuck Island, Monomoy Shoals, Smaller Project, Condensed Array, and Phased Development.

The South of Tuckernuck Island Alternative Site is located in the Atlantic Ocean southwest of Tuckernuck Island between Muskeget Channel to the west and the southwestern coast of Nantucket Island to the east in open waters. The Monomoy Shoals alternative site is approximately 3.5 miles (5.6 kilometers) southeast of Monomoy Island within the eastern approach to Nantucket Sound. The Smaller Project Alternative (a total of 65 wind turbine generators) would have the same electric service platform location and transmission cable location as the proposed action, and would be in the same foot print as the proposed action, but 65 wind turbine generators at the north, south and east sides of the proposed action configuration would be removed. The Condensed Array Alternative would be located in the same area as the proposed action but the wind turbine generators would be spaced closer together in a grid with a separation distance of 6 turbine rotor diameters by 6 turbine rotor diameters versus the proposed action which has wind turbine generator spacing of 6 x 9 turbine rotor diameters. The Phased Development Alternative involves constructing the full electric service platform and one half of the 130 wind turbine generators first, and then the remainder of the wind turbine generators later after the first phase has been installed and had a chance to operate so that monitoring of operational impacts can take place.

Principal Issues and Concerns

The following is a general summary of the issues and concerns raised in comments combined from both the Minerals Management Service and the U.S. Army Corps of Engineers processes. A number of comments received on the U.S. Army Corps of Engineers Draft Environmental Impact Statement dealt with issues and concerns about how certain information was presented or analyses performed. Minerals Management Service had taken these comments and addressed them either internally or through requests to Cape Wind such that the comments would be dealt with during development of the Minerals Management Service Draft Environmental Impact Statement (see Section 7 for a full presentation of scoping comments and issues). This Draft Environmental Impact Statement has addressed all comments to the extent they are applicable and necessary to reach conclusions as to the scope and extent of the proposed action characteristics and potential impacts. The comments are summarized below in the following categories:

- **Regulatory Process**
- **Alternatives Analysis**
- **Construction, Operations, Decommissioning** – Activities, Methods, and Materials
- **Physical Resources** – This section contains comments on Geology and Sediments, Oceanography, Water Quality, Air and Climate, Noise, and Electric Magnetic Fields.
- **Biological Resources** – This section contains comments on Avian and Bat Resources, Freshwater and Coastal Wetlands, Wildlife, Fisheries –Impacts to Commercial and Recreational Fishing’ Fisheries – Environmental Impacts, Benthos, Vegetation including eelgrass and macroalgae, and Threatened & Endangered Species
- **Socioeconomic Resources and Land Uses** – This contains comments on Urban and Suburban Infrastructure, Population and Economic Background, Visual Resources, Cultural Resources, Recreation and Tourism, Competing Uses in the Vicinity of The Project
- **Navigation and Transportation** – Overland Transportation Arteries, Airport Facilities, Port Facilities, Communications

Regulatory Process: Comments with respect to the regulatory process generally fell into the following subtopics: public trust issues; objectivity concerns/conflicts; request for further review/information/data in the new Draft Environmental Impact Statement; homeland security; need for national policy for use of ocean resources; the Ocean Sanctuaries Act; state boundary issues; Marine Mammal Protection Act; compensatory mitigation; the U.S. Army Corps Engineers jurisdiction; and inclusion of agency comments.

In addition, some of the comments summarized under the regulatory heading are no longer applicable to review under the Minerals Management Service jurisdiction. For instance, many comments were made that the U.S. Army Corps of Engineers was not the appropriate review agency, and as the Minerals Management Service is now reviewing the proposed action, this type of comment is no longer applicable.

Alternatives Analysis: Comments with respect to the types of alternatives considered generally fell under the following six categories: on land; further offshore/deeper water and other offshore locations; smaller scale and/or phased; alternative technologies, alternate configurations, and energy conservation.

Construction, Operation, and Decommissioning: Comments pertaining to construction, operation, and decommissioning of the proposed action generally fell into the following subtopics: decommissioning activities needed to be more thoroughly presented and discussed; Oil Spill Response Plan; design, performance, stability and maintenance; public safety; pollution prevention; grid integration problems; inaccurate wind production numbers/ production capacity; construction issues; taxes and insurance certificates; monitoring before, during, and after construction; and onshore construction concerns/ Storm Water Pollution Prevention Plan.

Physical Resources: The comments submitted for the various physical resources ranged from concern over inadequate data collection for the baseline condition; general lack of characterization of impacts due to physical processes such as sand migration, alteration of waves and currents, noise propagation and generation of electromagnetic fields; inadequate modeling efforts for sediment resuspension and transport, spill trajectory analysis, and underwater noise transmission. Other commenters indicated that monitoring and mitigation measures were needed to gain a better understanding of physical processes and then offset potentially adverse impacts through mitigation measures. Comments with respect to air and climate generally focused on better characterization of how the proposed action relates to global warming, more characterization of public health effects as they relate to purported emission reductions; description of potential visibility improvement, and providing a summary of local meteorological data.

Biological Resources: Comments with respect to biological resources centered on several overall concerns such as lack of adequate baseline data for the diverse array of species occurring on the ocean floor, in the water, and in the air around the turbines, the need for expanded discussion of mitigation measures and monitoring approaches, and more information on alternatives. For on land resources, commenters questioned whether the construction methods represented Best Management Practices, whether there was adequate discussion of short and long term effects, and that not much project specific data was collected on species occurrence along the transmission line route. For wildlife in general, commenters felt that the assessment of harm was not species specific, there was no monitoring plan for wildlife, and that only non-project specific data covering the larger Nantucket Sound region were used to represent the pinnipeds and other smaller marine mammals.

Regarding commercial and recreational fisheries, many comments reflected inadequacy in the data collected up to the time of the release of the U.S. Army Corps of Engineers Draft Environmental Impact Statement. Largely in response to these comments, Minerals Management Service has subsequently been provided more data from the applicant that has been incorporated into this Draft Environmental Impact Statement. Commenters expressed concern about the quality of the data presented, the absence of certain data, such as on recreational fishing activity, and concern that the use of statistical data collected for larger regions and for other intended uses was being mis-applied and could therefore understate actual catches and where the economic benefits or harm might accrue. From a fish biology perspective, comments ranged from criticism of the thoroughness of the impact characterizations, inaccuracy in the representation of short and long term potential impacts to the fishery resource and habitats, and the lack of mitigation. Comments with respect to benthos were somewhat similar to those for fish, namely that there were baseline data limitations, particularly benthic habitat mapping, that there was inadequate presentation of a thorough range of potential impacts from all phases of the proposed action, and that the relationship between benthos and other fish and wildlife species was not discussed.

Socioeconomic Resources and Land Use: Comments with respect to socioeconomics ranged from incomplete assessment of the costs and benefits to local economies, the reality of purported changes in dependency on foreign oil or reduction in energy costs, and inaccurate assessment of impacts to property values and other negative economic impacts to issues surrounding environmental justice and who really benefits and who pays from the construction and operation of the proposed action. Some comments were

also received stating that the economics of the proposed action should be shared and that it is questionable that the proposed action is economically viable, particularly in the absence of subsidies, or legislated renewable portfolio standards.

Comments with respect to human resources centered on past, present and future use of the site of the proposed action. Comments with respect to cultural resources generally fell under three main subtopics, including a need for documented compliance with Section 106 of the National Historic Preservation Act, inadequacy of the identification of historic properties potentially affected, and concerns about adverse affects on historic properties. The comments with respect to aesthetic impacts covered a broad spectrum, from statements that the proposed action would have positive or no impacts to aesthetics, to comments that the proposed action would have unacceptable negative impacts to aesthetics. Also, given the visual simulation approach taken, comments were also received that this approach was inadequate because it did not analyze enough different daylight and weather conditions, and that visual simulations from other locations and more varied distances were needed.

Navigation and Transportation: Comments focused on the hazard to mariners and aviators that cross Nantucket Sound that could include actual collision with the structures as well as adverse affects on navigation equipment such as radar. Other commenters stated dissatisfaction with having to alter how they use the area around the site of the proposed action, whether it is for recreational boating, commercial fishing, or flights between the mainland and the islands. Possible interference with various forms of communication/navigation systems, such as Federal Aviation Administration/Department of Defense radar, instrument landing system, global positioning system, and VHF Omni-directional Radio Range, leading to aircraft and public safety issues were stated as inadequately analyzed.

Impact Level Definitions

Anticipated impacts to physical, biological, socioeconomic resources and land use, and navigation and transportation from the proposed action are categorized as negligible, minor, moderate, or major. These impact levels are used in the impact section of the Draft Environmental Impact Statement to provide consistency in the assessment of environmental impacts and socioeconomic issues.

The impact levels for biological and physical resources are used for the analysis of water quality, air quality, marine and terrestrial mammals, marine and coastal birds, fish resources, sea turtles, coastal and seafloor habitats, archaeological resources, and areas of special concern (such as essential fish habitats, marine sanctuaries, parks, refuges, and reserves). The four impact levels are defined as follows:

- (1) **Negligible**
 - No measurable impacts.
- (2) **Minor**
 - Most impacts to the affected resource could be avoided with proper mitigation, or
 - If impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated.
- (3) **Moderate**
 - Impacts to the affected resource are unavoidable, and
 - The viability of the affected resource is not threatened although some impacts may be irreversible, or

- The affected resource would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.

(4) Major

- Impacts to the affected resource are unavoidable, and
- The viability of the affected resource may be threatened, and
- The affected resource would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

The impact levels for socioeconomic issues are used for the analysis of demography, employment, and regional income; land use, visual and infrastructure; fisheries; tourism and recreation; socio-cultural systems; and environmental justice. Although impact levels for direct physical impacts to archaeological resources use the definitions above, indirect visual impacts to archaeological resources are defined by the following criteria. The four impact levels are defined as follows:

(1) Negligible

- No measurable impacts.

(2) Minor

- Adverse impacts to the affected activity or community could be avoided with proper mitigation, or
- Impacts would not disrupt the normal or routine functions of the affected activity or community, or
- Once the impacting agent is eliminated, the affected activity or community would return to a condition with no measurable effects from the proposed action without any mitigation.

(3) Moderate

- Impacts to the affected activity or community are unavoidable, and
- Proper mitigation would reduce impacts substantially during the life of the proposed action, or
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the proposed action, or
- Once the impacting agent is eliminated, the affected activity or community would return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

(4) Major

- Impacts to the affected activity or community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the proposed action.

- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normally acceptable, and
- Once the impacting agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

Summary of Impacts

A summary of overall impacts organized by resources is provided in [Table E-1](#) and a full presentation of impacts is located in Section 5. A description of mitigation measures under consideration can be found in Section 9.

Supporting Reports

The Draft Environmental Impact Statement draws directly from numerous technical and environmental reports (refer to the bibliography at Section 10.1) and also takes into consideration information in many more additional reports (refer to the bibliography in Section 10.3), as well as a substantial amount of other available scientific and technical information (refer to the bibliography in Section 10.2). Reports referenced in Section 10.1 are included directly following applicable sections of text, appearing as “(Report no. x)” and include hyperlinks so that the reader of the electronic version can click on the report referenced in the text and immediately have access to the full referenced report (the CD copy of the Draft Environmental Impact Statement contains the full text of all the reports referenced). In an effort to conserve paper and reduce the bulk of the Draft Environmental Impact Statement, hard copies of the reports are not provided. The reports and Draft Environmental Impact Statement are also available on the Minerals Management Service’s web site at: <http://www.mms.gov/offshore/RenewableEnergy/CapeWind.htm>, or the reports and Draft Environmental Impact Statement can be obtained by contacting either of the following people:

For further information regarding this statement please contact:

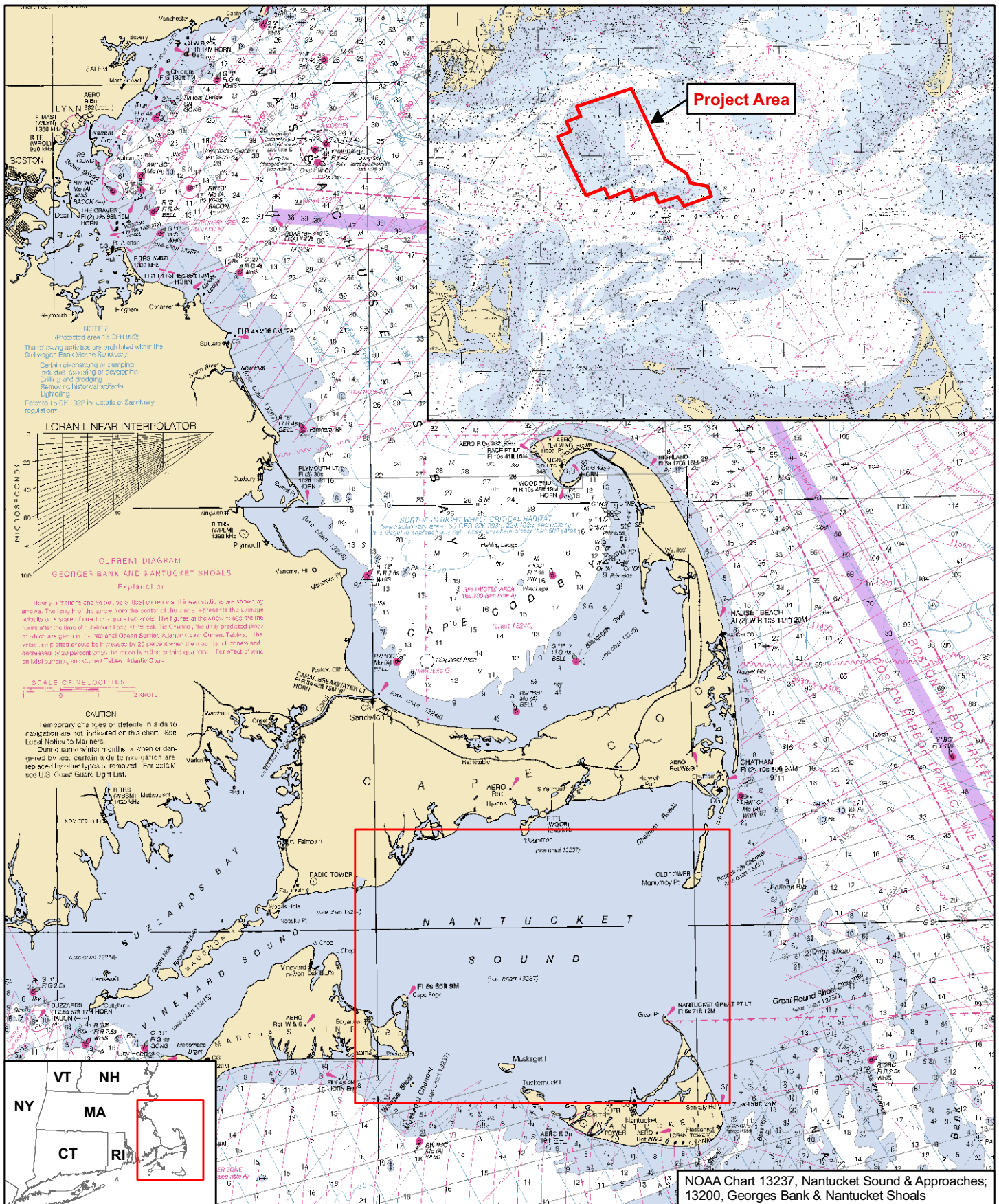
James F. Bennett
Chief, Branch of Environmental Assessment
Minerals Management Service
U.S. Department of the Interior
381 Elden Street
Mail Stop 4042
Herndon, VA 20170
Phone: 703-787-1656

For further information regarding the project please contact:

Rodney E. Cluck, Ph.D.
Project Manager
Alternative Energy Program
Minerals Management Service
U.S. Department of the Interior
381 Elden Street
Mail Stop 4080
Herndon VA 20170
Phone: 703-787-1300

Hard copies of the Draft Environmental Impact Statement have also been sent to the following libraries:

- Edgartown Free Public Library
- Boston Public Library
- Hyannis Public Library
- Falmouth Public Library
- Eldredge Public Library
- Nantucket Atheneum



CAPE WIND ENERGY PROJECT
 Project Locus Map
 Figure E-1

TABLE E-1		
Summary of Impacts		
Resource	Impacts	
	Construction Impacts	Operation Impacts
Regional Geologic Setting	minor	minor
Noise	<i>Onshore:</i> minor <i>Offshore:</i> minor <i>Underwater:</i> minor	<i>Onshore:</i> negligible <i>Offshore:</i> negligible <i>Underwater:</i> negligible
Oceanography	<i>Currents:</i> negligible <i>Waves:</i> negligible <i>Salinity:</i> negligible <i>Temperature:</i> negligible <i>Sediment Transport:</i> minor <i>Water depth/bathymetry:</i> minor	<i>Currents:</i> minor <i>Waves:</i> negligible <i>Salinity:</i> negligible <i>Temperature:</i> negligible <i>Sediment Transport:</i> minor <i>Water depth/bathymetry:</i> minor
Climate and Meteorology	minor	negligible
Air Quality	<i>Public Health:</i> negligible <i>Visibility:</i> negligible <i>Emissions:</i> minor	<i>Public Health:</i> negligible <i>Visibility:</i> negligible <i>Emissions:</i> minor (beneficial to climate change)
Water Quality	minor	negligible (with the exception of spills)
Electric and Magnetic Fields	negligible	negligible
Terrestrial Vegetation	negligible to minor	negligible to minor
Coastal and Intertidal Vegetation	negligible to minor	negligible (negligible to minor for repairs, depending on location)
Terrestrial and Coastal Faunas other than Birds	negligible to minor	negligible (minor for migratory bats)
Avifauna	<i>Terrestrial Birds:</i> Raptors - negligible Passerines - minor <i>Coastal Birds:</i> negligible to minor <i>Marine Birds:</i> minor to moderate Pelagic Species - minor Waterfowl and Non-Pelagic Water Birds - minor	<i>Terrestrial Birds:</i> Raptors - negligible. Passerines – minor to negligible. <i>Coastal Birds:</i> negligible to moderate <i>Marine Birds:</i> negligible to moderate Pelagic Species - minor Waterfowl and Non-Pelagic Water Birds - minor
Subtidal Offshore Resources	<i>Soft-Bottom Benthic Invertebrate Communities:</i> minor <i>Shellfish:</i> minor <i>Meiofauna:</i> minor <i>Plankton:</i> negligible	<i>Soft-Bottom Benthic Invertebrate communities:</i> minor <i>Shellfish:</i> minor <i>Meiofauna:</i> minor <i>Plankton:</i> minor
Non-ESA Marine Mammals	<i>Acoustical Harassment:</i> minor <i>Vessel Strikes:</i> minor <i>Vessel Harassment:</i> minor <i>Temporary Reduced Habitat:</i> minor <i>Turbidity:</i> negligible to moderate (due to pile driving) <i>Pollution/ Potential Spills:</i> minor	<i>Acoustical Harassment:</i> negligible <i>EMF:</i> negligible <i>Pollution/ Potential Spills:</i> minor to moderate <i>Vessel Strikes:</i> minor <i>Vessel Harassment:</i> minor <i>Fouling Communities:</i> negligible to minor

TABLE E-1		
Summary of Impacts		
Resource	Impacts	
	Construction Impacts	Operation Impacts
Fisheries	<i>Finfish</i> : minor <i>Demersal Eggs and Larvae</i> : moderate <i>Commercial & Recreational Fishing/Gear</i> : minor	<i>Commercial & Recreational Fishing/Gear</i> : Negligible to minor <i>Sound and Vibration</i> : negligible to minor <i>Vessel Traffic</i> : negligible <i>EMF</i> : negligible <i>Lighting</i> : negligible/none <i>Alterations to Waves, Currents, Circulation</i> : negligible <i>Habitat Change</i> : minor <i>Displacement of Prey</i> : none
EFH	<i>Benthic/Demersal</i> : negligible to minor <i>Water Column</i> : negligible to minor <i>SAV/Eelgrass</i> : negligible to minor	<i>Benthic/Demersal</i> : negligible to minor <i>Water Column</i> : negligible to minor <i>SAV/Eelgrass</i> : negligible to minor
T&E	<i>Sea turtles</i> : negligible to minor <i>Cetaceans</i> : negligible to minor <i>Avifauna</i> : negligible to minor <i>Eastern Cottontail Rabbit</i> : negligible	<i>Sea Turtles</i> : negligible to minor <i>Cetaceans</i> : negligible to minor <i>Avifauna</i> : minor to moderate <i>Eastern Cottontail Rabbit</i> : negligible
Urban and Suburban Infrastructure	negligible to minor	negligible
Population and Economics	minor	minor
Environmental Justice	Negligible (i.e., not a disproportionately high impact on minority or low income populations)	Negligible (i.e., not a disproportionately high impact on minority or low income populations)
Visual Resources	minor	moderate Impacts on Shore (Major impacts on-water in close proximity to proposed action)
Cultural Resources	minor	Pending on the outcome of Section 106 process
Recreation and Tourism	minor	minor
Competing Uses of Waters and Seabed	minor	minor (except for impacts to Figawi Race which are moderate)
Overland Transportation Arteries	minor	negligible
Airport Facilities and Aviation Traffic	negligible to minor	minor
Port Facilities and Vessel Traffic	minor	minor (sailing vessel impact expected to be moderate)
Communications: EMF, Signals, and Beacons	minor	minor

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

°C	Degrees Celsius
°F	Degrees Fahrenheit
ACK	Nantucket Memorial Airport
AC	Alternating Current
ACEC	Area of Critical Environmental Concern
ADCP	Acoustic Doppler Current Profiler
ACHP	Advisory Council on Historic Preservation
Alliance	Alliance to Protect Nantucket Sound
AMPS	amperes
AMSL	Above Mean Sea Level
ANG	Massachusetts Air National Guard
APE	Area of Potential Effect
APPEs	Areas of Potential Physical Effects
ARNG	Massachusetts Army National Guard
ARPA	Archeological Resource Protection Act
ARTCC	Air route Traffic control Center
ASA	Applied Science Associates, Inc.
ASFMC	Atlantic States Marine Fisheries Commission
ATC	Air Traffic Control
ATON	Additional Aids-to-Navigation
BA	Biological Assessment
BACI	Before Action Control Impact
BIA	Bureau of Indian Affairs
BMPs	Best Management Practices
BO	Biological Opinion
BOS	Boston's Logan Airport
BVW	Bordering Vegetated Wetland
CAA	Clean Air Act
CCCA	Cape Cod Commission Act
CCCT	Combined Cycle Combustion Turbines
CEQ	Council on Environmental Quality
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CFR	Code of Federal Regulations
CGP	Construction General Permit
CI	Confidence Interval
C/I	Construction and Installation
CIOS	Cape and Islands Ocean Sanctuary
cm	Centimeters
CMR	Code of Massachusetts Regulations
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CPA	Closest Point of Approach
CPT	Cone Penetrometer Testing
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
dB	Decibels

dB _A	Decibels A-Weighted Scale
dB _L	Decibels (Linear)
dB _{ht}	Hearing Threshold Sound Level
DC	Direct Current
DCA	Washington D.C. Reagan National Airport
DO	Dissolved Oxygen
DOD	Department of Defense
DOE	Department of Energy
DOER	Massachusetts Division of Energy Resources
DOI	Department of the Interior
DPA	Designated Port Areas
DPW	Department of Public Works
draft EIS	Draft Environmental Impact Statement
draft EIR	Draft Environmental Impact Report
DRI	Development of Regional Impact
DPU	Department of Public Utilities
DWPC	Division of Water Pollution Control
EERE	Energy Efficiency and Renewable Energy
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Assessment
EFSB	Massachusetts Energy Facilities Siting Board
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELF-EMF	Extremely Low Frequency Electromagnetic Fields
EMF	Electro Magnetic Field
EMF-RAPID	Electric and Magnetic Fields Research and Public Information Dissemination Program
ELMR	Estuarine Living Marine Resources
EMS	Environmental Management System
EOEA	Executive Office of Environmental Affairs
EPAct	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
ER-L	Effects Range-Low
ER-M	Effects Range-Median
ERP	Emergency Response Plan
ES	Electrical Services
ESA	Endangered Species Act
ESP	Electrical Service Platform
ESW	Extreme Storm Wave
ETF	Electric Transmission Facilities
EUIRA	Electric Utility Industry Restructuring Act
EWB	New Bedford Regional Airport
FAA	Federal Aviation Administration
FAD	Fish Attracting Devices
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
final EIR	Final Environmental Impact Report
FIRM	Flood Insurance Rate Map
FPM	Flashes Per Minute

FR	Federal Register
ft	Feet
ft ²	Square Feet
ft ³	Cubic Feet
ft/s	Feet per Second
G	Gauss
GE	General Electric
G&G	Geotechnical and Geophysical
GHG	Greenhouse Gas
GMI	Geo-Marine, Inc.
GPS	Global Positioning System
GSA	Geological Survey of Alabama
GW	Giga Watts
GWh	Gigawatt Hour
GWh/y	Gigawatt Hour per Year
HAB	Harmful Algal Bloom
HAPC	Habitat Areas of a Particular Concern
HAPs	Hazardous Air Pollutants
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HF	High Frequency
HG	Mercury
Horns Rev	Horns Rev Offshore Wind Farm
HRGS	High Resolution Geophysical Survey
HSS	Horseshoe Shoal
HVDC	High Voltage Direct Current
HYA	Hyannis' Boardman-Polando Field
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IARC	International Agency for Research on Cancer
IBA	Important Bird Area
IFR	Instrument Flight Rule
IHA	Incidental Harassment Authorization
ISO-NE	Independent System Operation New England
ITS	Incident Take Statement
KC	Keulagan-Carpenter
kcmil	Thousand Circular Mils
kg	Kilograms
kHz	Kilohertz
km	Kilometers
km ²	Square Kilometers
km/h	Kilometers Per Hour
kV	Kilovolt
kV/m	Kilovolts per meter
kW	Kilowatts
kWhr	Kilowatt Hour
L ₉₀	The Level of Noise Exceeded for 90% of the Time
lbs	Pounds
L _{dn}	Day-Night Sound Level

LEDs	Light-Emitting Diodes
LGA	New York LaGuardia Airport
L _{eq}	Equivalent Continuous Noise Level
L _{eq(24)}	24-Hour Equivalent Sound Level
L _{max}	Maximum Sound Level
LIPA	Long Island Power Authority
LNG	Liquefied Natural Gas
LOA's	Length Overall
LORAN	Long Range Navigation
LUWW	Land Under Waterbodies and Waterways
m	Meter
m ²	Square Meters
m ³	Cubic Meters
MAFMC	Mid-Atlantic Fishery Management Council
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MARMAP	Marine Resources Monitoring Assessment and Prediction Program
MAS	Massachusetts Audubon Society
MassDEP	Massachusetts Department of Environmental Protection
MassDEP-DWPC	Massachusetts Department of Environmental Protection-Division of Water Pollution Control
MassDMF	Massachusetts Division of Marine Fisheries
MassGIS	Massachusetts Geographic Information System
MassHighway	Massachusetts Highway Department
MATidal	Massachusetts Tidal Energy Company
MBUAR	Massachusetts Board of Underwater Archaeological Resources
MDCR	Massachusetts Department of Conservation and Recreation
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
mG	MilliGauss
mg/L	Milligrams Per Liter
M.G.L.	Massachusetts General Law
MHC	Massachusetts Historical Commission
MHD	Massachusetts Historic District
MHW	Mean High Water
MHz	Megahertz
MLLW	Mean Lower Low Water
mm ²	Square Millimeters
mm	Millimeters
MMA	Massachusetts Maritime Academy
MMPA	Marine Mammal Protection Act
MMR	Massachusetts Military Reservation
MMS	Minerals Management Service
MOU	Memorandum of Understanding
mph	Miles Per Hour
MRA	Multiple Resource Area
MRFSS	Maine Recreational Fisheries Statistics Survey
m/s	Meters Per Second
MSA	Metropolitan Statistical Areas
MSD	Marine Sanitation Device
MSL	Mean Sea Level

MTC	Massachusetts Technology Collaborative
MVA	Megavolt amp
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NCDC	National Climatic Data Center
NDA	No Discharge Areas
NEFMC	New England Fishery Management Council
NEFSC	New England Fisheries Science Center
NEISO	New England Independent System Operator
NEPA	National Environmental Policy Act of 1969
NEPOOL	New England Power Pool
NGVD	National Geodetic Vertical Datum
NHL	National Historic Landmark
NHESP	Natural Heritage and Endangered Species Program
NHPA	National Historic Preservation Act
NIEHS	The National Institute of Environmental Health Sciences
NIH	National Institute of Health
NMFS	National Marines Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries Service	NOAA National Marines Fisheries Service
NOI	Notice of Intent
NO _x	Nitrogen Oxides
NPC	Notice of Project Change
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSA	Noise Sensitive Area
NTHP	National Trust for Historic Preservation
Nysted	Nysted Offshore Wind Farm
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act of 1953
O&M	Operation & Maintenance
OPA	Oil Pollution Act of 1990
OSA	Ocean Sanctuaries Act
OSI	Ocean Surveys, Inc.
OSHA	Occupational Safety and Health Administration
OSRP	Oil Spill Response Plan
OTEC	Ocean Thermal Energy Conversion
OWEC	Ocean Wave Energy Converter
PAL	Public Archaeological Laboratory
PCBs	Polycarbonate Biphenyls
PHL	Philadelphia, Pennsylvania
PM	Particulate Matter
PMSA	Primary Metropolitan Statistical Area
ppm	Parts Per Million
ppt	Parts Per Thousand
psi	Per Square Inch
PSP	Paralytic Shellfish Poisoning
PV	Photovoltaic

PVA	Population Viability Analysis
PVC	Polyvinyl Chloride
REC	Renewable Energy Credit
REIDC	Rhode Island Economic Development Corporation
RF	Radio Frequency
RGGI	Regional Greenhouse Gas Initiative
RIDOT	Rhode Island Department of Transportation
RIEDC	Rhode Island Economic Development Corporation
ROD	Record of Decision
ROI	Region of Impact
ROVs	Remote Operated Vehicles
ROW	Right-Of-Way
RPM	Revolutions Per Minute
RPP	Cape Cod Regional Policy Plan
RPS	Renewable Portfolio Standards
RSP05	2005 Regional System Plan
SAR	Search and Rescue
SAV	Submerged Aquatic Vegetation
SCADA	Supervisory Control and Data Acquisition
Seabees	U.S. Navy Construction Battalion
SHF	Super High Frequency
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SMDS	Scientific Measurement Devises Station
SO ₂	Sulfur Dioxide
SPCC	Spill Prevention Control and Countermeasure
SSA	Steam Ship Authority
SSCS	Seabed Scour Control System
SWPPP	Storm Water Pollution Prevention Plan
T	Tesla
T&D	Transmission and Distribution
T&E	Threatened and Endangered
The Applicant	Cape Wind Associates, LLC
THPO	Tribal Historic Preservation Officer
TISEC	Tidal In-Stream Energy Conversion
TSS	Total Suspended Solids
TRACON	Terminal Radar Approach Control
TV	Television
TWh	Terawatt Hour
UHF	Ultra High Frequency
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	Volts
VFR	Visual Flight Rules
VHF	Very High Frequency

Vibracores	Vibratory cores
V/m	Volts per meter
VOC	Volatile Organic Compounds
VP	Viewpoint
VTR	Vessel Trip Report
WAMS	Waterways Analysis and Management System
WARP	Wind Amplifier Rotor Platform
WEC	Wave Energy Conversion
WPA	Wetlands Protection Act
WPR	Yarmouth Wetlands Protection Regulations
WQC	Water Quality Certification
WTG	Wind Turbine Generators
WTGHA	Wampanoag Tribe of Gay Head/Aquinnah
XLPE	Cross-Linked Polyethylene
yd ³	Cubic Yard
μg/m ³	Micrograms Per Cubic Meter
μT	Microtesla

1.0 INTRODUCTION

1.1 PURPOSE AND NEED

The underlying purpose and need to which the MMS is responding is to provide an alternative energy facility that utilizes the unique wind resources in waters offshore of New England using a technology that is currently available, technically feasible, and economically viable, that can interconnect with and deliver electricity to the New England Power Pool (NEPOOL), and make a substantial contribution to enhancing the region's electrical reliability and achieving the renewable energy requirements under the Massachusetts and regional renewable portfolio standards (RPS).

Cape Wind Associates, LLC (the applicant) proposes to build, operate, and eventually decommission a wind energy facility with a maximum electric output of 468 megawatts (MW) in Nantucket Sound off the coast of Massachusetts. The proposed action would generate electricity from wind energy resources on the Federal OCS. The applicant seeks to commence construction of the proposed action in 2009 and begin full operation in 2011.

The applicant requests a lease, easement, right-of-way (ROW) and any other related approvals from Minerals Management Service (MMS) necessary to authorize construction and operation of the proposed action. The MMS's authority to approve, deny, or modify the Cape Wind Energy Project derives from the Energy Policy Act of 2005 (EPAAct – <http://www.mms.gov/2005EnergyPolicyAct.htm#Renewables>). Section 388 of the EPAAct amended the OCS Lands Act by adding subsection 8(p), which authorizes the Department of the Interior (DOI) to grant leases, easements or ROWs on OCS lands for activities that produce or support production, transportation, or transmission of energy from sources other than oil and gas, such as wind power.

The Massachusetts and other regional RPSs mandate that a certain amount of electricity come from renewable energy sources, such as wind. Specifically, the Massachusetts RPS regulations at 225 CMR 14.00 require that all retail electricity providers in the state utilize new renewable energy sources for at least 2.5 percent of their power supply in 2006 and increasing this percentage to 4 percent by 2009.

Since 1995, the Massachusetts Energy Facilities Siting Board (EFSB) has authorized more than a dozen fossil fueled power plants with nominal generating capacities that range from approximately 200 MW to 1500 MW, with an average generating capacity of approximately 500 MW. The applicant seeks to construct a similar large size "commercial" scale project that would satisfy a substantial portion of the projected Massachusetts 2009 RPS requirements¹, while also providing the generation capacity needed to respond to the magnitude of the regional reliability requirements.²

The NEPOOL operates as a tightly integrated system for purposes of both dispatch and compliance with reliability standards, including standards as to adequacy of generation resources. The Independent System Operation New England (ISO-NE) 2005 Regional System Plan (RSP05) for NEPOOL considered the constraints upon potential energy imports into NEPOOL and found that in order to adequately supply

¹ Based on the distribution of wind speeds monitored at the site, the net annual energy production the proposed action would deliver to the regional transmission grid would be 1,600 giga watt hours (GWh) (equivalent to an average of 182.6 MW), which would be approximately 75 percent of the 2009 projected RPS requirement of 2,100 GWh (2004, MA RPS Annual Compliance Report).

² NEISO conducted a system-wide analysis of energy demand and concluded that New England needs approximately 170 MW of additional electricity production resources before the summer of 2010 and increasing annually to 2100 MWs of additional capacity by 2014 to meet New England's electricity reliability requirements (ISO Regional System Plan, 2005).

operable capacity, New England will need to begin to supply its own resources and rely less heavily on neighboring systems for capacity during the 2009 through 2013 planning period (ISO-NE, 2005).

The EFSB found there was a need for at least 110 MW of energy resources beginning in 2007 with a much greater need within the following years (EFSB Siting Decision, 2004). The EFSB also found a need in New England for the capacity that would be provided by the proposed action for reliability and economic purposes.

The New England region is heavily dependent on natural gas to meet its increasing demand for energy. In New England natural gas accounts for 18 percent of the region's total energy consumption and approximately 40 percent of the fuel used to generate electricity, and consumption of natural gas is expected to increase 31.6 percent by 2024 (The Power Planning Committee of the New England Governor's Conference, 2005). In addition, more than 9,000 MW of planned gas-fired power plants are considered likely to be built in New York, Ontario, and Quebec, which would in turn compete with New England's limited gas supply and delivery infrastructure. The ISO-NE has stated that over-reliance on natural gas subjects the New England region to substantial price fluctuations that are influenced by a variety of market-based factors (i.e., exercising of natural gas contractual rights, tight gas spot-market trading), and physical factors (i.e., pipeline maintenance requirements and limited pipeline capacity). Over-reliance on natural gas and other fossil fuel sources (e.g., coal) for the generation of electricity also subjects the region to adverse air quality impacts associated with ground level ozone. There is, therefore, a need for projects in New England that aid in diversifying the region's energy mix in a manner that does not significantly contribute to the region's existing air quality concerns.

In summary, this draft Environmental Impact Statement (draft EIS) assesses the physical, biological and socioeconomic, and human impacts of this proposed action and all reasonable alternatives, including no action, in an objective fashion in order to determine if the proposal is environmentally sound. A final decision would account for the regional, state and local benefits and impacts as well as for the overall public interest of the United States.

1.2 STATUTORY AND REGULATORY FRAMEWORK

The following information provides a discussion of Federal and State reviews required, including legal authority, jurisdiction of the agency, and the regulatory process involved. The information is also summarized in [Table 1.2-1](#).

1.2.1 Federal Review

1.2.1.1 Outer Continental Shelf Lands Act of 1953 (OCSLA) as Amended on August 8, 2005

In November 2001, the applicant filed a permit application with the U.S. Army Corps of Engineers (USACE), New England District, under Section 10 of the Rivers and Harbors Act of 1899, in anticipation of constructing a wind energy facility located on Horseshoe Shoal in Nantucket Sound, Massachusetts. However, the EPA³ amended the OCSLA (67 Stat. 462, as amended, 43 U.S.C. §1331 et seq.) to grant primary authority to the DOI to authorize alternative energy projects on the OCS (43 U.S.C. 1337(p)(1)(C7)). The Secretary of the Interior has delegated primary responsibility for the environmental analysis and regulatory oversight of such projects, including the proposed action, to the MMS.

³ Enacted on August 8, 2005.

The applicant requested from MMS a lease, easement, ROW and any other related approvals to construct and operate the proposed action located on Federal submerged lands offshore of Cape Cod, Massachusetts. This draft EIS is prepared relevant to the authority granted to the Secretary of the Interior under Section 388 of the EAct (Pub. L. 109-058) and in accordance with the National Environmental Policy Act of 1969 (NEPA).

1.2.1.2 National Environmental Policy Act of 1969

The NEPA of 1969 (42 U.S.C. 4321 *et seq.*) was implemented to ensure that Federal agencies consider the environmental impacts of their actions, and protect the quality of the environment through consideration of alternatives that would serve to avoid or minimize damage to the environment. The Council on Environmental Quality (CEQ) Regulations for implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508) state that Federal agencies shall integrate the NEPA process at the earliest possible time to ensure that the agency makes informed permitting decisions to avoid delays later in the process, and to head off potential conflicts.

The NEPA requires that Federal agencies produce detailed statements on the environmental impacts of proposed major Federal actions significantly affecting the quality of the human environment. On May 30, 2006, the MMS published a Notice of Intent (NOI) to prepare an EIS in the *Federal Register* (FR) requesting written scoping comments and inviting participation by cooperating agencies. As the lead agency in the NEPA process, the MMS is required to prepare the draft EIS, accept public and agency comments, and produce a Record of Decision (ROD). Based on the findings of the NEPA documentation and other information, the MMS would determine whether to authorize the proposed action.

1.2.1.3 Section 10 of the Rivers and Harbors Act of 1899, and Section 404 of the Clean Water Act (CWA)

Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401 *et seq.*) prohibits the unauthorized obstruction or alteration of any navigable water of the U.S. The construction of any structure in or over any navigable water of the U.S., the excavating from or depositing of dredged material or refuse in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful without prior approval from the USACE. The legislative authority to prevent inappropriate obstructions to navigations was extended to installations and devices located on the seabed to the seaward limit of the OCS by Section 4(e) of the OCSLA of 1953, as amended.

Section 404 of the CWA (33 U.S.C. §1344) prohibits discharges of dredge or fill material into waters of the United States, including wetlands without a permit from the USACE. Waters of the United States include those waters and their tributaries, adjacent wetlands, and other waters or wetlands where degradation or destruction could affect interstate or foreign commerce. Section 404 of the CWA defines the landward limit of jurisdiction as the high tide line in tidal waters and the ordinary high water mark as the limit in non-tidal waters. When adjacent wetlands are present, the limit of jurisdiction extends to the limit of the wetland. The seaward limit is the 3.5-mile (5.6 km) state limit.

The installation of the Wind Turbine Generators (WTGs) and ESP, the installation of the submarine cable systems, and the cable landfall transition structures would be subject to regulatory permitting review and approvals under Section 10 jurisdiction, because the proposed action would be located in designated navigable waters of the United States.

An Individual Permit application requesting Section 10 approval was filed on November 21, 2001, and the applicant provided the USACE with information with respect to project modifications on June 30, 2005. In addition, the applicant will be required to update the USACE application to reflect Section 404 jurisdiction, which would be triggered as a result of the backfilling of a dredged area in the ocean. The

dredged area would be temporarily used for the horizontal directional drill operations associated with the installation of the submarine transmission cable where it comes ashore and then backfilled after construction is completed (see Section 2.3.6).

Note that in November 2001, the applicant filed an application with the USACE under the Rivers and Harbors Act of 1899 (“Section 10 Permit”) to construct and operate a Scientific Measurement Devices Station (SMDS) in Nantucket Sound. The USACE issued a Section 10 Permit for the SMDS on August 19, 2002, stating that “the data tower shall be completely disassembled and removed from the waterway within five years of the start of construction.” On August 3, 2006, the applicant requested that the USACE modify the condition in the Section 10 Permit to require the removal of the SMDS by October 31, 2012, and the USACE approved the time extension.

1.2.1.4 Clean Water Act - National Pollutant Discharge Elimination System

The U.S. Environmental Protection Agency (USEPA) is responsible for implementing certain provisions of the CWA regulations, 40 CFR Part 122 to 125. The CWA prohibits the discharge of pollutants into waters of the United States unless a National Pollutant Discharge Elimination System (NPDES) permit has been issued (33 U.S.C. § 1342). The NPDES storm water permit program requires operators of a construction site one acre or larger to obtain authorization to discharge storm water under a NPDES Construction Storm Water Permit. The overall goal of this permit is to protect the quality and beneficial uses of the surface water resources from pollution in storm water runoff from construction activities. This goal is achieved through the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) and associated Best Management Practices (BMPs).

Installation of the proposed onshore transmission lines and associated components would require a NPDES General Stormwater Construction permit. The proposed onshore transmission line route is approximately 5.9 miles (9.5 kilometers [km]) in length and therefore construction activities would result in the alteration of more than one acre. A NPDES NOI for construction activities that includes general project information and certification that the activity would not impact endangered or threatened species would be submitted to the NPDES permitting authority. An application for a NPDES General Stormwater Construction Permit would be filed prior to commencement of construction.

1.2.1.5 Section 7627 of the Clean Air Act (CAA)

The USEPA is also responsible for implementing sections of the CAA (42 U.S.C. 7627) relating to air emissions from certain OCS activities. Section 7627 was added to the CAA by amendment in 1990 in order to establish requirements for controlling air emissions from “sources” on the OCS in order to attain and maintain Federal and State ambient air quality standards. The regulations of the USEPA under Section 7624 (40 CFR 55.1, et seq.) define an “OCS Source” subject to such provisions as any equipment, activity, or facility that: (1) emits or has the potential to emit any air pollutant; (2) is regulated under the OCSLA; and (3) is located on the OCS or in or on waters above the OCS. With respect to vessels, Section 55.2 of the Regulations specifies that vessels shall not constitute an “OCS Source” unless they are: (1) permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources there; or (2) physically attached to an OCS facility. It further provides, however, that the emissions of vessels associated with an OCS Source shall be considered direct emissions of such a source while at the source, and while en route to or from the source when within 25 miles (40.2 km) of the source.

The applicant is seeking a permit from the USEPA under the foregoing provisions for its activities on the OCS during construction. During the operational phase, there would also be equipment and activities that would emit air pollutants or constitute an “OCS Source” and would be subject to EPA permitting.

Section 55.4 of the USEPA regulations requires an applicant to submit an NOI to the USEPA, with copies to the air pollution control agencies of the nearest onshore areas adjacent, not more than 18 months prior to submitting an application for a preconstruction USEPA permit. The NOI information includes the facility description and estimates of potential emissions, and emissions from vessels associated with the proposed OCS Source when at or en route to or from the OCS Source, as referenced above. The applicant filed an NOI with the USEPA on December 7, 2007. The EPA will review the NOI and determine whether air modeling is required, and coordinate the establishment of an appropriate air quality modeling protocol as necessary.

1.2.1.6 United States Code 49, Section 44718

The Federal Aviation Administration's (FAA's) authority to promote the safe and efficient use of the navigable airspace, whether concerning existing or proposed structures, is predominantly derived from 49 U.S.C. 44718. Title 14, CFR, Part 77, Objects Affecting Navigable Airspace, was adopted to establish notice criteria for proposed construction or alteration that would protect aircraft from encountering unexpected structures. The regulations apply to structures located within any state, territory, or possession of the United States, within the District of Columbia, or within territorial waters (13.8 miles [22.2 km]) surrounding such states, territories, or possessions.

Any vertical structure greater than 200 feet (ft) (61 meters [m]) in height must have FAA approval to avoid or minimize obstruction to navigable air space. The height of individual WTGs would exceed this 200-foot threshold (overall height of 440 ft [134 m] mean sea level [MSL]), and therefore require FAA approved lighting/markings. All 130 WTGs are subject to FAA review and authorization. On September 25, 2002, the applicant filed a Notice of Proposed Construction or Alteration (FAA Form 7460-1) with the FAA, pursuant to 14 CFR Part 77, Objects Affecting Navigable Airspace, for each proposed WTG location. The FAA issued a Determination of No Hazard to Air Navigation on April 9, 2003 ([Appendix E](#)).

On August 27, 2004 the applicant requested an extension on the April 9, 2003 Determination due to delays in obtaining permits to start construction. The FAA granted the extensions on October 5, 2004. The FAA initiated an appeal of the original April 9, 2003 determinations based on their receipt of two petitions requesting discretionary review of the determinations. The FAA reviewed the new information submitted and upheld the original Determinations on February 2, 2005. As a result of the reconfiguration of the WTG's, design changes that increased rotor height from 417 ft (127 m) to 440 feet (134 m), and the release of new lighting guidelines by the FAA, the MMS has requested a new letter from FAA to confirm that the proposed turbine locations would not have a negative impact on aviation.

1.2.1.7 U.S. Coast Guard (USCG) Regulations

Pursuant to 33 CFR part 66.0, Subpart 66.01 and under the provisions of 46 U.S.C. and 33 U.S.C. 30, the USCG has safety and regulatory jurisdiction over projects located in navigable waters of the United States. The proposed action constitutes a fixed structure in navigable waters of the United States, which requires private aids to navigation marking. A permit application to establish and operate Private Aid-to-Navigation to a Fixed Structure has not yet been filed.

All 130 WTGs and the ESP are subject to USCG review for authorization to mark and light the WTGs and ESP. The USCG Marine Safety Office for the Port of Providence, Rhode Island, which has jurisdiction over general navigation in the site of the proposed action, has coordinated a Navigational Risk Assessment. This Risk Assessment prepared at the direction of, and in consultation with, the USCG Marine Safety Office at the Port of Providence provides a qualitative assessment of navigational risks related to the proposed action. The analyses required by the USCG are outlined in a letter to the USACE dated February 10, 2003 ([Appendix E](#)). Subsequent to the release of the draft EIS/draft Environmental

Impact Report (draft EIR) in November of 2004, the applicant was required to revise the 2003 Navigational Risk Assessment to incorporate design changes and new information and to address topics requested by the USCG in its letter of February 14, 2005.

1.2.1.8 USCG Reauthorization Act of 2006

Section 414(a) of the Coast Guard and Maritime Transportation Act of 2006 (Public Law 109-241, H.R. 5681) requires the Commandant of the Coast Guard to “not later than 60 days before the date established by the Secretary of the Interior for publication of a draft environmental impact statement...specify the reasonable terms and conditions... necessary to provide for navigational safety with respect to the proposed lease, easement, or ROW and each alternative to the proposed lease, easement, or ROW considered by the Secretary (of the Interior).” The USCG has provided terms and conditions (see [Appendix E](#)) in response to this Congressional mandate. The terms and conditions are considered by the Coast Guard to be reasonable and the minimum necessary to provide for navigational safety. The provision of the terms and conditions to MMS does not imply or indicate that the Coast Guard summarily approves or disapproves of the proposed action.

1.2.1.9 Executive Order 12898

The USEPA Headquarters Office of Environmental Justice defines environmental justice as the following:

“Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.” (Executive Order 12898, February 11, 1994)

The need to perform an environmental justice analysis for the proposed action is related to the establishment of Executive Order 12898, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations” (February 11, 1994). The order requires Federal agencies to consider disproportionate adverse human health and environmental impacts on minority and low-income populations.

The focus of an environmental justice analysis is the determination of whether the construction and operation of a proposed action would have both adverse and disproportionate impacts on minority and low income populations. Minority populations are generally defined by USEPA as areas that have a “meaningfully greater” percent of minorities than the general population in the surrounding area, and low income populations are defined based on the U.S. Census poverty statistics. In performing the environmental justice analysis, the MMS has used the methodology in USEPA’s “Final Guidance for Incorporating Environmental Justice Concerns in USEPA’s NEPA Compliance Analyses, April 1998.” Refer to the results of the Environmental Justice Review that are provided in the Socioeconomic section at 5.3.3.3. Information on agency consultations is provided in Section 7.0.

1.2.1.10 Coastal Zone Management Act Federal Consistency Review

Pursuant to 16 USC 1454 and 1465, the Coastal Zone Management Act (CZMA) requires that it be national policy to preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation’s coastal zone. The mapped coastal zone of Massachusetts includes the lands and waters

within an area defined by the seaward boundary of the state's mapped territorial sea (generally 3.5 miles [5.6 km] from shore), extending from the Massachusetts/New Hampshire border south to the Massachusetts/Rhode Island border, and landward to 100 ft (30.5 m) inland of specified major roads, rail lines, or other visible ROWs. The coastal zone includes all of Cape Cod, Martha's Vineyard and Nantucket. Federal consistency jurisdiction extends to any federally licensed or permitted activities occurring in the OCS that may have a reasonably foreseeable effect on land or water uses or natural resources of the Massachusetts coastal zone (15 CFR 930.11(b)). The applicant filed with the Massachusetts Executive Office of Environmental Affairs, Coastal Zone Management Program for a Federal Consistency Certification on November 21, 2001. The consistency review (CZMA) is currently ongoing and being coordinated with the MMS.

MMS is also coordinating consistency review (CZMA) with the Rhode Island Coastal Resources Management Council. The Rhode Island Coastal Resources Management Council has requested that the applicant file for Federal Consistency Certification in Rhode Island to address work associated with the staging area in Quonset and any transportation of equipment that takes place in Rhode Island waters.

1.2.1.11 Oil Pollution Act of 1990

The Oil Pollution Act of 1990 (OPA) (33 U.S.C. 2701 to 2761) amended the CWA and addressed the wide range of problems associated with preventing, responding to, and paying for oil pollution incidents in navigable waters of the United States. It created a comprehensive prevention, response, liability, and compensation regime to deal with vessel- and facility-caused oil pollution to U.S. navigable waters. The OPA greatly increased federal oversight of maritime oil transportation, while providing greater environmental safeguards by: setting new requirements for vessel construction and crew licensing and manning, mandating contingency planning, enhancing federal response capability, broadening enforcement authority, increasing penalties, creating new research and development programs, increasing potential liabilities, and significantly broadening financial responsibility requirements. The OPA requires oil storage facilities and vessels to submit to the Federal government plans detailing how they will respond to large discharges. The OPA also requires the development of Area Contingency Plans to prepare and plan for oil spill response on a regional scale.

1.2.1.12 Endangered Species Act (ESA)

Section 7 of the ESA (P.L. 93-205, 16 U.S.C. 1531 et seq.) directs all federal agencies to use their existing authorities to conserve threatened and endangered (T&E) species and, in consultation with the USFWS, to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7(a) of the Endangered Species Act requires that Federal agencies ensure that activities they authorize, fund or carry out do not jeopardize the continued existence of listed species nor adversely modify any designated critical habitat of such species. In regards to the proposed action, MMS has been in informal consultation under Section 7(a)(2) of the ESA with both the FWS and NMFS since January 2006. MMS plans to initiate formal consultation under Section 7(a)(2) of the ESA following the date of the DEIS publication.

1.2.1.13 The Marine Mammal Protection Act (MMPA)

The MMPA of 1972 (16 U.S.C. 1361 et seq.) prohibits, with certain exceptions, the taking of marine mammals in United States waters and on the high seas, and the importation of marine mammals and marine mammal products into the U.S. Congress defines "take" as "harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal."

The primary government agency responsible for enforcing the MMPA is the NOAA Fisheries Service (formerly the National Marine Fisheries Service), found in the Department of Commerce, National

Oceanic and Atmospheric Administration (NOAA). Under the MMPA, the Secretary of Commerce is responsible for ensuring the protection of cetaceans (whales, porpoises, and dolphins) and pinnipeds (seals and sea lions) except walruses. MMS has been informally consulting with NOAA Fisheries regarding the applicant's proposal since January 2006. This has included individual phone calls and emails between MMS and NOAA Fisheries. The Secretary of the Interior is responsible for ensuring the protection of sea otters, polar bears, walruses, and manatees. The species of marine mammals overseen by the Secretary of the Interior do not normally occur in the area of the proposed action. MMS notes that there is no required consultation under the MMPA between MMS and NOAA Fisheries/FWS and it is the responsibility of the applicant to seek authorization from these agencies under the MMPA (if needed). In addition to encouraging voluntary consultation, MMS will help ensure compliance with the MMPA by requiring that any authorizations deemed necessary by NOAA Fisheries and FWS are completed prior to the commencement of activities under MMS purview.

1.2.1.14 The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act)

The purposes of the Magnuson-Stevens Act (P.L. 94-265, 16 U.S.C. 1801 et seq.) are to take action to conserve and manage the fishery resource off the U.S. coasts; manage the U.S. anadromous species and continental shelf fishery resources; support the implementation and enforcement of international fishery agreements for the conservation and management of highly migratory species; promote domestic commercial and recreational fishing under sound conservation and management principles; provide for preparation and implementation of fishery management plans to achieve and maintain the optimum yield of each fishery on a continuing basis; establish Regional Fishery Management Councils to protect fishery resources through preparation, monitoring, and revision of plans that allow for participation of states, fishing industry, consumer and environmental organizations; encourage the development of underutilized U.S. fisheries; and promote the protection of essential fish habitat (EFH). To promote the protection of EFH, Federal agencies are required to consult on activities that may adversely affect designated EFH. The responsible agency is NOAA Fisheries, Department of Commerce. An EFH assessment for the proposed action has been prepared by MMS and can be found in [Appendix D](#). This assessment includes a list and description of species with designated habitat, potential impacts to those species and their habitat, and proposed mitigation.

1.2.1.15 Migratory Bird Treaty Act and Migratory Bird Executive Order 13186

The Migratory Bird Treaty Act (16 U.S.C. 703-712) is a domestic law that implements the United States' commitment to international conventions with Canada (1916), Mexico (1936), Japan (1972) and Russia (1978) for protection of shared migratory bird resources (USFWS, 2002). The Act prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the Act has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as wind turbines even if all reasonable measures to avoid it are implemented. The USFWS Office of Law Enforcement carries out its mission to protect migratory birds through investigations and enforcement, and also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the Act to absolve individuals, companies, or agencies from liability if they follow recommended interim guidelines established by USFWS, May 13, 2003, the Office of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals, companies, or agencies who have made good faith efforts to avoid the take of migratory birds.

The Migratory Bird Executive Order 13186 of 2001 is a step in the creation of a more comprehensive strategy for migratory bird conservation by the Federal government (USFWS, 2007). The Executive Order provides a specific framework for the Federal government's compliance with treaty obligations to Canada, Mexico, Japan, and Russia.

The Migratory Bird Executive Order 13186 of 2001 requires any Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement, within 2 years, a Memorandum of Understanding (MOU) with the USFWS that shall promote the conservation of migratory bird populations. The MOU shall support the conservation of migratory birds through integrating bird conservation principles, measure and practices into agency activities and by avoiding or minimizing the impacts of activities to migratory birds. In addition, it shall restore and enhance the habitat of migratory birds, as practical; prevent or minimize the pollution or destruction of the environment for the benefit of migratory birds; design migratory bird habitat and population conservation principles, measures and practices into agency plans and planning processes; ensure environmental analyses of Federal actions or other environmental review processes; evaluate the effects of actions on migratory birds; and promote research and information exchange related to the conservation of migratory birds. All proposed actions by agencies must adhere to the MOU.

The USFWS would lead coordination and implementation of the Executive Order and the Act and provide training opportunities to other Executive Branch agencies and departments. An interagency Council for the Conservation of Migratory Birds would monitor and oversee progress in the implementation of the Executive Order. The Council is to include representation, at the bureau director/administrator level, from the Departments of the Interior, State, Commerce, Agriculture, Transportation, Energy, Defense, USEPA, and from such other agencies as appropriate.

1.2.1.16 National Historic Preservation Act (NHPA)

The goal of the NHPA (P.L. 89-665, 16 U.S.C. 470, et seq.), established in 1966, is to have federal agencies act as responsible stewards of our nation's resources when their actions affect historic properties. Section 106 of the NHPA requires MMS to take into account the effects of the projects that it approves on properties listed on or eligible for listing on the National Register of Historic Places (NRHP), including prehistoric or historic sites, districts, buildings, structures, objects, or properties of traditional religious or cultural importance, and to afford the Federal Advisory Council on Historic Preservation (ACHP) an opportunity to comment on the proposed action.

MMS worked with the National Trust for Historic Preservation to develop the methodology used in the Historic Properties analysis (Section 5.3.3.5). It was determined that three properties could be impacted adversely by the proposed action. Upon release of the draft EIS, MMS will consult with the necessary entities (State Historic Preservation Officer [SHPO], Tribal Historic Preservation Officer [THPO], National Trust for Historic Preservation [NTHP], local government, etc.) under Section 106 of the Historic Preservation Act in order to develop appropriate mitigation.

1.2.2 State Regulatory Permitting and Consistency

1.2.2.1 Massachusetts Environmental Policy Act (MEPA)

The MEPA (G.L.c.30 §§ 61 through 62H, 301 CMR 11.00) jurisdiction occurs when an entity undertakes certain activities in the Commonwealth of Massachusetts that requires one or more State permits but does not involve financial assistance. The scope of an Environmental Impact Report (EIR) document, if required, is generally limited to those aspects within the subject matter of any required State permits that are likely, directly or indirectly, to cause damage to the environment. The MEPA review

process includes an alternative analysis, environmental impact assessments, analyses of consistency with applicable state regulations and policies, and implementation of appropriate mitigation measures.

The applicant filed an Environmental Notification Form with the MEPA Office on November 15, 2001. The Secretary of Environmental Affairs issued an ENF Certificate on April 22, 2002 calling for an EIR and defining the scope of the required EIR. On May 28, 2003, the Secretary expanded the Scope of the April 22, 2002 EIR requirements to include Chapter 91 variance considerations and the Massachusetts Ocean Management Initiative. The applicant filed a draft EIR with the MEPA Office on November 15, 2004. The Secretary issued a DEIR Certificate on March 3, 2005 calling for a Notice of Project Change (NPC) and a final EIR, defining the scope of the required final EIR ([Appendix E](#)).

A NPC was filed with the MEPA office on June 30, 2005. The change involved the relocation of turbines from state waters to Federal waters due to changes in the state territorial 3.5 mile (5.6-km) limits. The effect of the boundary change expanded the 3.5 mile (5.6 km) state territorial boundary further into Nantucket Sound, resulting in 10 proposed turbine locations and an additional 1 mile (1.6 km) of 115 kV submarine cable system falling within the new boundary. MEPA issued a Certificate on the Final EIR on March 29, 2007 (see [Appendix E](#)).

1.2.2.2 Energy Facility Siting Board (EFSB) Review

The EFSB is an independent state review board within the Department of Public Utilities (DPU). The EFSB reviews proposals to construct certain energy facilities, including large power plants, electric transmission lines, and natural gas pipelines. Pursuant to G.L. Chapter 164, § 69J and the regulations at 980 CMR 1.00, 2.00, 6.00, and 9.00, no applicant shall commence construction of a “facility” unless a petition for approval of construction has been granted by the EFSB. Pursuant to G.L. Chapter 164, § 69G, a jurisdictional “facility” includes “a new electric transmission line having a design rating of 69 kV or more and which is one mile or more in length on a new transmission corridor.”

In accordance with G.L. c. 164, § 69H, the EFSB is responsible for implementing energy policies to provide a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost. When reviewing proposals to construct electric transmission lines, the EFSB is required to consider several things. First, it must evaluate the need for new transmission resources. Second, it must consider whether activities will be consistent with the enforceable policies of Massachusetts coastal management plan.

The applicant and Commonwealth Electric Company d/b/a NSTAR Electric filed a joint Petition to the EFSB, on September 17, 2002, for an approval of construction for a new electric transmission line located within the mapped 3.5-mile (5.6 km) state territorial sea boundary. The Petition was for electric transmission lines to serve the public interest by transmitting wind-generated alternative energy to the Commonwealth of Massachusetts and New England from the offshore proposed action located in Federal waters in Nantucket Sound. The Petition sought approval for construction of the two jurisdictional 115 kV transmission lines approximately 18 mile (29 km) and 12.5 mile (20.1 km) within the Massachusetts Coastal Zone in length in order to transmit the generated electricity to the New England transmission grid.

In their May 11, 2005 Final Decision⁴, the EFSB approved the joint petition of the applicant and NSTAR Electric to construct two new 115 kV electric transmission lines, approximately 18 mile (29 km) in length, for the purpose of interconnecting a proposed offshore wind energy generating facility in Nantucket Sound with the regional electric grid in New England. This decision was upheld on appeal in December 2006.

⁴ The Final Decision can be downloaded from the DPU’s website at http://www.mass.gov/dte/siting_board.htm.

In addition to the above approval, the applicant filed a petition on November 21, 2007 with the Massachusetts EFSB for a Certificate of Environmental Impact and Public Interest to provide for an exemption from Cape Cod Commission review.

1.2.2.3 Massachusetts Chapter 91 Waterways Regulations

The Massachusetts Department of Environmental Protection (MassDEP) requires written authorization in the form of a license or permit to perform any construction, placement, excavation, addition, improvement, maintenance or removal of any fill or structures in tidelands or other waterways of the Commonwealth. The geographic areas subject to Chapter 91 jurisdiction include certain filled tidelands, flowed tidelands, and submerged lands out to the mapped, 3.5-mile (5.6-km) state territorial sea boundary.

In Chapter 91, the Massachusetts Waterfront Act (G.L. c. 91, 310 CMR 9.00), the Legislature specified its intention to protect the rights of the public in tidelands by ensuring that the uses and activities of tidelands are limited to water-dependent uses or otherwise serve a proper public purpose. The basic goals of the Waterways Program administered by MassDEP include protecting and promoting tidelands for fishing, shipping, marine transportation, infrastructure facilities, marine terminals, and other activities and facilities that cannot reasonably be located away from tidal or inland waters.

Chapter 91 jurisdiction applies to the proposed action relative to the installation and construction of the proposed submarine transmission cables located in and over the submerged lands and flowed tidelands of the Commonwealth in Lewis Bay and Nantucket Sound, as well as the intertidal shoreline area of Lewis Bay at the proposed cable landfall location in the Town of Yarmouth. These cables are located within the Massachusetts Cape and Islands Ocean Sanctuary (CIOS). The applicant filed a Chapter 91 Waterways License application on December 13, 2004.

1.2.2.4 Massachusetts Water Quality Certification (WQC) Regulations

The MassDEP requires that any dredging or dredged material disposal of more than 100 cubic yards (yd³) must obtain a WQC pursuant to 314 CMR 9.04(12) and is subject to the criteria at 314 CMR 9.07 and the requirements at 314 CMR 4.00 (314 CMR 4.00 and 314 CMR 9.00 are adopted pursuant to § 27 of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26 through 53).

The transition of the interconnecting 115 kV submarine transmission lines from water to land would be accomplished through the use of horizontal directional drilling (HDD) methodology. To facilitate the HDD operation, a temporary cofferdam would be constructed at the end of the boreholes. The cofferdam would be approximately 65 ft (20 m) wide and 45 ft (14 m) long and would be open at the seaward end to allow for manipulation of the HDD conduits. Approximately 840 yd³ of sediment would be dredged from within the cofferdam pit temporarily and replaced upon completion of the submarine cable system. No removal of sediment outside of the cofferdam would be required. This dredging and backfilling component would be subject to a 401 Water Quality Certificate. In addition, a Section 401 Water Quality Certificate would also be required for the jet plow embedment of the submarine cable. A 401 WQC application was filed with the MassDEP on November 2, 2007.

1.2.2.5 Massachusetts Highway Department (MassHighway) Access Agreements and Massachusetts General Law (M.G.L.) Chapter 30, Section 61 Findings

The MassHighway primary responsibilities are the design, construction, and maintenance of the Commonwealth's state highways and bridges. The MassHighway jurisdiction would apply to the installation of the onshore transmission line route via trenchless technologies (i.e., HDD, horizontal

boring, or pipe jacking) under the State highways Route 28 and Route 6. In addition, the applicant would require MassHighway access agreements for maintenance access to the onshore cable system occurring within state highway ROWs.

The applicant is required to file a Permit to Access State Highway from the MassHighway. Engineering plans and specifications must show that there is safe and efficient access to the state highways thereby protecting the operational integrity of these roadways. Plan review and approval are based on the standards presented in the Manual on Uniform Traffic Control Devices, and any technical policies issued by MassHighway. The applicant must also receive the M.G.L. Chapter 30, Section 61 findings of MassHighway. The applicant filed for an Application for a Permit to Access State Highway on November 1, 2007.

1.2.2.6 M.G.L c. 9 § 27C and Chapter 254 of the Acts of 1988, Per Regulations at 950 CMR 70.00 and 71.00

The Massachusetts Historical Commission (MHC) was established by legislature in 1963 to identify, evaluate, and protect the historical and archaeological assets of the Commonwealth and maintain the State Register of Historic Places. The MHC contains 18 members appointed by the Governor and the Secretary of State. The Secretary of State serves as the MHC chair and appoints the State Archaeologist, who issues permits for onshore archaeological field investigations. The Massachusetts Board of Underwater Archaeological Resources (MBUAR), part of the Executive Office of Environmental Affairs (EOEA), issues permits for underwater archaeological investigations in state waters. These entities ensure field investigations are conducted to applicable standards. The MHC contains the office of the SHPO, who is designated by the Federal Secretary of the Interior to implement Section 106 of the NHPA, as amended. The SHPO nominates significant historic resources in Massachusetts to the NRHP, and reviews Federal projects for their impact on historic properties, in accordance with Section 106 and the Federal regulations of the ACHP.

The MHC provides comments to EOEA, under M.G.L c. 9 § 27C and Chapter 254 of the Acts of 1988, per regulations at 950 CMR 70.00 and 71.00. The MHC advises EOEA as to the presence or absence of significant archaeological or historic resources that could be affected within the state territorial boundaries, and, if those effects are determined to be adverse, would comment on measures to avoid, minimize and/or mitigate those effects. The MHC has been invited to participate as a cooperating agency in the preparation of this draft EIS.

1.2.2.7 Section 1856 of the Magnuson-Stevens Act

Massachusetts Division of Marine Fisheries (MassDMF) is primarily responsible for the protection and enhancement of the Commonwealth's marine fishery resources and for the promotion and regulation of commercial and sport fishing. In addition, for the exclusive purpose of managing highly migratory and OCS fishery resources, state regulatory jurisdiction extends to that part of the pocket of water west of the seventieth meridian west of Greenwich in Nantucket Sound necessary to establish consistent fishing regulations throughout the Sound.

During the MEPA Review Process, the MassDMF performed an analysis of proposed action effects on existing fisheries resources. In addition, MassDMF also reviewed and considered potential effects of the proposed action on highly migratory and/or OCS fishery resources.

The proposed action area is designated as EFH for several fishery resources. An EFH assessment is attached in [Appendix D](#) to address the requirements of the Magnuson-Stevens Act. In addition, MassDMF will have the opportunity to participate and comment on the EFH Assessment process under the MMS NEPA process.

1.2.2.8 302 CMR 5.00 and M.G.L. c. 132A, §§ 13, 16 and 18

The Massachusetts Department of Conservation and Recreation (MDCR) is responsible for the protection of the ecology and appearance of the waters in the five (5) state-designated ocean sanctuaries (out to the mapped 3.5 mile state territorial sea boundary) pursuant to 302 CMR 5.00 and M.G.L. c. 132A, §§ 13, 16 and 18. Portions of Nantucket Sound are located within the CIOS.

The WTG array, inner-array cables and ESP would be located outside of MDCR's Ocean Sanctuaries' jurisdiction. However, portions of the submarine cable connecting the ESP to the landfall would be within the CIOS.

No separate permit or authorization is required by the Ocean Sanctuaries Act (OSA); rather the provisions of the OSA are implemented by the state agencies with permitting authority for a project subject to the OSA, for example, the EFSB, MassDEP (Chapter 91) and the Massachusetts CZMP review process. A transmission line is a permitted use in an Ocean Sanctuary if approved by the EFSB pursuant to the OSA at c.132A §16 and 3.02 CMR 5.08(3).

1.2.2.9 Interconnection Approval by ISO-NE

In New England, the connection of a bulk power generation system into the electricity grid requires a System Impact Study to assess the impact on functionality and reliability of the grid electric system and to assess what if any improvements need to be made to the electric system to safely accommodate the proposed action. On April 2, 2002, the applicant entered into a System Impact Study Agreement with ISO-NE, the independent operator of New England's bulk power generation and transmission system. On October 6, 2005, ISO-NE approved the applicant's application for interconnection pursuant to Section I.3.9 of ISO-NE Transmission, Markets and Services Tariff. The applicant, by letter dated June 19, 2006, requested that ISO-NE revise the projected Commercial Operation Date and Initial Synchronization Date for the Cape Wind Project. On November 9, 2006, the ISO-NE granted the applicant's request to revise the Commercial Operation Date of the Cape Wind Project to November 2010 and the Initial Synchronization Date to June 2009.

1.2.2.10 Compliance with 1997 Electric Utility Industry Restructuring Act (EUIRA)

The EUIRA at Section 50, codified at G.L. c. 25A §11F, introduced a State RPS that requires that specified minimum percentages of retail sales within Massachusetts must come from new renewable resources, which are defined to include wind energy proposals such as the proposed action. Such minimum percentages commence in 2003 with 1 percent, and increase annually at a rate of one-half of 1 percent through 2009, and increase thereafter at the discretion of the Massachusetts Division of Energy Resources (DOER).

1.2.3 Local and Regional Regulatory Jurisdictions and Reviews**1.2.3.1 The Massachusetts Wetlands Protection Act - Yarmouth**

To protect the Commonwealth's wetland resources, the Massachusetts Wetlands Protection Act (WPA), Rivers Protection Act and regulations, and the Yarmouth Wetlands By-laws require approval from the Yarmouth Conservation Commission before activities can take place that would impact jurisdictional wetlands.

MassDEP and the Town of Yarmouth jurisdiction would include the submarine portion of the transmission line located within the mapped 3.5-mile (5.6 km) state territorial sea boundary and onshore cable components of the proposed action. Wetlands have been identified in the vicinity of the transmission cable route seaward and within the State territorial limit of Nantucket Sound and in the town

of Yarmouth waters in Lewis Bay, and along the onshore transmission cable route. The Yarmouth Conservation Commission would exercise jurisdiction over the installation of the onshore cable located within the statutory 100-foot (30.5 m) buffer zone abutting wetland resources, and the submarine portion of cable located in Lewis Bay and out to the mapped 3.5-mile (5.6 km) state territorial sea boundary. In Massachusetts, the permit application is called a NOI. An NOI was filed with the Yarmouth Conservation Commission on November 15, 2007.

1.2.3.2 The Massachusetts Wetlands Protection Act - Barnstable

To protect the Commonwealth's wetland resources, the Massachusetts WPA, Rivers Protection Act, and regulations and the Barnstable Wetlands Ordinance require approval from the Barnstable Conservation Commission before activities can take place that would impact jurisdictional wetlands.

The MassDEP and the Town of Barnstable jurisdiction would include the submarine portion of the transmission line located within the mapped 3.5-mile (5.6 km) state territorial sea boundary and the onshore cable components of the proposed action. The Barnstable Conservation Commission jurisdiction covers the installation of the portion of the submarine cable route located in the town of Barnstable waters in Lewis Bay. The onshore cable route located in Barnstable would not be located within any wetland resource areas and/or buffer zones. An NOI was filed with the Barnstable Conservation Commission on November 15, 2007.

1.2.3.3 Cape Cod Commission

The Cape Cod Commission was created in 1990 by the Massachusetts the General Court (state legislature) pursuant to the Cape Cod Commission Act (CCCA). The mission of the Commission is to manage growth, protect Cape Cod's unique environment and character, and foster a healthy community for present and future generations. The Commission acts as a regional planning and land use agency in the region known as Cape Cod – Barnstable County. The Commission created and implements the Cape Cod Regional Policy Plan (RPP), which is required by the CCCA. The RPP is both a planning and a regulatory agency.

According to the legislation, numerous factors trigger Commission review for proposed developments. Generally, these include: (1) the impact of the proposed development on the environment and natural resources, including but not limited to air, ground and surface water supply and quality; ecological, coastal, historical, cultural, architectural, archaeological, and recreational resources; endangered species habitats, open space, agriculture and aquaculture; and (2) the impact of the proposed development on existing capital facilities, including but not limited to transportation and infrastructure, sewage, waste disposal, water supply, fair affordable housing, and meaningful employment.

The applicant submitted a request to the Cape Cod Commission for approval for the proposed interconnection cables located in state jurisdiction (Cape Cod Commission File No. JR20084), and the Commission issued a procedural denial of the applicant's request for approval on October 18, 2007 due to lack of information. However, an exemption from Cape Cod Commission review is available following a successful petition to the EFSB. The applicant sought such an exemption by filing a petition on November 21, 2007.

Other Local Permits

In addition to the Wetland Permits described above, there are other local permits that may be required, that are not necessarily considered environmental permits but rather engineering permits. These could include local Department of Public Works (DPW) curb cut and street opening permits, building permits, zoning, planning board approval, etcetera.

1.3 PUBLIC SCOPING

In order to develop the scope of study for the MMS draft EIS, MMS requested comments on the proposed action via a public notice in the FR on May 30, 2006 (71 FR 30693). The MMS extended the time limit for the comment period from July 14, 2006, to July 28, 2006 at the request of commenters to allow extra time for development and submittal of scoping comments.

In addition, the proposed action had previously undergone a partial NEPA review with the USACE as the lead agency. During the USACE review process, a draft EIS was issued, and the USACE received approximately 5000 comment letters and email comments on the USACE draft EIS. For purposes of MMS' independent NEPA evaluation, the MMS incorporated all the previous comments originally made on the USACE draft EIS as scoping comments for this draft EIS. MMS also took into account in the scoping process, comments that were made at the USACE public hearings held in Yarmouth, Martha's Vineyard, Cambridge, and Nantucket, Massachusetts. As a result, there are an extensive number of comments, which have been used to develop the content or "scope" of this MMS draft EIS.

The comments were considered in aggregate from both the MMS and the USACE comment and scoping processes. This draft EIS addresses these comments to the extent they are applicable and necessary to reach conclusions as to the scope and extent of potential impacts. The comments were categorized into the following subject categories and a summary of the comments that were received can be found in Section 7.0:

- Regulatory Process
- Alternatives Analysis
- Construction, Operations, Decommissioning
- Geology and Sediments
- Oceanography
- Water Quality
- Air and Climate
- Noise
- Electric Magnetic Fields
- Avian and Bat Resources
- Freshwater and Coastal Wetlands
- Wildlife
- Fisheries – Socio-economic Impacts to Commercial and Recreational Fishing
- Fisheries – Environmental Impacts
- Benthos and Eelgrass
- T&E Species
- Socioeconomics
- Transportation
- Communications
- Cultural Resources
- Aesthetic/Landscape/Visual
- Transmission Interconnection

1.4 AGENCY CONSULTATION AND COOPERATIVE AGENCY STATUS

Agency consultation meetings were held in Boston, Massachusetts on November 2, 2005; June 27, 2006; and February 28, 2007. The purpose of the meetings was to solicit comment and concerns about the project and the scope of the DEIS. MMS received informal comments on a host of issues including the extent of environmental resources impacts (similar to the list of impacts shown above), the adequacy of data to address those impacts, and the scope of the alternatives analysis. The information was then considered along with the public comments to help form the scope of the DEIS. The agencies/tribes consulted to date include:

- NOAA Fisheries Service, formerly National Marine Fisheries Service
- US Army Corps of Engineers
- U.S. Coast Guard
- U.S. Department of Energy
- U.S. Environmental Protection Agency
- U.S. Federal Aviation Administration
- U.S. Air Force
- U.S. Fish and Wildlife Service
- Cape Cod Commission
- Massachusetts Department of Environmental Protection
- Massachusetts Energy Facilities Siting Board
- Massachusetts Executive Office of Environmental Affairs
- Massachusetts Historical Commission
- Wampanoag Tribe of Gay Head (Aquinnah)
- Mashpee Wampanoag Tribe

In accordance with the Council on Environmental Quality Regulations at 40 CFR 1501.6, MMS filed letters inviting agencies to become cooperating agencies in the DEIS process (see MMS consultation letters in [Appendix E](#)). The purpose of bringing cooperative agencies into the process is to assist in the review and development of information and matters related to project design, characterization of resources, assessment of environmental impacts, and mitigation. The following agencies have provided a formal written request to become a cooperating agency (see cooperating agency request letters in [Appendix E](#)):

- U.S. Coast Guard
- U.S. Department of the Army, Corps of Engineers New England District
- U.S. Environmental Protection Agency
- Cape Cod Commission
- Massachusetts Historical Commission
- Town and County of Nantucket
- Town of Barnstable
- Barnstable Municipal Airport

Further details on the agency consultation process and issues of concern are discussed in Section 7.2.

1.5 DEFINITIONS OF IMPACT LEVELS

The following impact levels are used in the impact section of the draft EIS to provide consistency in the assessment of environmental impacts and socioeconomic issues. The conclusions for most analyses in this EIS use a four-level classification scheme to characterize the impacts predicted, if the proposed action or an alternative is implemented and activities occur as assumed.

1.5.1 Impact Levels for Biological and Physical Resources

The impact levels for biological and physical resources are used for the analysis of water quality, air quality, marine and terrestrial mammals, marine and coastal birds, fish resources, sea turtles, coastal and seafloor habitats, cultural resources, and areas of special concern (such as EFHs, marine sanctuaries, parks, refuges, and reserves). The four impact levels are defined as follows:

- (1) **Negligible**
 - No measurable impacts.
- (2) **Minor**
 - Most impacts to the affected resource could be avoided with proper mitigation, or
 - If impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated.
- (3) **Moderate**
 - Impacts to the affected resource are unavoidable, and
 - The viability of the affected resource is not threatened although some impacts may be irreversible, or
 - The affected resource would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.
- (4) **Major**
 - Impacts to the affected resource are unavoidable, and
 - The viability of the affected resource may be threatened, and
 - The affected resource would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

1.5.2 Impact Levels for Socioeconomic Issues

The impact levels for socioeconomic issues are used for the analysis of demography, employment, and regional income; land use, visual and infrastructure; fisheries; tourism and recreation; socio cultural systems; and environmental justice. Although impact levels for direct physical impacts to cultural resources are defined under Section 1.4.1, indirect visual impacts to cultural resources are covered by the criteria below. The four impact levels are defined as follows:

(1) Negligible

- No measurable impacts.

(2) Minor

- Adverse impacts to the affected activity or community could be avoided with proper mitigation, or
- Impacts would not disrupt the normal or routine functions of the affected activity or community, or
- Once the impacting agent is eliminated, the affected activity or community would return to a condition with no measurable effects from the proposed action without any mitigation.

(3) Moderate

- Impacts to the affected activity or community are unavoidable, and
- Proper mitigation would reduce impacts substantially during the life of the proposed action, or
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the proposed action, or
- Once the impacting agent is eliminated, the affected activity or community would return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

(4) Major

- Impacts to the affected activity or community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the proposed action.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normally acceptable, and
- Once the impacting agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

2.0 DESCRIPTION OF PROPOSED ACTION

2.1 PROJECT DESCRIPTION

The proposed action entails the construction, operation, and decommissioning of 130 WTGs located in a grid pattern on and near Horseshoe Shoal in Nantucket Sound, Massachusetts, as well as an ESP, inner-array cables, and two transmission cables. Each of the 130 WTGs would generate electricity independently of each other. Solid dielectric submarine inner-array cables from each WTG would interconnect within the grid and terminate at their spread junctions on the ESP. The ESP would serve as the common interconnection point for all of the WTGs. The proposed submarine transmission cable system is approximately 12.5 mile (20.1 km) in length (7.6 mile [12.2 km] within the Massachusetts 3.5-mile [5.6 km] territorial line) from the ESP to the landfall location in Yarmouth. The two submarine transmission cables would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue. The applicant seeks to commence construction in 2009 and begin operation in 2010.

2.1.1 Wind Turbine Generator

Each turbine is pitch-regulated with active yaw to allow it to turn into the wind, and has a three-blade rotor. The main components of the WTG are the rotor, transmission system, generator, yaw system, and the control and electrical systems, which are located within the nacelle (see [Figure 2.1.1-1](#)). The nacelle is the portion of the WTG that encompasses the drive train and supporting electromotive generating systems that produce the wind-generated energy. The WTGs nacelle would be mounted on a manufactured tubular conical steel tower, supported by a monopile foundation system. A pre-fabricated access platform and service vessel landing (approximately 32 ft [10 m]) from mean lower low water (MLLW) would be provided at the base of the tower. The rotor has three blades manufactured from fiberglass-reinforced epoxy, mounted on the hub. The monopiles within the proposed action area would utilize two different diameter foundation types depending on water depth. Water depths of 0 to 40 ft (0 to 12.2 m) would utilize a 16.75 ft (5.1 m) diameter monopile and water depths of 40 to 50 ft (12.2 to 15.2 m) would utilize an 18.0 ft (5.5 m) diameter monopile.

Each WTG has an energy generating capacity of 3.6 MW \pm and the proposed action is designed for a maximum delivered electrical energy capacity of 468 MW. The generating capacity is based on the design wind velocity of 30 miles per hour (mph) (13.4 meters per second [m/s]) and greater, up to the maximum operational velocity of 55 mph (24.5 m/s). Based on the average wind speed in Nantucket Sound of 19.75 mph (8.8 m/s), there would be an average generation capacity of 182.6 MW, and the net energy production delivered to the regional transmission grid would be approximately 1,600 gigawatt hours/year (GWh/y).

In order to generate maximum wind energy production, the WTGs would be arranged in specific parallel rows in a grid pattern. For this area of Nantucket Sound, the wind power density analysis conducted by the applicant determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the WTGs. This alignment would position the WTGs perpendicular to prevailing winds, which are generally from the northwest in the winter and from the southwest in the summer for this geographic area in Nantucket Sound. The WTGs would have a computer-controlled yaw system that ensures that the nacelle is always turned into the wind and perpendicular to the rotor. In addition to maximizing potential wind energy production, the WTGs must also be sufficiently spaced within the array in order to minimize power losses due to wind shear and turbulence caused by other WTGs within the array. The optimal WTG spacing within the array is 0.39 mile (629 m) by 0.62 (1,000 m) between each WTG based on wind direction analysis. The spacing of the wind turbines is discussed further in Section 3.3.6 under "Condensed Array Alternative."

As a result of technological advancements and design changes by the manufacturer of the General Electric (GE) 3.6 MW wind turbine, the overall dimensions of the machines have changed since the publication of the USACE draft EIS. The primary change involves the use of larger rotor blades, which require mounting on a taller tower to maintain the desired 75 ft (23 m) of clearance to the sea surface. The 75 ft (23 m) of clearance beneath the WTGs was initially chosen, and is being maintained, in order to minimize any impacts to the use of the water sheet area by boats. The following describes the other changes in the turbine specifications since the publication of the USACE draft EIS ([Figure 2.1.1-1](#)).

- a. Rotor Diameter: As a result of technological advancements that allow for greater efficiencies, GE has updated the offshore 3.6 MW machine and is presently produced with a rotor diameter of 364 ft (111 m) (originally 341 ft [104 m]).
- b. Nacelle Hub Height: In order to maintain the previously stated 75 ft (23 m) of clearance between the sea surface and a rotor blade tip in its lowest position, the nacelle hub has been raised to a height of 257.5 ft (78.5 m) (originally 246 ft [75 m]).
- c. Overall WTG Height: As a result of the larger rotor blades and the desire to maintain the previously stated 75 ft (23 m) of clearance beneath the turbines, the maximum overall WTG height has increased to 440 ft (134 m) (originally 417 ft [127 m]).
- d. Rotor Swept Zone: As a result of the changes noted above, the resulting rotor swept zone is now 75 to 440 ft (23 to 134 m) (originally 75 to 417 ft [23 to 127 m]).

The northernmost WTGs would be approximately 3.8 mile (6.1 km) from the dry rock feature (offshore near Bishop and Clerks) and approximately 5.2 mile (8.4 km) from Point Gammon on the mainland; the southernmost WTG would be approximately 11 mile (17.7 km) from Nantucket Island (Great Point), and the westernmost WTG would be approximately 5.5 miles (8.9 km) from the island of Martha's Vineyard (Cape Poge) ([Figure 2.1.1-2](#)). The proposed action area as presented in the application submitted to MMS on September 14, 2005, includes an expanded perimeter around the site of the proposed action in order to ensure that a sufficient buffer exists between the proposed action area and any other subsequent wind projects authorized by MMS in the future that could impact the ability of the proposed action to produce power at the anticipated level.

The water depths within Nantucket Sound range from 0.5 to 70 ft (0.3 to 21.3 m) at MLLW. Depths on Horseshoe Shoal range from as shallow as 0.5 ft (0.15 m) to 60 ft (18.3 m) at MLLW. Along the transmission cable interconnection corridor, between Horseshoe Shoal and the Cape Cod shoreline, water depths vary from 16 to 40 ft (4.9 to 12.2 m) at MLLW, with an average depth of approximately 30 ft (9.1 m) at MLLW. Water depths within Lewis Bay and Hyannis Harbor range from 8 to 16 ft (2.4 to 4.9 m) at MLLW in the center of the bay to less than 5 ft (1.5 m) at MLLW along the perimeter and between Dunbar Point and Great Island.

2.1.2 Inner Array Cables

Within the nacelle of each turbine, a wind-driven generator would produce low voltage electricity, which would be "stepped up" by a transformer to produce 33 kV electric transmission capacity. Submarine cables from each WTG would interconnect within the turbine array and terminate at their spread junctions on the ESP. The inner array submarine cable system would use a three-conductor cable with all phases under a common jacket. The inner-array cables would consist of solid dielectric alternating currents (AC) cable specifically designed for installation in the marine environment. These types of cables do not require pressurized dielectric fluid circulation for insulating or cooling purposes. Each cable would consist of three copper conductors (extruded XLPE insulation and lead sheathed) plus an interstitial fiber optic cable equipped with 24 single mode ITU-T G.652 fibers. The entire cable

assembly would be wound and protected by a single layer of galvanized steel wire armor and an outer sheathing of polypropylene strings.

The inner-array cables would be arranged in strings, each of which would connect up to approximately 10 WTGs to a 33 kV circuit breaker on the ESP. The electrical current in the cable segments within each string would vary depending on WTG's location within the string. Cable segments closer to the ESP would provide greater transmission capacity compared to cables further away from the ESP. It is anticipated that three different cable sizes (150 mm², 400 mm², and 600 mm²) would be used to accommodate this variation in transmission capacity related to the distance of the WTG from the ESP. The conductor cross sections would be 3x150 mm², 3x400 mm², and 3x600 mm² and the overall diameter of the cable would be 132 mm (5.19 inches), 146 mm (5.75 inches), and 164 mm (6.45 inches) respectively. The inner-array cables would be installed six feet (1.8 m) below the seafloor by jet plow embedment.

See [Figure 2.1.2-1](#) for the location of the revised turbine array showing the inner-array cable layout.

2.1.3 115 Kilovolt (kV) Transmission Cable System

Two 115 kV transmission circuits would interconnect the ESP with the existing NSTAR Electric transmission grid serving Cape Cod. Two AC circuits are necessary to provide the required electric transmission capacity when operating at high capacity to the NSTAR Electric transmission system and to provide increased reliability and redundancy in the event of a circuit outage. Each circuit consists of two (2) three-conductor cables, resulting in a total of four (4) cables.

The submarine transmission line would consist of solid dielectric AC cable specifically designed for installation in the marine environment. These types of cables do not require pressurized dielectric fluid circulation for insulating or cooling purposes. Each cable would consist of three 800 square millimeters (mm²) (1.24 square inch) copper conductors, XLPE insulated to 123 kV and lead/PE sheathed, plus an interstitial fiber optic cable equipped with 24 single mode ITU-T G.652 fibers, with an overall diameter of 197 mm (7.75 inches). The entire cable assembly would be wound and protected by a single layer of galvanized steel wire armor and an outer sheathing of polypropylene strings (see [Figure 2.1.3-1](#)). The four submarine transmission cables would be installed as two circuits by bundling two cables per circuit together during installation and installing the two circuits.

The proposed transmission cable system would be approximately 12.5 miles (20.1 km) in length (7.6 miles [12.2 km] within the Massachusetts 3.5-mile [5.6 km] territorial line) from the ESP to the landfall location in Yarmouth. The transmission cables would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue (see [Figure 2.1.3-2](#)). The transmission cables would be installed six feet (1.8 m) below the seafloor by jet plow embedment. See [Figure 2.1.3-3](#) for a typical cross section of a submarine cable trench using jet plow embedment. The submarine transmission cables would transition to the onshore transmission cable by using HDD methodologies to drill shafts for pulling of conduits, pulling the cable through the conduits, and then transition into a vault positioned at the end of New Hampshire Avenue.

Upon making landfall, the proposed transmission cable route would then follow New Hampshire Avenue north, merging with Berry Avenue. The route continues north on Berry Avenue, crossing Route 28 and continuing north on Higgins Crowell Road to Willow Street. Proceeding north on Willow Street, the route passes under Route 6 to the proposed intersection point with the existing NSTAR Electric 115 kV transmission cable ROW, approximately 500 ft (152.4 m) north of Summer Street. The route then turns westerly within the NSTAR Electric's existing ROW to the Barnstable Switching Station, crossing under Route 6. The proposed onshore transmission cable would be located within the existing public

roadways for a length of approximately 4 miles (6.4 km) from landfall to NSTAR Electric transmission cable ROW located on the west side of Willow Street. The onshore transmission cable would then continue underground approximately 1.9 miles (3.1 km) along existing NSTAR Electric ROW and running from Willow Street to the Barnstable Switching Station (see [Figure 2.1.3-2](#)).

The onshore cables would be joined to the submarine cables at the landfall in Yarmouth. The onshore transmission cable system would utilize 12 single-conductor 115 kV cables. The 12 cables would be segregated into two circuits, each composed of two cables per phase. The cables would run in a concrete encased duct bank. The conductor cross bank would be 1.24 square inches (800 mm²). See [Figures 2.1.3-4](#) and [2.1.3-5](#) for typical duct bank cross sections.

Installation of the proposed onshore transmission cable includes constructing a utility easement within and along four roadways: New Hampshire Avenue, Berry Avenue, Higgins Crowell Road, and Willow Street. The easement would also include the crossing of Route 28 and Route 6. The onshore transmission cable would affect several intersections.

New Hampshire Avenue

New Hampshire Avenue is a two-lane residential road allowing vehicle access in a north-south direction. The roadway is a dead-end with a concrete retaining wall at its southern end. There are no sidewalks on either side of the roadway. In addition, there is no on-street parking. The transmission cable would be installed within the east side of the roadway.

Berry Avenue

Berry Avenue is a two-lane residential road allowing vehicle access in a north-south direction. There are sidewalks on both sides of the roadway. The transmission cable would cross to the west side of Berry Avenue off of New Hampshire Avenue.

Intersection 1 - Route 28 between Berry Avenue and Higgins Crowell Road

At the intersection with Berry Avenue and Higgins Crowell Road, Route 28 is a two-lane roadway with a painted divider. Vehicles on Route 28 travel in an east-west direction. The intersection of Route 28 with Berry Avenue and Higgins Crowell Road is signalized. There are sidewalks on both sides of Route 28. The transmission cable would be installed underneath Route 28 using trenchless technologies.

Higgins Crowell Road

Higgins Crowell Road is a two-lane road with a painted divider and vehicle travel is in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. The transmission cable would be placed on the east side of Higgins Crowell Road.

Intersection 2 - Buck Island Road

At the intersection with Higgins Crowell Road is a two-lane roadway with a painted divider. Vehicle on Buck Island Road travels in an east-west direction. The intersection of Buck Island Road with Higgins Crowell Road is signalized. The transmission cable would be installed beneath Buck Island Road using trenchless technologies.

Willow Street

Willow Street is a two-lane road with a painted divider. Vehicle travel is in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. The transmission cable would be placed on the west side of Willow Street.

Route 6 Crossings

The transmission cable would be installed using trenchless techniques as it passes underneath the Route 6 overpass. Approximately 0.5 mile (0.8 km) past the Route 6 overpass, the transmission cable would enter the NSTAR Electric ROW. The transmission cable would also cross under Route 6 from the NSTAR Electric ROW from north to south to connect with the Barnstable Switching Station. This crossing would also be accomplished using trenchless techniques.

Ancillary Structures

The duct system enclosing the onshore transmission and related cables would consist of a single duct bank system with a total of sixteen 6-inch polyvinyl chloride (PVC) ducts encased within a concrete envelope. The duct bank would be constructed within a trench beneath existing roadway corridors along the majority of the route. Twelve of the 16 ducts would be occupied with the onshore transmission cables, two ducts would contain fiber optic line for protective relaying and communications, and two vacant ducts would be reserved for future use as spares.

In addition to the landfall transition vault at the landfall site, the proposed transmission facility would include underground vaults along the public roadway and NSTAR Electric's ROW. These vaults would be required at locations utilizing trenchless techniques as well as typical splice vaults. All vault locations would include two parallel vaults constructed of reinforced concrete.

2.1.4 Electrical Service Platform (ESP)

An ESP would be installed and maintained within the approximate center of the WTG array and serve as the common interconnection point for all of the WTGs. The inner-array cable system would interconnect with circuit breakers and transformers located on the ESP in order to transmit wind-generated power through the 115 kV shore-connected submarine cable system. The ESP would provide electrical protection and inner-array cable sectionalizing capability in the form of circuit breakers. It would also include voltage step-up transformers to increase the 33 kV inner-array transmission voltage up to the 115 kV voltage level of the transmission cable connection to the land-based system.

The ESP would be a fixed template type platform consisting of a jacket frame with six 42-inch diameter (1.1 m) driven piles to anchor the platform to the ocean floor. The platform would consist of a steel superstructure of approximately 100 ft by 200 ft (30.5 m by 61 m). The platform would be placed approximately 39 ft (11.9 m) above MLLW in 28 ft (8.5 m) of water.

In addition to the electrical equipment, the ESP would include fire protection, battery backup units, and other ancillary systems. These systems would include ventilation, safety, communications, and temporary living accommodations. The living accommodations are for emergency periods when maintenance crews cannot be removed due to weather issues. These accommodations would utilize waste storage holding tanks that would be pumped to the service vessel for proper disposal. All equipment would be contained within an enclosed weather-protected service area.

Maintenance and service access to the ESP would normally be by service boat. A boat landing dock consisting of a fender structure with ladder is attached to the ESP to allow boat landing and transfer of personnel and equipment and temporary docking of the service craft. The ESP would have a helicopter deck to allow personnel access when conditions preclude vessel transport, and for emergency evacuation. Equipment and material transfer would be by a crane mounted on the ESP.

2.2 SPACE REQUIREMENTS

Submerged Land

The 130 WTGs and the ESP would occupy 0.67 acres (0.003 square kilometers [km^2]) of submerged land. The 33 kV inner-array cables (ranging in diameter from 5.19 in [132 millimeters [mm]] to 6.45 in [164 mm] depending on the required current load for sections of the cable) would occupy approximately 4.35 acres (0.018 km^2). The 115 kV transmission line, consisting of two circuits of two 7.75 in (197 mm) cable would occupy 1.54 acres (0.006 km^2) beneath federal waters. An additional 2.38 acres (0.01 km^2) beneath Massachusetts state waters would be occupied by the 115 kV transmission line. Scour protection for the WTGs would cover between 2.5 acres (0.01 km^2) with use of scour mats and 41.8 acres (0.17 km^2) with rock armoring. The project facilities occupy 0.07 percent (11.44 acres) of the total project area of 25 square miles (64.7 km^2) with scour mats and 0.35 percent (56.76 acres) with rock armor (see [Table 5.3.2-2](#) for additional information)

During installation of the WTGs, ESP, cable, and scour protection, it is anticipated that between 812 and 866 acres (3.29 and 3.5 km^2) (depending on the method of scour protection) would be temporarily disturbed. This represents between 5.1 and 5.4 percent of the total project area.

Onshore

The proposed onshore transmission cable route to its intersection with the NSTAR Electric ROW would be located entirely along existing paved ROWs where other underground utilities already exist. All of the roadways within Yarmouth and Barnstable in which the proposed transmission cable would be placed are town owned and maintained roads with the exception of Routes 6 and 28, which are owned and maintained by MassHighway. A portion of the onshore transmission cable route would also be located underground within the existing maintained NSTAR Electric ROW.

2.3 CONSTRUCTION METHODOLOGY AND SCHEDULE

2.3.1 Schedule

The anticipated schedule for the permitting of the proposed action and its construction is provided in [Figure 2.3.1-1](#). The anticipated construction sequence is as follows: (1) the onshore ductbanks would be installed; (2) the ESP and onshore 115 kV cables would be installed; (3) the monopiles, scour protection, and WTGs would be installed; and (4) full operation would begin.

2.3.2 Wind Turbine Generator Installation

The installation of the WTGs would comprise four activities: (1) installation of the foundation monopiles; (2) erection of the WTGs; (3) installation of the inner-array cables; and (4) installation of the scour protection mats or rock armor.

2.3.2.1 Quonset Staging Area

The major construction activities would be supported by onshore facilities, which are anticipated to be located in Quonset, Rhode Island (see [Figure 2.3.2-1](#)). Material and equipment would be staged onshore, at existing port facilities in Quonset, Rhode Island, and then loaded onto various vessels for transportation to the offshore site, and ultimately installation. Construction personnel would be ferried by boat and/or helicopter depending upon weather conditions and other factors. Once loaded, the vessels would travel from Quonset through Narragansett Bay to Rhode Island Sound to Vineyard Sound, North of Martha's Vineyard to the Main Channel, a distance of about 63 miles (102 km).

The applicant has identified an existing, industrial port facility in Quonset, Rhode Island as having the attributes required for staging an offshore construction project of the magnitude of the Project. The Quonset Davisville Port & Commerce Park is located on Narragansett Bay in the town of North Kingstown, Rhode Island. It is owned and controlled by the Rhode Island Economic Development Corporation (RIEDC). This site is a portion of what once was a much larger government facility known as the U.S. Naval Reservation–Quonset Point, part of which is still actively utilized as a civilian airport and base for an Air National Guard Reserve squadron.

The Quonset Davisville Port & Commerce Park is an active marine industrial site that houses several industrial businesses such as General Dynamics (shipbuilding) and Senesco (marine construction). Following the downsizing of the U.S. Naval Reservation – Quonset Point, the commerce park was created in order to develop prime industrial sites, create job opportunities, and to improve the economic conditions throughout the region.

The entire park consists of approximately 3,150 acres (12.75 km²), of which 817 acres (3.3 km²) have been sold for such uses as industrial, offices, and transportation/utility (railroad and highways). Another 463 acres (1.9 km²) have current leases, 605 acres (2.45 km²) are used for a civilian airport (Quonset State Airport - OQU) operated by the State of Rhode Island, approximately 600 acres (2.4 km²) are designated open space, about 200 acres (0.8 km²) are utilized for recreation including a golf course, and the remaining 465 (1.9 km²) acres are vacant, open land available for industrial and commercial activities.

The site has deep-water capacity (30 ft [9.1 m] depth) and two piers that are 1,200 ft (365.9 m) in length and capable of servicing large ships. One of the piers (Pier 1) is currently leased by a company as an automobile unloading and transfer operation. The other pier (Pier 2) has intermittent use as a staging area for the Rhode Island Department of Transportation bridgework. Pier 2 would become available in the near future; however, based on timing, either pier may be available for lease.

The applicant has been actively pursuing the use of Pier 2 because it has a load bearing capacity of over 1,000 pounds (lbs) per ft² and is 1,200 ft (365.9 m) long by 650 ft (198.2 m) wide. This Pier would be used for the receiving, storing and assembly of the large turbine parts such as the monopiles, towers, nacelles, transition pieces, hubs, and blades. The applicant and RIEDC have started discussions pertaining to leasing all or part of Pier 2 and the land contiguous to it, which consists of approximately 33.5 acres (0.14 km²) zoned for industrial or commercial activity. Additional land is also available within the park, approximately 3,000 ft (914.6 m) away, which is accessible by a public road approximately 40 ft (12.2 m) in width. These satellite parcels consist of approximately 25 plus acres (0.1 km²) that could be used for other components of the wind turbines and associated infrastructure if needed. One of the parcels has two large buildings, which were utilized by the U.S. Navy Construction Battalion (Seabees) during the 1940's, 1950's and 1960's, which may be capable of handling certain requirements of the project for covered storage and enclosed workspace. Some modifications to the buildings and roadways may be required to accommodate the specialized equipment and wind turbine components. The deep-water piers are adequate to accommodate anticipated construction vessels and are not expected to require any additional dredging or modification.

Monopile installation would begin by loading individual monopiles onto a barge, six to ten at a time, for transport to the work site. Depending upon the actual barge utilized and other logistical requirements, approximately 20 trips are anticipated to move monopiles to the work site.

2.3.2.2 Installation of Monopiles

A jack-up barge with a crane would be utilized for the actual installation of the monopiles. The jack-up barge would have four legs with pads a minimum of four meters on a side (approximately 172 ft²

[0.0039 acre or 16 square meter [m²]). The crane would lift the monopiles from the transport barge and place them into position. The monopiles would be installed into the seabed by means of a pile driving ram or vibratory hammer to an approximate depth of 85 ft (26 m). This would be repeated at all WTG locations. Only two pieces of pile driving equipment would be present within the proposed action area at any one time, and they are not planned to be operated simultaneously. Since the monopiles are hollow, sediments would be contained within them.

Length of monopile, insertion distance, and finished elevation would vary by individual location due to water depth and structural and geotechnical parameters. Monopiles to be installed would range in length from approximately 122 ft (37 m) for those installed in the shallowest locations to more than 172 ft (52.4 m) at the deepest sites. The anticipated time to install all of the monopiles is expected to be approximately eight months plus any delays due to weather.

2.3.2.3 Installation of Wind Turbine Generators

The installation of the WTG itself would be from a specialized vessel configured specifically for this purpose (see [Figure 2.3.2-2](#) for an example of a typical vessel). Work vessels for the proposed action would comply with applicable mandatory ballast water management practices established by the USCG in order to avoid the inadvertent transport of invasive species.

This vessel would be loaded at Quonset, Rhode Island with the necessary components to erect six to eight WTGs. The components include transition pieces to place on the monopiles, towers, nacelles, hubs, and blades.

The vessel would transit from Quonset to the work site as described above and set up adjacent to one of the previously installed monopiles. A jacking system would then stabilize the vessel in the correct location. Depending on the actual circumstance, four or six jacking legs would raise the vessel to a suitable working elevation. A transition piece unique to the specific WTG, is placed by the vessel's crane onto the monopile, leveled and set at the precise elevation for the tower. This piece would be a fabricated steel structure complete with a turbine tower flange, J-tubes for cable connections and a boat landing device. The transition piece is then grouted in place to the foundation monopile using a product such as Ducorit® D4 by Densit. The crane would then place the lower half of the tower onto the deck of the transition piece. Once this piece is secured, the upper tower section is raised and bolted to the lower half. In order, the nacelle, hub and blades are raised to the top of the tower and secured. Several of these components may be pre-assembled prior to final installation. This process is anticipated to take approximately 30 to 40 hours to cycle through one complete WTG and would be repeated for each of the 130 WTG locations. Including the twenty or so trips from Quonset to Horseshoe Shoal, this process would take approximately nine months plus any delays due to weather. The installation of the WTGs would overlap with the installation of the monopiles.

As the monopiles and WTGs are completed, the submarine inner-array cables would be laid in order to connect each string of wind turbines (up to 10 WTGs), and then the seabed scour control system would be installed on the seabed around each monopile. The scour control system would help to prevent underwater currents from eroding the substrate adjacent to the WTG foundation. This would consist of a set of six scour-control mats arranged to surround the monopile. Each mat is 16.5 ft by 8.2 ft (5 m by 2.5 m) with eight anchors that securely tied to the seabed (see [Figure 2.3.2-3](#) for the arrangement of the mats). It is anticipated that the process of completing one string of WTGs (10 WTGs with associated inner-array cable and scour mats) would take up to approximately one month.

The scour mats are placed on the seabed by a crane or davit onboard the support vessel. Final positioning is performed with the assistance of divers. After the mat is placed on the bottom, divers use a

hydraulic spigot gun fitted with an anchor drive spigot to drive the anchors into the seabed. The mats are removed with divers and a support vessel in a similar manner to installation, and are expected to result in greater amounts of suspended sediments than levels associated with the original installation of the mats.

Rock armor scour protection has also been proposed for an alternative approach to scour control. Rock armor design is driven by wave action (wind-driven and ocean swell) and currents (tidal and wind-driven). The armor stones are sized so that they are large enough not to be removed by the effects of the waves and currents, while being small enough to prevent the stone fill material placed underneath it from being removed.

If it were used, the rock armor and filter layer material would be placed on the seabed using a clamshell bucket or a chute. In those locations where rock armoring had been used for scour protection, it would also be removed following project decommissioning.

The transition piece of the WTGs, which would be located within the submerged/splash zone, would be coated with a product equal or similar to Dupont Interzone 954. The portions of the structural steel and steel surfaces not directly exposed to seawater, such as the tower, would be coated with an epoxy-polyamide. A cathodic protection system using a galvanic (sacrificial) aluminum anode system would be employed to assist in preventing corrosion.

2.3.3 Electric Service Platform Installation

The ESP design is based on a piled jacket/template design with a superstructure mounted on top. The platform jacket and superstructure would be fully fabricated on shore and delivered to the work site by barge.

The jacket would be removed from the barge by lifting with a crane mounted on a separate derrick barge. The jacket assembly would then be sunk and leveled in preparation for piling. The six piles would then be driven through the pile sleeves to the design tip elevation of approximately 150 ft (46 m) below the surface of the sea bottom. The piles would be vibrated and hammered as required.

The superstructure would be installed by lifting it from the transport barge onto the jacket. It would then be connected to the jacket in accordance with the detail design requirements. After attachment, additional components including ladders, heliport and vessel docking structure would be lifted from a barge and set onto the superstructure for attachment. The installation of the ESP is anticipated to take approximately one month to complete ([Figure 2.3.3-1](#), sheets 1 and 2).

After the ESP is fully constructed, installation of the inner-array cables and the high voltage transmission cables would take place. These cables would be routed through J-tubes located on the outside of the support jackets. Once the inner-array cables are connected to the ESP, the scour mats would be installed to the ESP piles utilizing a similar design as the WTG foundations.

The ESP would be coated with a similar paint system as the WTG. A cathodic protection system utilizing a galvanic (sacrificial) aluminum anode system would be utilized.

2.3.4 33 Kilovolt Inner-Array Submarine Cable System Installation

The 33 kV cable would be transported to Quonset Point, Rhode Island from the Pirelli Cable factory in a special cable transport vessel. The cable would be transferred onto the cable installation barge. The linear cable machines on-board the barge would pull the cables from coils on the transport vessel onto the barge, and into prefabricated tubs. The installation barge and auxiliary barge loading take place in Quonset, Rhode Island. After the cable has been transferred, the installation barge would be towed to the Horseshoe Shoal site. This would be repeated as required to deliver and install all the required cable.

The proposed method of installation of the submarine cable is by the hydroplow embedment process, commonly referred to as jet plowing (see [Figure 2.1.3-3](#)). This method involves the use of a positioned cable barge and a towed hydraulically-powered jet plow device that simultaneously lays and embeds the submarine cable in one continuous trench from WTG to WTG and then to the ESP. The barge would propel itself along the route with the forward winches, and the other moorings holding the alignment during the installation. The six point mooring system would allow a support tug to move anchors while the installation and burial proceeds uninterrupted on a 24-hour basis.

When the barge nears the ESP, the barge spuds would be lowered to secure the barge in place for the final end float and pull-in operation. The cable would be pulled into the J-tube and terminated at the switchgear.

2.3.5 115 Kilovolt Submarine Transmission Cable System Installation

The transmission cable system consists of the two 115 kV solid dielectric AC submarine transmission circuits (two three-conductor cable systems per trench equals one circuit, for a total of 4 cables). The two circuits of interconnecting transmission cables linking the ESP to the landfall location would be embedded by jet plow approximately 6 ft (1.8 m) below the sea floor, with approximately 20 ft (6.1 m) of horizontal separation between circuits.

The 115 kV cable would be transported from the manufacturer to Quonset Point, Rhode Island, the mobilization point. The cable would be transferred to the installation barge by pulling via the linear cable machines mounted on the barge. After the cable has been transferred, the installation barge would be towed to the Lewis Bay installation site offshore of the New Hampshire Avenue landfall (described in Section 2.3.6 of this document). A second smaller barge, capable of operating in shallow water, would also be used in conjunction with the larger installation barge.

Prior to pulling the cable ashore to the sea-land transition vault, the jet plow would be set up in the pre-excavation pit located at the offshore end of the drilled conduit. The cable would then be floated from the barge with assistance of small support vessels. The cable end would be anchored in place after being pulled through the Hydroplow and into the High Density Polyethylene (HDPE) conduits installed during the HDD and secured beyond the transition vault.

From the HDD exit point, the cable is embedded across the shallows by means of towing the jet plow along the cable route from the smaller barge's winch. The cable and jet hose would be supported by cable floats to maintain control of cable slack and the amount of hose out.

When the cable embedment has proceeded into deeper water and nears the larger installation barge, the operation would be transferred, and the barge would lift its spuds and begin winching along the cable route, with the six point mooring system towing the jet plow and feeding cable off the barge and into the plow funnel as it moves along the route at a rate equal to the barge movement. This would be repeated for the second circuit.

The barge would propel itself along the route with the forward winches, and the other moorings holding the alignment of the route. When the barge nears the ESP, the barge spuds would be lowered to secure the barge in place for the final end float and pull-in operation. The transmission cable would be pulled into the J-tube and terminated at the switchgear.

The following is a list of the primary installation equipment:

- Hydroplow cable burial machine designed for 6 ft burial depth;
- Installation barge 100 ft wide x 400 long x 24 height;
- Anchor handling tugs - two 3000 hp twin screw (would be with the barge for the duration of the installation);
- Six-point mooring system with two 60-inch (1.52 m) spuds. The mooring system would consist of 3 double winches, plus another double drum winch for controlling the two spuds. Each winch drum would contain approximately 2,000 ft (610 m) of 1 1/8 inch (28.6 mm) mooring cable and have an anchor attached. Mid-line buoys would be attached to minimize anchor cable scour. Pendant wire with 58-inch (1.48 m) steel ball buoys would be attached to anchors for deployment and quick recovery;
- Cable burial support system including pumps, and Hydroplow accessories;
- Cable laying support system including cable machines, chute, tubs and complete diving operations center to support divers;
- Auxiliary trencher pulling barge - a barge of 40 x 100 ft (12.2 x 30.5 m) dimensions outfitted with spuds; and
- Auxiliary vessels - there would be a crew boat, two inflatable boats, and several skiffs.

Jet plow equipment uses pressurized sea water from water pump systems on board the cable vessel to fluidize sediments. The jet plow device is typically fitted with hydraulic pressure nozzles that create a direct downward and backward “swept flow” force inside the trench. This provides a down and back flow of re-suspended sediments within the trench, thereby “fluidizing” the in situ sediment column as it progresses along the predetermined submarine cable route such that the submarine cable settles into the trench under its own weight to the planned depth of burial. The jet plow’s hydrodynamic forces do not work to produce an upward movement of sediment into the water column since the objective of this method is to maximize gravitational replacement of re-suspended sediments within the trench to bury or “embed” the cable system as it progresses along its route. The pre-determined deployment depth of the jetting blade controls the cable burial depth.

A skid/pontoon-mounted jet plow, towed by the cable-laying barge, is proposed for the submarine installation. This jet plow has no propulsion system of its own. Instead, it depends on the cable vessel for propulsion. For burial, the cable barge tows the jet plow device at a safe distance as the laying/burial operation progresses. The cable system is deployed from the vessel to the funnel of the jet plow device. The jet plow blade is lowered onto the seabed, pump systems are initiated, and the jet plow progresses along the pre-selected submarine cable route with the simultaneous lay and burial operation, creating a fluidized sediment trench approximately 4 to 6 ft (1.2 to 1.8 m) wide (top width) to a depth of 8 ft (2.4 m) below the present bottom into which the cable system settles through its own weight. The jet plow does not create an open trench of these dimensions but rather fluidizes the sediment with enough injected water that the cable can settle into the “soupy” sediments to a minimum depth of 6 feet below the bottom. The

jet plow device is equipped with horizontal and vertical positioning equipment that records the laying and burial conditions, position, and burial depth. The pontoons can be made buoyant to serve different installation needs.

The installation of the submarine transmission cable via jet plow embedment is anticipated to take approximately two to four weeks to complete. As the jet plow progresses along the route, the water pressure at the jet plow nozzles would be adjusted as sediment types and/or densities change to achieve the required minimum burial depth of 6 ft (1.8 m). In the event that the minimum burial depth of 6 ft (1.8 m) below present bottom is not met during jet plow embedment, additional passes with the jet plow device or the use of diver-assisted water jet probes would be utilized to achieve the required depth.

2.3.6 Landfall Transition Installation

The transition of the interconnecting 115 kV submarine transmission cables from water to land would be accomplished through the use of HDD methodology in order to minimize disturbance within the intertidal zone and near shore area. The HDD would be staged at the onshore landfall area and involve the drilling of the boreholes from land toward the offshore exit point. Conduits would then be installed the length of the boreholes and the transmission cable would be pulled through the conduits from the seaward end toward the land. A transition manhole/transmission cable splicing vault would be installed using conventional excavation equipment (backhoe) at the onshore transition point where the submarine and land transmission cables would be connected.

There would be four 18-inch (457 mm) diameter HDPE conduit pipes (one for each three-conductor 115 kV cable and fiber optic cable set) installed to reach from the onshore transition vaults to beyond the mean low water level. The offshore end would terminate in a pre-excavated pit where the jet plow cable burial machine would start. The four conduits would have an approximately 10 ft (3 m) separation within the pre-excavation area. The four boreholes would be approximately 200 ft (61 m) long (borehole diameters would be slightly larger than the conduit diameter to allow the conduit to be inserted in the borehole).

A drill rig would be set up onshore behind a bentonite pit where a 40 ft (12.1 m) length drill pipe with a pilot-hole drill bit would be set in place to begin the horizontal drilling. A bentonite and freshwater slurry would then be pumped into the hole. The HDD construction process would involve the use of bentonite and freshwater slurry in order to transport drill cuttings to the surface for recycling, aid in stabilization of the in situ sediment drilling formations, and to provide lubrication for the HDD drill string and down-hole assemblies. This drilling fluid is composed of a carrier fluid and solids. The selected carrier fluid for this drilled crossing would consist of water (approximately 95 percent) and inorganic bentonite clay (approximately 5 percent). The bentonite clay is a naturally occurring hydrated aluminosilicate composed of sodium, calcium, magnesium, and iron.

After each 40 ft (12.1 m) of drilling, an additional length of drill pipe is added, until the final drill length is achieved. To minimize the release of the bentonite drilling fluid into Lewis Bay, freshwater would be used as a drilling fluid to the extent practicable for the final section of drilling just prior to the drill bit emerging in the pre-excavated pit. This would be accomplished by pumping the bentonite slurry out of the hole, and replacing it with freshwater as the drill bit nears the pre-excavated pit. When the drill bit emerges in the pre-excavated pit, the bit is replaced with a series of hole opening tools called reamers, to widen the borehole. Once the desired hole diameter is achieved a pulling head is attached to the end of drill pipe and then the drill pipe is used to pull back the 18-inch (457 mm) diameter HDPE conduit pipe into the bored hole from the offshore end. As with the pilot hole drilling process, freshwater would be utilized to the maximum extent practicable as the reaming tool nears the pre-excavated pit.

Smaller conduits with pulling wires would be placed inside the 18-inch (457 mm) diameter HDPE pipe to house the submarine cable system. Once the internal cable conduits have been inserted into the 18-inch (457 mm) HDPE conduit, a clay/bentonite medium would be injected into the conduit system to fill the void between the cable conduits and the 18-inch (457 mm) pipe. The conduits would be sealed at both ends until the submarine cable system is ready to be pulled through the conduit. After submarine cable system installation, the conduits would be permanently sealed at each end to complete the installation process.

The HDD operation would include an onshore based HDD drilling rig system, drilling fluid recirculation systems, residuals management systems, and associated support equipment. The HDD drilling material handling equipment would be located on New Hampshire Avenue. The drilling would take place from the onshore to Lewis Bay. Excavated soils would be temporarily stored near the HDD drill rig during construction, and would then be reused onsite or removed and disposed of as required.

To further facilitate the HDD operation, a temporary cofferdam would be constructed in Lewis Bay. The cofferdam would be approximately 65 ft (19.8 m) wide and 45 ft (13.7 m) long and would be open at the seaward end to allow for manipulation of the HDD conduits. The area enclosed by the cofferdam would be approximately 2,925 ft² (271.7 m²). The cofferdam would be constructed using steel sheet piles driven from a barge-mounted crane. The top of the sheet piles would be cut off approximately 2 ft (0.61 m) above mean high water (MHW). The cofferdam is intended to help reduce turbidity associated with the dredging and subsequent jet plow embedment operations and to provide a visual reference to its location for mariners. While the cofferdams would be located outside of areas normally subject to vessel traffic, the location of the cofferdam would be appropriately marked to warn vessels of the temporary cofferdam presence.

The area inside the cofferdam would be excavated to expose the seaward end of the borehole. Sediment inside the cofferdam would be excavated to expose the area where the HDD borehole would end at an elevation of approximately -10 ft (-3 m) MLLW, with a 1 ft (0.3 m) allowable overdredge. A 20 ft (6.1 m) long level area would be created at the closed end of the cofferdam at this elevation. From that point, the bottom of the excavated area would be sloped at 4 horizontal:1 vertical until it meets the existing seafloor bottom contour. Approximately 840 yd³ (642.2 cubic meters [m³]) of sediment would be excavated from within the cofferdam. At the end of cable installation, the cofferdam excavation would be backfilled, rather than allowed to in-fill over time. The dredged material would be temporarily placed on a barge for storage, and then the dredged area of the cofferdam would be backfilled with the dredged material. If necessary, the dredged material backfill material would be supplemented with imported clean sandy backfill material to restore the seafloor to preconstruction grade.

The drilling fluid system would recycle drilling fluids and contain and process drilling returns for offsite disposal, and while the intention is to minimize the discharge or release of drilling fluids to marine or tidal waters in Lewis Bay, the HDD operation would be designed to include a drilling fluid fracture or overburden breakout monitoring program to minimize the potential of drilling fluid breakout into waters of Lewis Bay. It is likely that some residual volume of bentonite slurry would be released into the pre-excavated pit. The depth of the pit and the temporary cofferdam perimeter are expected to contain any bentonite slurry that may be released. Prior to drill exit and while the potential for bentonite release exists, diver teams would install a water-filled temporary dam around the exit point to act as an underwater "silt fence." This dam would contain the bentonite fluid as it escapes and sinks to the bottom of the pre-excavated pit to allow easy clean-up using high-capacity vacuum systems.

It is expected that the HDD conduit systems would be drilled through sediment overburden at the landfall location. However, it is anticipated that drilling depths in the overburden would be sufficiently deep to avoid pressure-induced breakout of drilling fluid through the seafloor bottom based primarily on

estimates of overburden thickness and porosity. Nevertheless, a visual and operational monitoring program would be implemented during the HDD operation to detect a fluid loss. This monitoring includes:

- visual monitoring of surface waters in the adjacent Lewis Bay by drilling operation monitoring personnel on a daily basis to observe potential drilling fluid breakout points;
- drilling fluid volume monitoring by technicians on a daily basis throughout the drilling and reaming operations for each HDD conduit system;
- development and implementation of a fluid loss response plan and protocol by the drill operator in the event that a fluid loss occurs. The response plan could include drill stem adjustments, injection of loss circulation additives such as Benseal that can be mixed in with drilling fluids at the mud tanks, and other mitigation measures as appropriate; and
- use of appropriate bentonite drilling fluids that would gel or coagulate upon contact with sea water.

In the event of an unexpected drilling fluid release, the bentonite fluid density and composition would cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment.

Each of the two landfall transition vaults would be approximately 8 ft (2.4 m) wide by 35 ft (10.7 m) long (outside dimensions). The submarine transmission cables would be spliced to the onshore transmission cables within these transition vaults. The transition vault would contain two 38-inch (965 mm) manholes for access and be installed approximately with its bottom ten ft (3 m) below grade. The submarine transmission cables would enter through the four 18-inch (457 mm) HDPE conduits and the onshore transmission cables would exit the landfall transition vault to the ductbank system through 6-inch diameter PVC conduits. There would be a total of 16 PVC conduits encased within concrete: 12 transmission cable conduits, two conduits for 96-fiber fiber optic cables for telecommunications, Supervisor Control and Data Acquisition (SCADA) and protective relaying, and two spare conduits for the onshore transmission cable.

It is anticipated that the installation of the borehole and conduit by HDD techniques would take approximately two to four weeks.

Upon completion of the installation of the conduit pipes and submarine cable system, the HDD equipment would be removed and New Hampshire Avenue would be restored to its pre-construction grades and conditions. Standard stormwater erosion and sedimentation controls would be installed on the site prior to the initiation of construction activities, and would be inspected and maintained throughout construction operations. Once construction is completed, all equipment and construction materials would be removed from the site and the area would be returned to its original condition.

2.3.7 Onshore Transmission Cable Installation

Construction of the onshore transmission cable would occur in two phases. The first phase would consist of installing the ductbanks, conduits, and vaults. The second phase would consist of the installation of the onshore 115 kV transmission cables, including splices and terminations. Phase I is anticipated to take approximately five months to complete. Phase II is also anticipated to take approximately five months. Once the installation of the duct bank and vaults (Phase I) has progressed

significantly from the landfall (approximately 2-3 months), the pulling and splicing of the onshore 115 kV cable (Phase II) would commence behind the duct bank installation crews. Assuming onshore construction commences in September, both Phases of installation are expected to be completed in the 9 month period prior to the following Memorial Day. Therefore, the installation of the onshore components would occur outside of the summer tourist season.

The onshore transmission cable installation, from the transition vault at the landfall to the Barnstable Switching Station, would involve installation of the transmission cable in the underground splice vaults and ductbanks within existing public ways and ROWs. Most excavation would be performed with standard machinery, including excavators and backhoes, with the exception of four railroad/state highway intersection crossings which would be accomplished using trenchless techniques. All work would be performed in accordance with local, state, and/or Federal safety standards.

Underground onshore transition vaults would be constructed approximately every 500 to 1,700 ft (152.4 to 518 m) (the approximate length of transmission cable that can be effectively transported by truck and pulled within manufacturer's tension specifications). These vaults would accommodate cable splicing and cross-bonding of cable metallic sheaths. Each of the two parallel underground onshore splice vaults utilized at each splice location would be approximately 8 ft (2.4 m) wide by 35 ft (10.7 m) long (outside dimensions) (see [Figure 2.3.7-1](#)). The underground onshore transition vaults would be placed approximately nine to ten ft (3 m) deep (bottom of vault) and each underground vault would contain two 38-inch (965 mm) manholes.

The transmission cables would be installed within a ductbank consisting of PVC conduits spaced approximately eight inches apart (on center) encased in unreinforced concrete (minimum of 2,000 lbs per square inch [psi]), which is backfilled with native material or suitable backfill to original grade. In addition, there would be two copper ground wires placed within the encasement. The trench opening would be a minimum of 10 ft (3 m) wide within the roadways and a minimum of 8 ft (2.4 m) wide within the ROW and supported by temporary trench boxes. The ductbank would be approximately 2 ft high by 5 ft 8 inches wide. Burial depth to the top of the ductbank would be a minimum of 56 inches (1.42 m) within the roadways to allow passage under existing water and gas lines and a minimum of 24 inches (610 mm) within the NSTAR Electric ROW (with the exception of road-crossings along the ROW where the burial depth would revert to 56 inches [1.42 m]). A warning tape would be placed approximately one ft below the surface of the trench opening for dig-in protection. There would be a total of 16 six-inch (152 mm) diameter PVC conduits inside the concrete ductbank. The ductbank would be installed in a single trench (see [Figures 2.1.3-4](#) and [2.1.3-5](#)).

The excavated soil from the trench and vaults would be temporarily stored adjacent to the worksite or transported off-site if on-site storage is not possible. Where soil is stored at the site, it would be stabilized with erosion and sedimentation controls. Following the completion of the installation of the transmission cable, the excavation would be backfilled and repaved. Stormwater erosion and sedimentation controls would be in place prior to the initiation of construction activities. Once construction is completed, all equipment and construction debris would be removed from the site and the area would be returned to its original condition.

To minimize the potential for erosion during construction, mitigation measures, such as hay bales and silt fences would be placed as appropriate around disturbed areas and any stockpiled soils. Prior to commencing construction activities, erosion control devices would be installed between the work areas and downslope water bodies and wetlands to reduce the risk of soil erosion and siltation. Erosion control measures would also be installed downslope of any temporarily stockpiled soils in the vicinity of waterbodies and wetlands. These mitigation measures would be fully described in an Erosion and Sedimentation Control and Storm Water Management Plan, which would incorporate applicable BMPs

for erosion control and stormwater management during construction. It is possible that dewatering of the excavated trench or vault locations close to the transition point would be required because of high groundwater. A de-watering plan would be prepared to address the procedures for handling of any water encountered during excavation.

Trenchless technologies would be employed in several areas along the onshore cable route to cross heavily traveled state highway layouts and railroad beds and avoid the disturbances caused by standard construction methods. Trenchless technologies may include HDD, Horizontal Boring, or Pipe Jacking.

In all instances where trenchless technology is used a starting pit would be excavated to initiate the advancement of a casing or carrier pipe. Both boring and pipe jacking require pre-excavated pits on either end of the cable segment to be installed. Shoring of the pit walls and dewatering may be necessary depending upon soil and groundwater conditions. The receiving pit is excavated at the receiving end to accept the casing or carrier pipe. Four carrier pipes would be used to accommodate all the conduits from the duct bank. Depending on the method used the casing is advanced by drilling, boring or simply pushing the casing pipe through the soil. Drilling would be similar to the HDD process discussed above for the shoreline crossing. Boring involves using an auger type drill head that removes soil from the drill hole into the pit, which is then stockpiled or removed from the site, in a manner similar to drilling a hole through a piece of wood. Pipe Jacking involves pushing a casing pipe into the soil, along the desired alignment, and removing the soil from within the casing pipe. The trenchless technology utilized would be selected on a case-by-case basis at each location and would depend on the distance required to advance the carrier pipe beyond the roadway or railroad in question, the nature of the soils at the location, and the space available for mobilization and excavation of starting and receiving pits.

Following the installation of the carrier pipes, transition vaults would be installed to transition between the standard duct bank installation and the carrier pipes.

2.4 OPERATION AND MAINTENANCE REQUIREMENTS AND PROCEDURES

2.4.1 Introduction

Any WTG, whether operating as an individual unit or within an array, is designed to operate without attendance by any operators. The monitoring is conducted over a SCADA system from a remote location. Such a monitoring station could be within a short radius of the wind turbine, or hundreds of miles away.

The local or regional monitoring center would have an effective level of control allowing remote intervention in the operation of the turbine. Sensors within the turbine's nacelle gather and transmit data via the SCADA system not only on the electrical performance of the generator itself but also on much of the critical associated equipment. Sensors include thermal, visual (web-cams), audio (microphones), vibrations (accelerometers) and a host of electrical measurements which combine to provide an accurate picture of the operating state of the turbine.

Bearing sensors are now configured throughout the drive train, including within the gearbox casing itself. Not only is the temperature of the gearbox oil monitored, but also the metallic content of it circulating within the cooling system. Changes in bearing temperature, vibration levels, acoustic profile and metallic content within the oil are all early indicators of potential failure. This level of information enables the remote operator to make decisions that would affect the degree of remedy that may be eventually required. Without remote intervention, such as shutting down the turbine, catastrophic failure of the gearbox may occur requiring an expensive and time consuming complete change-out of the gearbox. With early warning it is also possible for the remote operator to decide to reduce the output of

the particular wind turbine until such time as a technician can gain physical access in order to determine the precise nature of the problem.

The SCADA system also monitors elements such as navigation and aviation warning lights. However, with today's common use of multiple light-emitting diodes (LEDs) it is very rare that any illumination would be lost completely. Within the same area each access door lock is wired to monitor any attempt to gain unauthorized access to the wind turbine tower and its equipment.

The use of wave height radar detectors and vertically aligned web-cams are also useful to the shore based maintenance crew in determining the actual sea state at the site and judging their ability to gain marine access.

The operation and maintenance (O&M) of an offshore wind farm also includes those elements pertaining to the seabed and its environs. Scouring around the base of the turbine foundation and movement of the marine electrical cables are the most significant elements requiring periodic inspection in order to determine if anything has occurred either as a result of continuous strong currents or, a significant storm.

Service and maintenance falls into two distinctive categories:

- (1) The work that only requires personnel activity; and
- (2) The work requiring large marine vessel operation.

The latter requires a harbor base that can accommodate vessels with a significant draft whereas crew boats can operate from a typical sailing harbor located as close to the wind farm as possible. While much of the routine service and maintenance operations would likely occur during summer months because of the greater number of days with lower wave heights, other weather windows (approximately 3 days duration for maintenance of a single WTG) would be used throughout the year in order to minimize wear and tear and the potential for excessive equipment breakdown or parts replacement.”

2.4.2 Operation

It is anticipated that the main operation center for the proposed offshore farm would be located in the town of Yarmouth. The remote monitoring and command center where all decisions concerning the operation of the marine generating facility would be made would be located here. These operational decisions would also include any instructions received either manually or automatically from the operator of the ISO-NE. It is also to this center that all commands, instructions or requests would be received from government entities with marine and aviation safety and protection jurisdiction, such as the USCG, MMS and the FAA. All operations would be in accordance with MMS requirements, as well as the USCG terms and conditions received for this project ([Appendix E](#)).

The service and maintenance personnel would be stationed at one of two additional onshore locations: one for the parts storage and larger maintenance supply vessels and the second located closer to the site for crew transport. The maintenance operation would be based in New Bedford, Massachusetts and would also deploy several crew boats out of Falmouth, Massachusetts.

The New Bedford facility would be located on Popes Island. It would include dock space for two 65 ft (19.8 m) maintenance vessels, as well as a warehouse for parts and tool storage, and crew parking. An off-site warehouse would also be utilized to increase parts storage. The New Bedford facility would house tools, spare parts and maintenance materials and would be organized to support daily work assignments. These would be loaded into small containers, assigned to each of the work teams and

loaded onto the maintenance vessel for deployment to the wind farm site. The maintenance vessel would then go to either the WTG or the ESP and offload the containers for the work crews. During maintenance operations, one vessel per day would leave the New Bedford facility, go to the site of the proposed action, and then return.

Additional dock space would be rented in Falmouth Inner Harbor. From this facility work crews would be deployed to either the WTG and/or the ESP in 35 to 45 ft (10.7 to 13.7 m) long crew boats manned by professional mariners. In addition, a high-speed emergency response boat (20 to 25 ft long boat) would be maintained at this harbor ready to respond whenever there is marine activity taking place.

The Control and Monitoring center in Yarmouth would maintain a 24/7 telecommunication protocol with all members of the operation both at management level as well as the engineers. As is normal with such operations a roster system is in place whereby designated personnel are on emergency call-out during the night, weekends and holidays. Night and holiday watch staff at the center would normally be restricted to two persons.

Depending upon the chosen manufacturer of the WTGs the SCADA system would normally monitor the following parameters through remote access:

Electrical:

- Power (Output/reactive)
- Voltage
- Frequency
- Recorded Power Curve

Climate:

- Wind speeds
- Wind direction
- Temperature
- Humidity
- Atmospheric pressure/s
- Wave heights

Turbine:

- Temperatures
- Humidity levels
- Acoustics
- Particulates
- Transformer gases
- Other

Service

While much of the routine service and maintenance operations would likely occur during summer months because of the greater number of days with lower wave heights, other weather windows (approximately 3 days duration for maintenance of a single WTG) would be used throughout the year in order to minimize wear and tear and the potential for excessive equipment breakdown or parts replacement.

If a WTG required this level of repair, a longer period of low wave heights and suitable weather conditions would be required in order to allow access and suitable working conditions. The duration necessary to complete a repair would be determined and the next available opportunity would be capitalized upon to complete the repair. Given the typically more suitable conditions during summer months, more repairs may occur during summer than winter months.

Planned preventative service and maintenance of a WTG would include:

- Testing of fog horns;
- Cleaning of the machine rooms;
- Changing of carbon brushes;
- Changing of filters for air and all liquids as necessary;
- Topping up of all fluids;¹
- Replacement of defective instruments;
- Change-out of calibrated anemometers;
- Cleaning of lenses;
- Recharging of auto-grease systems;
- Appropriate local measurements;
- Control of dehumidifiers;
- Torquing of bolts;²
- Replacement of brake pads;
- Control / replacement of hazard warning lights; and
- Heavy duty electrical connections.

Routine service, excluding the 100 percent bolt torquing and major oil change is usually a two day exercise for 3 to 4 persons. Such a 3 to 4 man crew would normally consist of an electrical technician, an electronics/instrumentation technician, a mechanical technician and a general helper.

All personnel would be trained in maritime operations and survival including emergency evacuation of the turbine nacelle. Every operative is equipped with a life jacket and survival suit. Provisions for emergency stays are provided in the event that conditions occur suddenly which precludes offloading of maintenance personnel.

In the event of a medical emergency it would be normal for affected personnel to be evacuated by a helicopter hoist from the heave-hoist platform atop of the nacelle.

Servicing of the offshore ESP would be conducted by the crew of a specialist sub-contractor trained in the service and maintenance of HV equipment. The platform would be similarly equipped with survival equipment and rations to be used in the event of weather prevented egress. As this structure would include a helicopter landing platform, emergency evacuation can be affected by direct conveyance onto the aircraft rather than via a hoist cable.

¹ Depending on manufacturers, gearbox oil is usually changed after one year of operation and thereafter every two years. Some manufacturers have longer intervals. For this operation a larger vessel is required than the regular crew boats. Drums of oil must be transported, lifted to the transition platform and hoisted up the tower to the nacelle machine room. Equally, the old oil must be transported in reverse. This operation is usually conducted by a separate team taking approximately one day per turbine. The Project would have a detailed Spill Prevention Control and Counter Measure Plan (SPCC) to ensure proper oil handling procedures are used and to provide procedures to address possible contingencies in the use of oil or other potential pollutants.

² Torquing of all tower flange bolts is typically conducted after the first 100 hours of operation, and then again after twelve months of operation. Thereafter 10 percent of the bolts of each flange are torque tested on an annual basis.

2.4.3 Maintenance

Unplanned maintenance on any part of the WTG is carried out in response to a breakdown or failure. This activity may be simple and require only hand tools, in which case the normal crew vessels would suffice. If there is a requirement to exchange larger items, the use of the 65 ft maintenance vessel would be required to transport and lift the particular items. Such items of equipment could be an electrical control cabinet, and 33kV voltage transformer, generator, gearbox parts, etc. The ability to conduct such operations would depend heavily on the prevailing weather conditions. It is unlikely that such repairs could be carried out where significant wave heights exceed 4.9 ft (1.5 m). Accurate weather forecasting is an essential ingredient in the planning of such offshore operations where a weather window of 1 to 3 days is required to complete the task.

2.4.3.1 Maintenance Intervals

Based on both offshore and onshore WTG operational experience, five days per year per turbine has been established as the anticipated maintenance requirement. These visits cover two days of planned or preventative maintenance, and three days of unplanned or forced outage emergency maintenance. The WTG design is based on a twenty year operating life and all components have been analyzed to meet this design criterion. Based on 130 WTGs, this is equivalent to 630 maintenance days. Based on 252 workdays per year (which adjusts for weather days and holidays) this results in 2.5 work teams or conservatively three teams being deployed. During these deployments, maintenance on the ESP would be included. Experience has shown that wind speeds must be less than 17.9 mph (8 m/s) to gain safe access to the WTGs, although safe access with winds up to 26.8 mph (12 m/s) is possible depending on direction and sea state. Based on these weather related concerns, the number of trips per day could be altered to take advantage of good weather.

The submarine cables would be inspected periodically to ensure adequate coverage is maintained. If problem areas are discovered, the submarine cables would be re-buried. Depending upon the extent of re-burial required, either hand jetting or re-deployment of a jet plow would be used.

2.4.3.2 Number of Vessel Trips

Based on the above analysis the normal activity would include two vessel trips per working day (252 days/year), which would include one crew boat from Falmouth and the maintenance support vessel from New Bedford. In addition, an occasional second round trip from Falmouth could take place in times of fair weather or for emergency service.

2.4.3.3 Major Repairs

Major repairs are classed as those that require the intervention of a special heavy lift jack-up vessel similar to the one that would have been used during the original construction of the wind farm.

The items requiring replacement include:

- Turbine blades;
- Hub unit;
- Main drive shaft;
- Gearbox; and
- Complete nacelle.

Limitations on jack-up vessels are usually related to the sea state at the time of jacking up/down. Due to the height of their jib crane, they are restricted to lifting when wind speeds are less than 12 m/s (25 mph). If a WTG required this level of repair, a longer period of low wave heights and suitable weather

conditions would be required in order to allow access and suitable working conditions. The duration necessary to complete a repair would be determined and the next available opportunity would be capitalized upon to complete the repair. Given the typically more suitable conditions during summer months, more repairs may occur during summer than winter months.

2.4.3.4 Inspections

Under the terms of any MMS authorization, MMS would require inspections to take place to ensure worker, structural, engineering and environmental safety. Such inspections would be carried out on a regular basis, as determined by MMS and set forth in the authorizing instrument.

Blades: The WTG blades operating in a marine environment tend to be self-cleaning and therefore are not anticipated to require inspections on a regular basis. Deterioration of the measured power curve is an indicator that blade surfaces have become excessively pitted or have a high level of salt encrustation, at which point cleaning of the blades would be undertaken.

Towers: The WTG tower would normally be inspected externally once every five years unless there are obvious signs of corrosion developing that were not predicted. These visual inspections are conducted from a manned basket lowered from and with the nacelle mounted winch.

Foundations: The steel monopile foundations, and their associated transition sections and platforms are inspected on an annual basis usually at the time of the planned service visit. It is the areas within the splash zone that are most prone to corrosion as a consequence of occasional instances of inferior treatment coating during manufacturing or installation.

Cathodic Protection: The sacrificial anodes would be inspected on an annual basis and replaced as required.

Scour Protection: The seabed around the base of the monopile foundations would have scour protection (scour mats or rock armor) installed in order to provide the required level of protection from scouring. It is prudent to visually inspect the seabed footing after the first year of being installed and thereafter at least on a biennial basis if no initial deterioration has been observed. It may also be prudent to conduct sample surveys after any significant storm activity. Such inspections can be carried out by divers or by the use of Remote Operated Vehicles (ROVs) carrying underwater cameras and lighting.

Marine cables: Though the electrical cables are to be buried to a depth of 6 ft (2 m), there would be inspections of these runs conducted during the early years following their laying. A full inspection may be appropriate after the first two years, and thereafter on a random basis conducted at the same time as the scour protection inspections. As with the scour protection, it would also be prudent to conduct such an inspection after the first major storm affecting the area.

2.4.4 WTG Work Crew Deployment

The work crews would be transferred from the crew boat to the WTG by exiting the stern of the vessel. This operation would be performed only when the sea conditions are within the workable range of the crew and vessels.

2.4.5 ESP Service

The ESP would have a helicopter-landing platform in addition to the boat dock. This would allow for maintenance crews to be deployed to the ESP during periods when wind and wave conditions are unsuitable for boat transfers. The helicopter platform would also allow for emergency evacuation of any individuals who may become injured.

2.4.6 Submarine Cable Repair

The potential for a fault occurring during the operational lifetime of a buried cable system is minimal, based on industry experience. However, a cable repair plan would be formulated by the applicant to cover the remote possibility of a fault occurring in the offshore submarine cable system. The focus would be to repair the cable quickly, while minimizing or eliminating environmental and community impacts.

Should a cable failure occur, a cable repair plan would be implemented. Once the location of the fault is identified, should the cable fault occur in the onshore sections of the project, then typical trench, repair and backfill methods would be used and no formal fault plan required. Communication with the appropriate people would take place at least 48 hours prior to repair and would specify the location, method, and date of work. Along the submarine cable, the procedures listed below are one way of repairing a cable fault.

- Mobilize the splice boat and fine tune the location of the fault;
- The splice boat would likely be a barge, equipped with water pumps, jetting devices, hoisting equipment and other tools typically used in repairs of cables;
- Expose the cable with hand-operated jet tools and cut the cable in the middle of the damaged area;
- Position the repair vessel above the cut cable, and raise one end;
- Cut off the damaged portion of the cable;
- Perform a cable splice between the retrieved cable and one end of the spare cable onboard;
- Pay out cable and move to the other end of the spare cable, keeping a portion of the spare cable onboard;
- Retrieve the other damaged cable end;
- Cut off the damaged portion of the cable;
- Perform a cable splice between the retrieved cable and the remaining end of the spare cable onboard;
- Lower the second joint and position it on the sea bottom;
- Hand jet the repaired and exposed sections into the sea bottom; and
- Demobilize the repair vessel.

2.5 DECOMMISSIONING METHODOLOGY

The applicant is required to submit a decommissioning plan to MMS for approval which must comply with MMS's structural removal standards. Upon decommissioning of the facility, the applicant must implement the decommissioning plan to remove and recycle equipment and associated materials, thereby returning the area to pre-existing conditions.

The applicant would be obligated to remove the project once operations have ceased. The applicant would provide a financial instrument or other assurance to the reasonable satisfaction of the MMS, which would secure its obligations to decommission the facility to the satisfaction of MMS and pursuant to the terms of its authorization.

The decommissioning process is largely the reverse of the installation process. Decommissioning can be broken down into several steps, closely related to the major components of the facilities:

- Inner-array cables;
- Submarine transmission cables;
- Turbine generators and towers, monopile foundations, scour mats or rock armor scour protection, ESP; and
- Onshore transmission cables.

It is anticipated that equipment and vessels similar to those used during installation, would be utilized during decommissioning. For offshore work, this would likely include a jet plow, crane barges, jack-up barges, tugs, crew boats, and specialty vessels such as cable laying vessels or possibly a vessel specifically built for erecting WTG structures. For onshore work, traditional construction equipment such as backhoes and cable trucks would be utilized. The environmental impacts from the use of this equipment during decommissioning activities would be similar, although not identical, to impacts experienced during construction as described in Section 5.0.

The decommissioning of the offshore facilities would necessitate the involvement of an onshore disposal and recycling facility with the capacity and capabilities of handling the large quantities of steel, fiberglass and other materials from the Project. Acknowledging the fact that other potential onshore disposal and recycling facilities may exist 20 years from now that may prove to be more desirable, facilities do currently exist that are capable of handling the materials. Prolerized New England Inc. operates several facilities, two which are located in Everett Massachusetts, and Johnston Rhode Island. Prolerized staff has indicated that they have the capabilities and capacity to handle the disposal and recycling of the materials from the proposed action, if it were to take place today. The Everett facility has deep water access, allowing for the steel towers and monopiles to be directly offloaded from the barges, cut into manageable sections, sheared into smaller pieces and then shipped to end-users as scrap metal. For this reason, the Everett facility would be the proposed location for the onshore disposal and recycling of project materials. Currently there is no commercial scrap value for the fiberglass in the rotor blades. The fiberglass from the blades would be cut into manageable pieces and then disposed of as solid waste at an approved onshore facility.

2.5.1 Decommissioning Process

The initial step in the decommissioning process would involve the disconnection of the inner-array 33 kV cables from the WTGs. The cables would then be pulled out of the J-tubes, and removed from their embedded position in the seabed. Where necessary the cable trench would be jet plowed to fluidize the

sandy sediments covering the cables, and the cables would then be reeled up onto barges. The cable reels would then be transported to the port area for further handling and recycling.

The WTGs would be prepared for dismantling by properly draining all lubricating fluids according to established O&M procedures, and removing the fluids to the port area for proper disposal and/or recycling. This would be followed by the WTGs being deconstructed (down to the transition piece at the base of the tower) in much the same way as they were installed. Utilizing the same or similar types of cranes and vessels as during their construction, the blades, hub, nacelle, and tower would be sequentially disassembled and removed to port for recycling.

Once the wind turbines and towers have been removed, the foundation components (transition piece, monopile, scour mats, and rock armor) would be decommissioned. Sediments inside the monopile would be suctioned out to a depth of approximately 15 ft (4.6 m) below the existing seabottom in order to allow access for the cutting of the pile in preparation for its removal. The sediments would be pumped from the monopile and stored on a barge. All scour mats would be recovered, brought to the surface by crane, placed on a barge and brought to port for recycling or disposal. In those locations where rock armoring has been used for scour protection, it would be excavated with a clamshell dredge, placed on a barge, and disposed of at an upland location. The monopile would then be cut from the inside at approximately 15 ft (4.6 m) below grade. The sediments previously removed from the inner space of the monopile would be returned to the depression left when the monopile is removed, using the vacuum pump and diver assisted hoses in order to minimize sediment disturbance and turbidity. Depending upon the capacity of the available crane, the assembly above the cut may be further cut into more manageable sections in order to facilitate handling, and then placed on a barge for transport to the port area for recycling. Cutting of the pile would likely be done using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or high pressure water jet.

2.6 SOLID AND HAZARDOUS MATERIALS

Construction, operation, and decommissioning would involve the transport, handling, and disposal of material considered to be hazardous to the environment and humans should they be handled, released, or disposed of in an inappropriate or illegal manner. This section presents the types of oils, lubricants, and greases that would be used, and the measures the applicant has proposed to ensure compliance with relevant regulations and laws.

2.6.1 WTG Fluid Containment

The WTG would utilize lubricating oil, cooling liquids, and grease, all of which would be located in the nacelle or hub. The WTG has been carefully configured to contain any fluid leakage and prevent overboard discharges. The primary WTG components and the fluids are:

- **Hub** - The hub houses the blade pitching system, which is controlled by electric motors and contains only grease to lubricate parts.
- **Main bed plate** - Inside the main bed plate (located in the nacelle) is the oil conditioning system of the gearbox, main bearing, and generator bearings. The fluid capacity of the gearbox and bearings is approximately 190 gallons. As part of the oil conditioning system an oil/water cooling system is also located in the main bedplate. In the event of leaking gear oil or a broken hose/pipe, the leaking oil would be guided through the manhole in the bottom of the bedplate and collected on the upper internal platform of the tower.

- **Tower** - The upper internal platform is designed and sealed in such a way that it can withhold the total amount of gearbox and hydraulic fluid until it can be transferred to containers for safe disposal.
- **Fluids** - The fluids utilized in the various systems include gear oil, mineral oil for the hydraulic system and a water glycol mix for the cooling system.

The possibility of leaks may occur in two different situations: (1) during service and maintenance; and (2) during operation:

- **Service** - During the servicing and maintenance of a WTG, a spill could happen during oil changes of hydraulic pump units or the gearbox oil conditioning system.
- **Operation failures** - During WTG operation, leakage may occur as the result of broken gear oil hoses/pipes, and/or broken coolant hoses/pipes. Gear oil leaks would be contained within the hub and main bed frame and/or tower as described above. Coolant leaks can occur in a number of locations within the nacelle and would be contained inside the nacelle fiberglass cover.

In order to minimize and mitigate any spill incidents, all service vessels would be equipped with oil spill handling equipment. In addition, waste collection systems would be installed on board each WTG. The waste collection system is based on a container system for easy and safe handling during transfer from/to turbine-service vessel-dock. The waste would be separated (i.e., used oil, coolant liquids, filters, paper/rags, etc.) for correct disposal once the containers are off-loaded at the dock.

2.6.2 ESP Fluid Containment

The ESP would have small amounts of lubricating oil, greases and coolants in pumps, fans, air compressors, emergency generators, and miscellaneous equipment, plus diesel fuel. The ESP would also have four oil-cooled step up transformers.

The primary systems and fluid contained are as follows:

- **Main Transformer** - The four 110-megavolt amp (MVA) oil cooled main step up transformers would each have a capacity of approximately 10,000 gallons of dielectric cooling oil. The oil would be circulated through oil/air heat exchangers mounted on the roof of the platform. Each transformer would be mounted in a leak proof detention area that would have the capacity of holding 150 percent of the transformer oil. Each of the detention areas would be connected via valves to a storage tank that has the capacity to store 100 percent of the oil from all four transformers. The oil piping to the coolers and the coolers would be configured so that any failures would result in oil being drained to the detention area.
- **Miscellaneous equipment** - Various pumps, fans, and an air compressor would be installed on the platform. They would be lubricated with either grease or oil in small quantities. The equipment would be installed in such a way that any leakage would be contained on the sealed deck of the ESP.

The ESP would have sealed, leak-proof decks, which would act as fluid containment. In addition, spill containment kits would be available near all equipment. The details of spill containment equipment and related spill control measures would be provided in Spill Prevention Control and Countermeasure (SPCC) Plan prior to operation of the facility.

2.6.3 Oil Spill Planning, Preparedness, and Response

MMS is the Federal agency responsible for oversight of oil spill planning, preparedness, and response for the proposed action. Specifically, the MMS requires that owners or operators of oil handling, storage, or transportation facilities that are located seaward of the coastline submit oil spill response plans (OSRPs) to MMS for approval prior to operations of that facility.

Since the ESP and the WTGs would contain various amounts and types of oil, the applicant would develop a SPCC plan which would meet the requirements of the OSRP in accordance with the above federal regulation. The OSRP must address all applicable components of the proposed action including the WTGs.

Additionally, the SPCC Plan/OSRP must describe the processes and procedures that would be used in the event of an oil spill from oil storage operations and would include, but not be limited to the following components:

- Designation of a trained qualified individual;
- Designation of a trained spill management team available on a 24-hour basis;
- Description of the spill-response operating team;
- A planned location for a spill-response operations center;
- Procedures for the early detection of a spill;
- Procedures for spill notification;
- Oil Spill Response Organizations that the plan cites;
- Contact information for Federal, State, and local regulatory agencies that must be notified when an oil spill occurs;
- Methods to monitor and predict spill movement;
- Methods to identify and prioritize the beaches, waterfowl, other marine and shoreline resources, and areas of special economic and environmental importance;
- Methods to protect beaches, waterfowl, other marine and shoreline resources, and areas of special economic or environmental importance;
- Methods to ensure that containment and recovery equipment as well as the response personnel are mobilized and deployed at the spill site; and
- An inventory of spill-response materials and supplies, services, equipment, and response vessels available locally and regionally.

2.7 POST LEASE GEOTECHNICAL AND GEOPHYSICAL FIELD INVESTIGATIONS

If MMS grants a lease for the proposed action, following issuance of the lease, a marine shallow hazards survey and a supplemental geotechnical program would be conducted prior to construction. The geotechnical and geophysical (G&G) field investigations would be designed to collect sufficient information, coupled with previous site-specific field data, to further characterize the surface and subsurface geological conditions within the vertical and horizontal areas of potential physical effects (APPEs), in preparation for final design and construction. These areas include the offshore construction footprints and associated work areas for all facility components, including the WTGs, the ESP, the inner array cables, and the 115 kV transmission cable to shore.

The shallow hazards survey would be designed to identify and evaluate conditions that might affect the safety of proposed activities, or conditions that might be affected by proposed activities. The supplemental post-lease geotechnical program would further analyze sediments and physical conditions within the proposed action APPEs, for use in final foundation design and to develop site-specific BMPs for constructability.

The survey plan, including the geophysical trackline spacing and coverage necessary to identify and delineate potential shallow hazards, would be finalized post-lease in consultation with the applicant and MMS. The shallow hazards survey would include a detailed geophysical program and would integrate the results of the supplemental geotechnical program, to build upon the previous offshore investigations.

2.7.1 Shallow Hazards Survey Geophysical Program

A high resolution geophysical survey (HRGS) would be conducted such that the quality and resolution of the data is adequate to delineate the extent of shallow hazards identified. Potential hazards to be assessed include, but are not limited to (subject to final development of the plan), the following:

- **Seafloor and/or shallow subsurface conditions:** locations, sizes and orientations of sand waves; boulders; man-made anomalies and debris; areas of sub-aquatic vegetation; presence of potential mud diapirs and gas venting features, areas of slope instability, shallow faulting.
- **Subsurface conditions to a minimum target depth of 200 ft (61 m) below the seafloor at the ESP location and 100 ft (30.5 m) at the wind turbine locations:** faults; shallow gas deposits, buried channels; potential for liquefaction, submarine slides, or slumping; and risk of seismic and tsunami events appropriate to the design life of the structures.

Rectilinear geophysical tracklines would be run specifically for the purpose of the shallow hazards assessment, and are anticipated to be oriented to capture expected dip and strike of the Horseshoe Shoal structure (subject to final survey design consultations). Up-to-date bathymetry would be collected using either single-beam or swath bathymetry, depending upon water depth and conditions. Two types of subbottom profiler datasets would be collected: the shallow (Chirp) and intermediate depth (Boomer) subbottom profiler data, the latter with resolution sufficient to penetrate a minimum of 200 ft (61 m) below the seafloor. If subsurface conditions are such that the intermediate Boomer cannot penetrate to the minimum target depth of 200 ft (61 m) below the seafloor, a deep-penetration Boomer profiler system would be used. Sidescan sonar and magnetometer data would also be collected, sufficient to identify potential obstacles on or just below the seafloor within the APPEs.

The shallow hazards geophysical survey would be conducted prior to the supplemental geotechnical program. Data from the survey would be used to finalize the geotechnical sampling locations.

The types of impacts to resource categories due to the geophysical survey are comparable to those resulting from the operation of an inshore lobster-fishing sized vessel. Because the trackline spacing would be finalized post-licensing, based upon the requirements of the selected contractor, the duration of the vessel deployment remains to be determined. At this time, it is expected that the geophysical survey would take several months to complete.

During the survey, an array of geophysical tools would be towed within the water column behind the vessel at certain depths above the seafloor. There would be no disturbance of the seafloor. The vessel would operate approximately 10 hours per day during relatively calm sea conditions in the warmer

seasons. The vessel would travel at approximately 15 knots when transiting between port at Falmouth to the survey area (1 hour each way), and at approximately 3 knots (5.6 kilometer per hour [km/h]) during the 8 hours of actual survey time per day. The vessel would continuously transect the area, obtaining an estimated 30 linear miles (48.3 km) of data each day, before returning to port each night.

2.7.2 Supplemental Geotechnical Program

Whereas the geophysical investigations do not involve seafloor disturbance or the collection of samples for analysis, the geotechnical program does involve the use of coring and boring equipment to collect sediment samples for laboratory analyses, which would disturb the seafloor in small discrete locations.

2.7.2.1 Vibracores

Additional vibracores would be taken along the proposed 115 kV cable route (approximately 2 vibracores per mile [1.6 km]) and along the inner array 33 kV cable routes (1 vibracore approximately every 3.5-mile [5.6 km]). Sediments from some of these vibracores would be evaluated for thermal resistivity for final cable design.

The vibracores would be advanced from a small gasoline-powered vessel likely less than 45 ft (14 m) in length. Approximately 50 additional vibracores are planned at this time, although the final number would be determined in consultation with the selected contractor and final design firm. Up to 6 vibracores can be collected in a field day with favorable bottom conditions and calm seas. The diameter of the core barrel is approximately 4 inches (102 mm), and the cores are advanced up to a maximum of 15 ft (4.6 m). The vessel is anchored during coring.

2.7.2.2 Borings

Approximately 20 borings additional to the previous 22 would be advanced at selected WTG sites, including those at the approximate corners of the site of the proposed action on Horseshoe Shoal, to span the vertical APPE of the proposed structures, and to collect site specific geotechnical data to assist in final foundation design. The analytical program would address liquefaction potential, gas concentrations in sediments, pressure regimes of gaseous sediments, and gas saturation versus shear strength properties of sediments.

The estimated 20 borings would be advanced from a truck-mounted drill rig placed upon a jack-up barge that rests on spuds lowered to the seafloor. Each of the four spuds would be approximately 4 ft (1.2 m) in diameter, with a pad approximately 10 ft (3 m) on a side on the bottom of the spud. The barge would be towed from boring location to location by a tugboat. The drill rig would be powered by a gasoline- or diesel-powered electric generator. Crew would access the boring barge daily from port using a small boat. Borings generally can be advanced to the target depth (100 to 200 ft [30.5 to 61 m] depending on location) within 1 to 3 days, subject to weather and substrate conditions. Drive and wash drilling techniques would be used; the casing would be approximately 6 inches in diameter.

2.7.2.3 Cone Penetrometer Testing (CPT)

CPT or an alternative subsurface evaluation technique (appropriate to site-specific conditions) would be conducted prior to construction as necessary, to evaluate subsurface sediment conditions. A CPT rig would be mounted on a jack-up barge similar to that used for the borings. The top of a CPT drill probe is typically up to 3 inches (76 mm) in diameter, with connecting rods less than 6 inches (152 mm) in diameter.

2.7.2.4 Report and Maps

A shallow hazards assessment report, including analytical results of the supplemental geotechnical program, would be submitted to MMS prior to commencement of operations and pursuant to the terms of the MMS authorization. The report would describe surficial and subsurface geologic conditions and geotechnical properties of sediments within the proposed action's marine APPEs.

3.0 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives to the proposed action must be derived from the stated purpose and need. In accordance with the CEQ regulations for implementing the NEPA, reasonable alternatives must be rigorously explored, objectively evaluated and, for those alternatives eliminated from detailed study, a brief discussion on the reasons for elimination must be provided. Additionally, reasonable alternatives not within the jurisdiction of the lead agency must be included in the analysis. Geographical and non-geographical alternatives (including No Action taken) must be analyzed and screening criteria must be clear and conclusive to insure that alternatives considered meet the basic purpose and need and are technologically feasible and economically viable. Discussion on the environmental impacts of the alternatives is first offered in a concise descriptive summary in a comparative form with associated tables. The environmental impacts of the proposed action, no action and considered alternatives are then subject to detailed analysis presented in sections on the affected environment (CEQ § 1502.15) and the environmental consequences (CEQ § 1502.16). The decision maker and the public are then provided with a description of issues and a clear basis for a choice to be made of the options available.

3.1 SCOPE OF ALTERNATIVES

To address the requirements under NEPA as described above, MMS conducted a comparison of other potentially reasonable alternative locations for offshore wind facilities in the New England region of the United States. CEQ §1502.14 requires the EIS to examine reasonable alternatives to the proposed action. In accordance with CEQ's guidelines for applying NEPA, reasonable alternatives are defined as those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant. Furthermore, an alternative that is outside the legal jurisdiction of the lead agency must still be analyzed in the EIS if it is reasonable. A potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered (CEQ § 1506.2(d)).

The purpose and need of the proposed action is to provide a renewable energy facility that utilizes the unique wind resources offshore of New England using a technology that is currently available, technically feasible, and economically viable, that can interconnect with and deliver electricity to the NEPOOL grid, make a substantial contribution to enhancing the regions electrical reliability and achieving the renewable energy requirements under the Massachusetts and regional RPS. With consideration of this, sites potentially capable of achieving this purpose and need were included in the scope of analysis. Analyzing such sites in this EIS provides the decision-maker as well as cooperating agencies and the public, useful information for understanding the environmental impacts of potential alternatives and comparing such impacts to the impacts of the proposed action.

3.2 PRELIMINARY SCREENING ANALYSIS

To select its alternatives for detailed evaluation, MMS first developed a screening process aimed at eliminating those project alternatives which did not meet the purpose and need statement (see Section 1.1) of the proposed action and which were not technically feasible and economically viable with the proposed action. The geographic scope of the alternatives analysis included areas offshore of the New England States.

3.2.1 Define Screening Analysis Criteria and Methodology

The criteria used in the screening analysis considered the applicability to the purpose and need for the proposed action, economic viability, and technological feasibility. The alternatives were then subjected to the screening criteria. The failure to meet the described criteria was considered cause for the elimination of the alternative. The geographical and non-geographical alternatives that met the described criteria

were then carried with the proposed action and no action alternative to further detailed environmental analysis. The screening criteria described below include applicability to the project's purpose and need, economic viability, and technological feasibility.

3.2.1.1 Applicability to the Project's Purpose and Need

Alternatives to be considered for detailed environmental analysis must meet the basic purpose and need as described in Section 1.1. Specifically, alternatives to the proposed action involve exploitation of offshore wind energy resources and the ability to operate with current technology on a scale capable of making a substantial contribution to the state's mandated percentage of energy required from renewable sources.

3.2.1.2 Economic Viability

In order to understand whether different alternatives were economically comparable, MMS developed an economic model to assess the economics of offshore wind facilities. The model was used to rank the alternative sites according to their relative economic performance, taking into account the projected schedule for development. The cost of energy was chosen as the measure of economic performance. A detailed description of the economic model as well as independent peer review comments on the model is available in [Appendix F](#).

The results of the economic model show that the site of the proposed action (Horseshoe Shoal site) has the greatest economic potential and that South of Tuckernuck Island, Monomoy Shoals, and the Smaller Project alternatives are generally economically comparable in terms of their cost per kilowatt hour (kWhr), albeit somewhat higher.¹

3.2.1.2.1 ISO Operation and Cost of Electricity

Electricity producers bid on the price of electricity on an hourly basis and therefore the price paid varies during the day throughout the year. The bidding is based on each producers particular set of costs for generating the electricity and the amount of profit they are trying to make. The New England ISO bidding system has made the production and sale of electricity a highly competitive process where slight changes in generation costs or production levels can have a major affect on profitability. Wind projects are particularly vulnerable to varying production because the source of the fuel (wind) cannot be controlled and hence the instantaneous amount of generation cannot be controlled. This factor alone affects how a wind energy producer would bid into the ISO system and what price they would be paid for their electricity. Since energy production output from a wind energy facility has less certainty than conventional power plants, it is important in assessing alternatives in the siting and design of a wind energy facility to understand factors that affect the generation and the sale of electricity within the ISO operating system, as this affects the profitability and ultimately the viability of the project (Refer to [Appendix F](#)).

3.2.1.3 Technological Feasibility Requirement

The technological feasibility requirement describes physical criteria that set the parameters within which a project can be constructed and operated, as well as, the technology available for construction and operation. Physical site screening criteria include water depth, extreme storm wave (ESW) height, avoidance of bedrock and large boulders, distance from the generation site to the onshore transmission system, and wind speed.

¹ Cost of energy is defined for this analysis as the starting electricity sales price, in 2007 dollars per kWhr, needed to meet or exceed a specified debt coverage ratio after the project is placed in service. Debt coverage ratios were calculated as the future annual operating cash flow divided by the principal and interest payment for a given year.

3.2.1.3.1 Water Depth

Water depth criteria include both a minimum and a maximum, given current construction method technologies and equipment, and foundation design. The current foundation technology limitations require that offshore wind projects be located in areas of water depths generally less than 100 ft (30 m) in depth to be considered economically feasible. Most existing commercial scale offshore wind projects are sited in areas of water depth ranging from 8 to 65 ft (2.5 to 20 m). Since offshore construction requires large vessels that typically draft at least 7 ft (2.1 m), waters shallower than this are inaccessible. The monopile is the current state of the art for offshore foundations, and this technology is limited by deeper water depths because of the horizontal loading forces of waves and wind. At water depths greater than about 70 ft (21.3 m) the monopile diameter becomes so large and the wall thickness so great in order to withstand the loading over greater height above the bottom, that it is not technologically feasible to manufacture, transport and install a monopile of this design, and a different type of foundation design is required (e.g., multi-legged foundation).

Water depths in the 65 to 147 ft (20 to 45 m) range are currently being pursued on several demonstration projects (such as the Beatrice Demonstrator Project). Depending upon the site specific characteristics of waves, water depths, and bottom conditions, a large commercial scale project could include a variety of foundation types in order to balance technology needs with costs (see [Table 3.2.1-1](#)).

3.2.1.3.2 Storm Wave

Storm wave criteria actually reflect a combination of wave heights and water depths, since the energetics associated with a long period swell passing by a wind turbine foundation are different than a breaking wave. As waves come to shore or approach shallow water associated with a shoal, drag on the bottom increases, causing the wave to stack up and assume a more vertical face, which at some point becomes unstable and the top of the wave curls forward and collapses. Waves affect an offshore wind turbine in two primary ways. Either a large wave exerts tremendous horizontal loading on the foundation as it passes by, with the worst case scenario being failure of the structural integrity and collapse of the tower. Or, large waves cause repetitive horizontal movement of the tower, nacelle and rotors that creates excessive wear and tear of moving parts and necessitating increased maintenance and replacement, or a worse case scenario being fatigue and failure of moving parts so that the turbine breaks down more frequently and does not operate enough to cover costs. Also, with greater wave heights the foundation has to extend further above the sea surface before the connection with the tower can be made, since the foundation is the component designed for wave impact and contact with sea water. The larger the foundation, the more costly it becomes. Foundations generally make up roughly 1/4th to 1/3rd of the cost of an offshore wind project.

A 2003 report prepared by the firm Garrad Hassan for the US Army Corps of Engineers, New England District, assessed various environmental design parameters for existing wind projects and those proposed for construction up to 2006 (Morgan et al., 2003). Of the 13 projects for which water depths and the 50 year return storm wave height information was available, 8 had ratios of average water depth to ESW height greater than one and 5 had a ratio less than one. The average ratio of average water depth to ESW for the 13 projects is 1.29. However, if only those in the majority category are included (ratios greater than 1), then the average ratio is 2.0. Based on this, and ignoring other parameters such as geologic conditions and foundation type, it appears that the current industry practice is that the ESW height should be no more than about half of the average water depth within the turbine array for projects located in relatively shallow water. There is anecdotal information that the Blythe project in the UK, with a ratio of about 0.75, is experiencing a significantly accelerated fatigue life from the breaking waves (see [Table 3.2.1-1](#)).

A secondary aspect of wave heights that can affect offshore wind project operations and maintenance is the number of days out of the year when wave heights exceed the ability to get maintenance personnel transferred from vessels to the tower in order to do required maintenance. While multiple maintenance crews can be deployed simultaneously to make up for missed days, at some point there is a diminishing return on performing maintenance. If extended periods of time occur when a proportion of wind turbines cannot operate because of breakdown or lack of maintenance, then the generation revenue drops and the project economics suffer. Current technology for maintenance access limits the suitable wave height to approximately 4.9 ft (1.5 m) or less.

3.2.1.3.3 Substrate

Since foundation design is typically 1/4 to 1/3 the total cost of a WTG installation, the type of foundation can have a substantial affect on the overall project costs and the economic viability and profitability of the project. Monopile installation would typically be accomplished by means of a pile driving ram or vibratory hammer to a substantial depth (about 85 ft [26 m] below the seafloor in the case of the proposed action). In areas of bedrock and excessive boulders, driven monopiles cannot be deployed and either a gravity based foundation or a multi-legged foundation is required in order to have a stable foundation on which to erect the tower and generating equipment. Given the greater amount of steel, increased installation costs, and potentially higher maintenance costs, gravity based and multi-legged foundations are generally more expensive than a driven hollow monopile. Also, these other types of foundations create a greater footprint which may exhibit greater environmental impacts. Finally, rocky substrate conditions can make it difficult and or cost prohibitive to bury interconnecting cables below the seafloor. Therefore site selection between alternative locations needs to consider substrate characteristics relative to the type of foundation that can be deployed to support the remaining wind generating equipment. Seabed geology for the regional alternatives was determined by the use of NOAA Charts. Detailed geotechnical data was collected for the proposed action site (see [Table 3.2.1-1](#)).

3.2.1.3.4 Transmission Line Distance

Transmission line distances are dependent upon which cable design is being considered. Basically, there are three types of electric transmission cables: pressurized fluid filled AC cables, solid dielectric AC cables, and high voltage direct current (HVDC) cables. Wind projects are typically designed with solid dielectric AC cables because of the ability to relatively easily install miles of cable having low maintenance characteristics, avoiding the pumping systems needed for fluid filled cables, and avoiding the need for converter stations associated with DC current transmission. As the cable length increases, so does the cost for the cable itself as well as installation.

Since the cost of the transmission cable is only one of numerous components of a wind project that are part of the *pro forma* calculations, the determination of a distance that can be used as a criterion is site specific. Of course, there are certain technological limits to some of the cable types that come into play as the cable lengths become very long (TRC, 2006). For example, the fluid filled AC cables typically cannot exceed about 20 miles (32 km) in length because of the limitations on pumping the cooling liquid, and the additional pump stations that would be needed for greater cable lengths. The HVDC cables can be very long, if designed to handle line losses, but they require that converter stations be built to switch the DC to AC flow of electricity. The solid dielectric AC cables that are the industry standard for offshore wind energy projects typically have limits of about 31 miles (49.9 km), and geologic conditions such as thermal resistivity must be taken into consideration when assessing line losses relative to cable length for buried cables (see [Table 3.2.1-1](#)).

3.2.1.3.5 Minimum Wind Speeds

There is no single minimum wind speed criterion that can be relied on as a siting criterion, because so many factors go into the costs for construction and operation, which must be subtracted from the revenue from the electricity generated. Modern turbines are designed with a minimum cut-in speed that balances the cost of wear and tear against the smaller amount of electricity and therefore smaller revenue generated at lower wind speeds. The typical range for cut-in wind speeds is 7 to 10 mph for commercial scale wind turbines. A project developer needs to consider the site specific wind data versus the revenue generated at low wind speeds and subtract the maintenance costs of running the turbines at lower wind speeds (see [Table 3.2.1-1](#)).

3.2.1.3.6 Technology Availability

The current foundation technology limitations require that offshore wind projects be located in areas of water depths generally less than approximately 100 ft (30 m) in depth to be considered economically feasible. One demonstration project, the Beatrice Demonstrator project in the UK is targeting turbine locations in waters up to 150 ft (45 m) to allow collection of information on the design and the economics relative to long term maintenance and operation.

Floating foundations have not yet been demonstrated at a commercial level and are probably 10-15 years or more in the future. Substantial investment in this technology is not occurring. Rather there is a focus on fixed structures in deeper water, typically occurring further offshore where average wind speeds are greater than in shallower nearshore areas.

Foundations for 65 to 147 ft (20 to 45 m) water depths are currently being explored in order to determine their technological feasibility within the requirements for a commercial scale project to be economically viable. Typically, it is expected that to go to these greater water depths would require tripod or quadra-pod foundations in order to get the anchoring and stability necessary in deeper water. The Beatrice Demonstrator project has recently constructed a single WTG in the Miray Forth area of the North Scottish Sea and a second one is planned. The project involves a jacketed structure as the foundation (four legs crossed braced) to support the large 5 MW turbine in a water depth of 144 ft (44 m). The economic viability for large scale commercial application of this technology has yet to be determined and most estimates place this design at least 5 to 10 years into the future (see [Table 3.2.1-1](#)).

3.3 ALTERNATIVES CONSIDERED

3.3.1 Geographic Alternatives

In order to conduct a comprehensive evaluation of reasonable alternative locations for an offshore wind energy project that would be capable of serving the New England region, MMS identified and initially screened nine wind farm sites (in addition to the proposed action) along the coast from Maine to Rhode Island. The sites were chosen based on geographic diversity, having at least some potential in terms of wind resources, and the necessary area required for the proposed facility size. The Phelps Bank site was chosen as a result of a comment/request from the Massachusetts Office of CZM that an alternative be evaluated for a site located more than 25 miles offshore with water depths less than 150 feet. The Offshore Nauset site was chosen as a result of agency interests in comparing a deep water alternative. The ten sites including the proposed action are as follows:

1. Offshore Portland, Maine
2. Offshore Cape Ann, Massachusetts
3. Offshore Boston, Massachusetts

4. Offshore Nauset, Massachusetts (east of Nauset Beach)
5. Nantucket Shoals (southeast of Nantucket Island, Massachusetts)
6. Phelps Bank (southeast of Nantucket Island, Massachusetts)
7. East of Block Island, Rhode Island
8. Monomoy Shoals (east of Monomoy, Massachusetts)
9. South of Tuckernuck Island
10. Horseshoe Shoals (proposed action)

Figure 3.3.3-1 shows the location of these sites with respect to the New England Coast Line.

3.3.2 Non-Geographic Alternatives

Alternatives that include modifications to the proposed action that reduce the scope (smaller or condensed configuration) or temporal impacts (phased development schedule) should be analyzed in an EIS. Non-geographic alternatives must include design alternatives that would decrease pollution emissions, construction impacts, aesthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. Non-geographic alternatives are subjected to the same screening criteria as geographical alternatives. As with geographical alternatives, those that meet the screening criteria are carried forward for further detailed analysis.

The non-geographic based alternatives that were analyzed in reference to the proposed action include:

- Smaller Alternative (half the MW capacity of the proposed action at the same location)
- Condensed Array Alternative
- Phased Development Alternative
- No Action Alternative

3.3.3 Alternatives Considered But Screened Out Due to Physical Constraints

Alternative sites were selected based upon their potential to meet the basic purpose and need to utilize offshore wind resources to provide electricity to the New England Power Pool. The application of the physical criteria (Section 3.2.1) resulted in the elimination of seven of the sites from further consideration. Therefore, in accordance with CEQ §1502.14, further detailed analysis was not conducted and the reasons that each site was eliminated is provided in the following discussion (see Table 3.2.1-1).

3.3.3.1 Offshore Portland Maine

The center of the Offshore Portland Alternative is located 19.3 miles (31 km) east of Portland, Maine. The alternative site would be located somewhere within a 197 square mile (511 km²) area as shown on Figure 3.3.3-1. Coordinates that bound the alternative location are shown in Table 3.3.3-1. The mean wind resources in this area are between 17.9 and 21.3 mph (8.0 and 9.5 m/s) (Figure 3.3.3-2).

The area around the outer harbor of Portland, Maine ([Figure 3.3.3-3](#)) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 200 ft (61 m), which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;
- Open ocean exposure to the east results in ESWs of approximately 90 ft (27 m), which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this area is likely to include an abundance of shallow bedrock and rock outcroppings that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13286).

In addition to these physical criteria, another potential concern with this site includes its potential to affect migratory movements of whales, particularly the endangered northern right whale, traveling between the Northern Right Whale critical habitats located at the northern and southern extents of the Gulf of Maine.

3.3.3.2 Cape Ann, Massachusetts

The center of the Offshore Cape Ann Alternative is located 8.3 miles (13.4 km) east of Cape Ann, Massachusetts. The alternative site would be located somewhere within a 196.4 square mile (508.7 km²) area shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The mean wind resources in this area are between 17.9 and 20.1 mph (8.0 and 9.5 m/s) ([Figure 3.3.3-2](#)). The area around Cape Ann, Massachusetts ([Figure 3.3.3-4](#)), was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 150 ft (45.7 m), which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;
- Open ocean exposure to the east results in ESWs of approximately 62 ft (19 m), which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this location appears to be primarily gravel, boulder piles and ridges; that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13286).

In addition to these physical criteria, an issue specific to this area which makes it less favorable is that the area is close to the Stellwagen Bank National Marine Sanctuary, and areas of dense whale congregations such as humpback and northern right whales (National Marine Sanctuary Program, 2007). The Sanctuary occupies approximately 42 square miles (108.8 km²) of the OCS east of the coastline of mainland Massachusetts and north of Cape Cod.

3.3.3.3 Boston, Massachusetts

The center of the Offshore Boston Alternative is located 14.2 miles (22.9 km) east of Boston, Massachusetts. The alternative site would be located somewhere within a 214.2 square mile (554.8 km²) area shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The mean wind resources in this area are between 17.9 and 20.1 mph (8.0 and 9.5 m/s) ([Figure 3.3.3-2](#)). The area around the outer harbor of Boston, Massachusetts ([Figure 3.3.3-5](#)) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth, wave height, and seabed substrate. Specifically:

- Water depths are estimated to average 200 ft (61 m) which would require monopiles of such large size that their construction, transport, and installation would not be technologically feasible. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development;
- Open ocean exposure to the east results in ESWs of approximately 75 ft (23 m) which can cause structural failure or excessive turbine fatigue; and
- Seabed geology in this location appears to include a number of relatively large boulder ridges that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13287).

In addition to these physical criteria, the majority of this potential alternative site is within the Stellwagen Bank National Marine Sanctuary, which makes this alternative less favorable due to potential for impacts to marine mammals in the area and conflicts with designated uses of the Sanctuary.

3.3.3.4 Nauset, Massachusetts (East of Nauset Beach)

The center of the Offshore Nauset Alternative is located 19.3 miles (31.1 km) east of Nauset, Massachusetts. The alternative site would be located somewhere within a 202.3 square mile (524 km²) area shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The mean wind resource in this area ranges from 20.1 to 21.3 mph (9.0 to 9.5 m/s) ([Figure 3.3.3-2](#)).

The area offshore of Nauset, Massachusetts (East of Nauset Beach) ([Figure 3.3.3-6](#)) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to water depth and wave height. Specifically:

- Water depths are estimated to average 650 ft (198 m) which would prevent the use of foundations resting on or inserted in the seafloor. Floating foundations have not been developed for deep water applications and foundation technology adapting oil and gas type floating platform substructures to wind energy applications is not likely to be proven by the date anticipated for project development; and
- Open ocean exposure to the east results in ESWs of approximately 55 ft (17 m) which can cause structural failure or excessive turbine fatigue.

In addition to these physical criteria evaluated, another issue is that the site is in close proximity to Northern Right Whale Critical Habitat precautionary area (National Marine Sanctuary Program, 2007).

3.3.3.5 Nantucket Shoals, Southeast of Nantucket Island, Massachusetts

The center of the Nantucket Shoals Alternative is located 4.8 miles (7.7 km) southeast of Nantucket Island, Massachusetts. The alternative site would be located somewhere within a 210.7 square mile (545.7 km²) area as shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The Nantucket Shoals area southeast of Nantucket Island, Massachusetts ([Figure 3.3.3-7](#)) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to wave height and transmission line distance. Specifically:

- Open ocean exposure to the east results in ESWs of approximately 65 ft (20 m) which can cause structural failure or excessive turbine fatigue; and
- The interconnection distance to shore (assuming landfall in Hyannis) is approximately 41 miles (66 km). This distance exceeds the normal use of AC transmission cables (should be less than approximately 31 miles [50 km]) and would require the use of HVDC transmission cable. HVDC transmission lines have not yet been proven to be a commercially available technology for offshore wind farms. DC transmission may be possible though likely more costly due to requirements to install AC to DC converters. It would not be possible to connect to the existing two Nantucket Cables that cross from Nantucket to the Cape Cod because of their limited transmission capacity.

3.3.3.6 Phelps Bank (Southeast of Nantucket Island, Massachusetts)

The center of the Phelps Bank Alternative is located 44.4 miles (71.5 km) southeast of Nantucket Island, Massachusetts. The alternative site would be located somewhere within a 210.5 square mile (545.2 km²) area as shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The area around the Phelps Bank (southeast of Nantucket Island, Massachusetts, [Figure 3.3.3-8](#)) was evaluated using the Site Screening Criteria described above and not selected for further environmental analysis due to wave height and transmission line distance. Specifically:

- Open ocean exposure to the east results in ESWs of approximately 65 ft (20 m) which can cause structural failure or excessive turbine fatigue; and
- The interconnection distance to shore (assuming landfall in Hyannis) is approximately 67 miles (108 km). This distance exceeds the normal use of AC transmission cables and would require the use of HVDC transmission cable. HVDC transmission lines have not yet been proven to be a commercially available technology for offshore wind farms. DC transmission may be possible though likely more costly due to requirements to install AC to DC converters.

3.3.3.7 East of Block Island, Rhode Island

The center of the East of Block Island Alternative is located 6.4 miles (10.3 km) east of Block Island, Rhode Island. The alternative site would be located somewhere within a 209.5 square mile (54.6 km²) area as shown on [Figure 3.3.3-1](#). Coordinates that bound the alternative location are shown in [Table 3.3.3-1](#). The area east of Block Island, Rhode Island ([Figure 3.3.3-9](#)) was evaluated using Site Screening Criteria described above and not selected for further environmental analysis due to wave height and seabed substrate. Specifically:

- Extreme storm waves in the area are estimated to be approximately 50 ft (15.2 m) which can cause structural failure or excessive turbine fatigue; and

- Seabed geology in this location is likely to consist of an abundance of boulders and rock outcroppings that would interfere with WTG foundation installation and embedment of submarine cables (NOAA Chart No. 13288).

3.3.4 Other Alternatives Considered But Not Subject to Detailed Analysis

The following additional alternatives were considered in the preparation of this EIS, but were not subject to detailed analysis, for the reasons identified and briefly described below.

3.3.4.1 Onshore Sites

Onshore wind energy projects, as well as other onshore renewable energy technologies, were not subject to detailed analysis in this EIS due to the fact that they do not satisfy the stated purpose and need, as described in Section 1.1. In addition, with respect to wind energy, there are limited contiguous sites in Massachusetts that are capable of accommodating commercial wind energy facilities. As compared to the approximately 14,000 MWs of wind energy capacity currently installed onshore in the United States, Massachusetts has approximately 5 MWs of existing installed wind energy capacity, with an additional 3 MWs capacity under construction (AWEA, 2007). According to DOE wind resource potential maps, Massachusetts onshore wind resources are rated in general by region, where eastern Massachusetts is rated “marginal”, central Massachusetts is rated “fair” and some areas of western Massachusetts are rated as “good” (DOE EIA, 2003).

3.3.4.2 Near Shore Waters

The geographic areas defined on [Figure 3.3.3.1](#) included near shore waters on some of the alternatives considered (e.g., Portland, Cape Ann, Block Island). These alternative sites were selected based upon their potential to meet the basic purpose and need as described in Section 1.1. Siting a facility near shore within the geographic confines of each alternative described in [Figure 3.3.3.1](#) was not selected for detailed analysis due to the potential increase in impacts and decrease in wind resources. The application of the physical criteria (Section 3.2.1.3.) to the offshore portion of each area resulted in the elimination of seven of the sites from further consideration. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.3 Dispersed Sites

The applicant has proposed a commercial scale alternative energy facility located within a specific contiguous area of the OCS. Distributing the power potential of this proposed project to multiple sites on the OCS (e.g., four locations on the OCS, each with approximately 100 MW of installed capacity) was considered but eliminated from detailed analysis due to the fact that such dispersal of construction and operational impacts throughout the offshore region increases the geographic scope of direct, indirect and cumulative impacts. Additionally, it is believed that such dispersal of generating sites would decrease the efficiency and reliability of the energy production, and the associated costs (i.e., additional cabling and electric service platform installations) would render any such project uneconomic. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.4 Tidal In-Stream Energy Conversion (TISEC) Device

TISEC devices are an exciting new renewable energy technology for the marine environment. However, commercial demonstration of such technologies is still relatively unproven, and available tidal resources in New England are considered marginal as compared to other sites nationally. TISEC development would not be consistent with the purpose and need of the proposed action, as described in Section 1.1.

TISEC devices are a similar technology to wind turbines except that they are installed in the water column and are moved by underwater tidal currents. Though the speed of tidal currents is very slow compared to that of wind, the density of water is more than 1,000 times that of air. Therefore, even slow tidal current speeds can generate considerable energy. Since tidal current speeds are predictable, the TISEC technology can be a more consistently reliable source of electric power generation. Because TISEC devices are underwater generation facilities, they avoid aesthetic impacts on the ocean surface or landscape. In addition to the turbines, which must be able to move toward the direction of changing currents or allow for multidirectional flow, the TISEC devices require an anchoring system and an electrical interconnection line to a land-based transmission system.

TISEC device projects must be sited at or near known areas with a strong tidal current regime and tidal current speeds that range from 2 to 4.7 knots (1.02 to 2.4 meters per second [m/s]). In addition, they generally need to be close to onshore transmission lines, either immediately adjacent to or within 0.25 to 0.5 mile (0.4 to 0.8 km) (TRC, 2006).

In general, research shows that New England has marginal resources in terms of tidal power generation relative to other locations across the country (TRC, 2006). For instance, there are many other potential TISEC locations in the United States and/or Canada that have tidal energy levels that exceed the tidal resources in New England. Construction and a full build out of a tidal energy facility would not be expected to take place for several years, and the size of the first pilot projects likely would be small and not able to provide a substantial contribution to the New England and regional RPS. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.5 Wave Energy

Wave energy project development is not consistent with the purpose and need of the proposed action described in Section 1.1. Wave energy conversion takes energy from ocean waves and converts it to mechanical energy that is then converted to usable electric energy. The initial conversion is done using various devices that capture the energy. Research in this area shows that the average power density of waves on the New England coast is approximately half that of California, and therefore the offshore areas of Massachusetts are less likely for development of this technology, especially given the infancy of this new field (TRC, 2006). Construction and a full build out of a wave energy project in New England would still be many years from now, and construction of the first pilot projects likely would be small and not able to provide a substantial contribution to the Massachusetts and regional RPS. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.6 Solar (Photovoltaic and Thermal Electric)

Development of a solar power system (photovoltaic or thermal electric) is not consistent with the purpose and need of the proposed action described in Section 1.1. Photovoltaic (PV) systems used to generate electricity include: (1) flat plate technology, which uses an arrangement of PV cells mounted on a rigid flat surface and exposed freely to incoming sunlight; and (2) concentrator technology, which uses an arrangement of PV cells and lenses to concentrate sunlight on a small area of cells.

Based on the PV systems currently in operation, flat plate technology ranges in size from 50 - 200 kilowatts (kW), while concentrator technology ranges between 2 kW and 200 kW. At these lower power generation levels, PV applications are most feasible and economical for off-grid and consumer applications.

Despite their prevalence in consumer applications, PV systems have the highest energy costs among alternative energy sources (greater than \$0.20/kWhr in 2002 as compared to \$0.12/kWhr for the Cape Wind project), which may be attributed to the costs of producing the materials used in PV cells and

modules (i.e., crystalline technologies). Because of the high capital costs associated with PV systems, coupled with low efficiencies, the technology does not represent a commercially competitive alternative to the proposed action within the timeframe of the proposed action.² Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.7 Ocean Thermal

Development of an Ocean Thermal Energy Conversion (OTEC) project is not consistent with the purpose and need of the proposed action described in Section 1.1. OTEC is a technology that converts solar radiation to electric power. Since the ocean is composed of layers of water that have different temperatures, it creates a natural thermal gradient. The OTEC systems use this gradient to drive a power-producing cycle, which can produce a significant amount of energy as long as the temperature differential is about 36 °F (20 °C) between the warmer surface water and colder deep water. The oceans cover more than 70 percent of the earth's surface making them the largest solar energy collector and energy storage system. The potential for OTEC as an alternative resource is great; however, the economics of energy production have delayed the financing of a permanent, continuously operating OTEC plant (TRC, 2006).

The natural thermal gradient necessary for OTEC operation is generally found in the tropical zone between the latitudes of 20 degrees North (N) and 20 degrees South (S). As a result, the siting criteria for such facilities are not compatible with the existing conditions found along the coast of New England and the technology as it exists today does not appear suitable for the New England area. Therefore, in accordance with CEQ §1502.14, further detail analysis was not conducted.

3.3.4.8 Floating Wind Turbines

This technology utilizes a floating structure that provides enough buoyancy to support the weight of a wind turbine. It must also be able to restrain pitch, roll, and heave motions within acceptable limits in order to operate efficiently and safely. A variety of platform, mooring, and anchoring technologies have been proposed for floating wind turbine systems. This technology remains in its infancy and is not expected to be commercially viable for at least 10 to 15 years. As such, development of a marine wind energy project employing this foundation technology is not consistent with the purpose and need of the proposed action as described in Section 1.1.

3.3.5 Geographic Alternatives Considered and Subject to Detailed Analysis Including the Proposed Action

In accordance with CEQ regulations for implementing NEPA, alternatives considered that meet the screening criteria are subject to further detailed environmental analysis in the "environmental consequences" section of the EIS which discusses the specific environmental impacts or effects of each of the alternatives including the proposed action and no action. In order to avoid duplication between the alternatives section and the sections of the EIS dedicated to detailed analysis, this section is dedicated to describing and comparing the alternatives to the proposed action with a brief summary of impacts.

The geographic alternatives considered and subject to detailed analysis include the proposed action, South of Tuckernuck Island, and Monomoy Shoals. Alternatives subject to detailed analysis, but not involving a change of location from the proposed action (Smaller Alternative, Phased Development

² Some installations have been constructed as a result of public funding, but costs remain high. For instance, a 425- kW PV solar energy system was recently constructed in Brockton, Massachusetts at a cost of \$7 per watt. Costs were addressed via a \$1.6 million city of Brockton bond, \$789,000 grant from the U.S. DOE, and more than \$1 million from the Massachusetts Technology Collaborative (MTC) Renewable Energy Trust. The Project would generate 535 MW hours per year and is expected to provide power to 71 homes and result in no emissions (MTC, 2007).

Alternative, Condensed Array Alternative, and No Action Alternative) are examined in Section 3.3.6. [Figure 3.3.5-1](#) shows all of the alternatives that met screening criteria.

3.3.5.1 Horseshoe Shoal - Proposed Action

3.3.5.1.1 Description

The proposed action entails the construction of an electric generating facility consisting of 130 wind turbine generators arranged in a grid pattern in the Horseshoe Shoal region of Nantucket Sound, Massachusetts. The northernmost WTGs would be approximately 3.8 miles (6.1 km) from the dry rock feature (offshore near Bishop and Clerks) and approximately 5.2 miles (8.4 km) from Point Gammon on the mainland; the southernmost part of the area of the proposed action would be approximately 11 miles (17.7 km) from Nantucket Island (Great Point), and the westernmost WTG would be approximately 5.5 miles (8.9 km) from the island of Martha's Vineyard (Cape Poge) (see [Figure 2.1.1-2](#)). The area occupied by the WTGs and ESP is 25 square mile (64.7 km²).

Each of the 130 wind turbine generators would generate electricity independently of each other. For this area of Nantucket Sound, the wind power density analysis determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the wind turbine generators. The optimal WTG spacing within the array is 0.39 mile (629 m) by 0.62 mile (1,000 m) between each WTG based on wind direction analysis, which corresponds to a 6 x 9 rotor diameter configuration.

Hydrographic surveys indicate water depths are as shallow as 0.5 ft (0.15 m) (MLLW), with depths of up to 60 ft (18.3 m) (MLLW) occurring between the northern and southern legs of the shoal. However, water depth within the portion of the site where WTGs would be sited ranges from 12 to 50 ft (3.7 to 15.2 m) (MLLW). WTG foundations installed in water depths of 10 to 40 ft (3 to 12.2 m) would utilize a 16.75 ft (5.1 m) diameter monopile and in water depths of 40 to 50 ft (12.2 to 15.2 m) would utilize an 18.0 ft (5.5 m) diameter monopile. The extreme wave height in the area is 17.4 ft (5.3 m).

An ESP would be required to be installed and maintained within the approximate center of the WTG array. It would serve as the common interconnection point for all of the WTGs within the area of the proposed action. The ESP would be a fixed template type platform consisting of a jacket frame with six 42-inch diameter (1.1 m) driven piles to anchor the platform to the ocean floor. The platform would consist of a steel superstructure of approximately 100 ft by 200 ft (30.5 m by 61 m). The platform would be placed approximately 39 ft (11.9 m) above the MLLW datum plane in 28 ft (8.5 m) of water. Each WTG would interconnect with the ESP via a 33 kV submarine cable system. The ESP would provide electrical protection and inner-array cable sectionalizing capability in the form of circuit breakers. It would also include voltage step-up transformers to step the 33 kV inner-array transmission voltage up to the 115 kV voltage level of the submarine cable connection to the land-based system.

Solid dielectric submarine cables from each wind turbine generator would interconnect within the grid and terminate at their spread junctions on an electrical service platform. The electric service platform would serve as the common interconnection point for all of the wind turbine generators. The proposed submarine cable system is approximately 12.5 mile (20.1 km) in total length (7.6 miles [12.2 km] within the Massachusetts 3.5 mile [5.6 km] territorial line and 4.9 miles [7.9 km] on the OCS) from the electric service platform to the landfall location in Yarmouth. The submarine transmission cable system consists of two parallel cables that would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue. The proposed onshore transmission cable route to its intersection with the NSTAR electric transmission ROW would be located entirely along existing paved ROWs where other underground utilities already exist.

The remaining portion of the onshore transmission cable route would be located underground within an existing maintained NSTAR electric transmission ROW, terminating at an existing substation.

The cables would be installed between the WTGs and ESP, as well as the transmission line between the ESP and shore, using a jet plow technology that simultaneously loosens sediments to create a space for the cable to be laid in and allows for natural in-filling. The shoreline crossing of the transmission cable would be installed using horizontal directional drilling technology and onshore cable construction would employ standard cable trenching, conduit placement, and cable pulling methods and equipment.

3.3.5.1.2 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the proposed action would result in varying levels of impacts to the physical environment, biological resources, socioeconomics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below (see [Table E-1](#) in the Executive Summary for additional summary information describing the impacts of the proposed action).

Physical Resources

The proposed action would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. The maximum calculated pile driving sound level at any location would be 41 dBA whereas the lowest ambient level measured would be 35 dBA. During operation, the sound levels of the proposed action would range from 19.2 to 25.9 dBA, well below the ambient conditions of 54 to 71 dBA.

In addition to noise impacts, the proposed action would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the proposed action. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable affect on air quality. A summary of total emissions from the proposed action is provided in [Table 5.3.1-7](#). With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the proposed action would generate a small EMF in the immediate vicinity of the undersea cables and onshore cables. This small EMF is not expected to adversely affect marine or human life (see Section 5.3.1.7 for information on predicted EMF levels for the proposed action at different locations).

Operation of the proposed action is not anticipated to impact hydrodynamics or water quality. The proposed action would require the storage of 40,000 gallons (151,400 liters) of mineral oil on the ESP. Based on analyses conducted, probabilities of a large spill are extremely small.

Biological Resources

The proposed action would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the proposed action is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and

habitat for roseate terns, and least terns (Perkins, et al., 2003) (Details on potential avian species affected are provided in Section 5.3.2.4). With respect to avian T&E species, information on the piping plover suggest that collision mortality associated with the proposed action would result in minor to moderate adverse impacts but would not jeopardize the Atlantic coast population. With respect to the roseate tern, information shows that a low level of WTG collisions can be expected but would only have a minor to moderate affect on the roseate tern population. Detailed analysis of the piping plover and roseate tern are provided in [Appendix C](#).

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs in the area of the proposed action, which results in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact for the proposed action due to the WTG and ESP piles is 0.67 acres (2,711 m²) and the total area of temporary impact for the cable that connects the WTGs to the ESP is 580 acres (2.3 km²). The temporary impact of the area disturbed from installation of the cable from the ESP to the shore is 86 acres (0.3 km²).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the proposed action include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the proposed action, there is potential for impact to these species during construction and decommissioning as a result of collisions with large construction vessels.

Socioeconomic Resources and Land Use

The proposed action would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the proposed action due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the proposed action.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

The proposed action would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the proposed action (refer to visual simulations of the proposed action at [Figure 5.3.3-5](#)). With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the proposed action. The proposed action would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the proposed action is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The proposed

action is not expected to affect overland transportation arteries or airport facilities. The proposed action received FAA approval indicating WTGs in the area would not affect air navigation or associated communication systems (refer to [Appendix E](#)). With regard to navigation, the turbine array would be located on a shoal away from navigational channels, where vessels are less likely to navigate (refer to detailed discussion of navigation in Section 5.3.4). In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels, including trawlers, to navigate through the area.

3.3.5.2 South of Tuckernuck Island

3.3.5.2.1 Description

The South of Tuckernuck Island Alternative is approximately 3.79 miles (5.31 km) southwest of Tuckernuck Island in Federal waters (see [Figure 3.3.5-1](#)). Water depth within the site ranges between 15 ft and 100 ft (4.6 m and 30.5 m) below MLLW, with an estimated average depth of approximately 57 ft (17.5 m). The extreme wave height estimate in the area is 52.5 ft (16.0 m). The South of Tuckernuck Island Alternative would have the same generation capacity as the proposed action (130 WTG's, 3.6 MW machines plus an ESP), but would require an area of approximately 36 square miles (93.2 km²). The proposed turbine spacing for the South of Tuckernuck Island Alternative is a grid arrangement approximately 9.0 rotor diameters (0.62 mile [1.0 km]) by 6 rotor diameters (0.34 mile [0.629 km]).

This site would require foundations to be placed in various water depths ranging from approximately 15 to 100 ft (4.6 to 30.5 m), but still benefits from some sheltering effects from open ocean waves due to Nantucket Island to the east. The South of Tuckernuck Island Alternative would likely require three different sized monopiles and a quad-caisson foundation depending on water depth. Foundations in water depths between 0 and 30 ft (0 and 9.1 m) would utilize a 16.75 ft (5.1 m) monopile, while foundations in water depths between 30 and 45 ft (9.1 and 13.7 m) would utilize an 18.0 ft (5.5 m) monopile, and foundations in water depths between 45 and 65 ft (13.7 and 19.8 m) would utilize a 19.0 ft (5.8 m) diameter monopile. The quad-caisson foundation, a fabricated steel structure, would be utilized for all WTGs installed at a water depth greater than 65 ft (20 m). This structure would consist of four tower foundations that support the tower interface (see [Figure 3.3.5-2](#)). This structure would require more fabrication and installation due to its large size and the more challenging sea conditions off the southern coast of Nantucket Island.

The construction sequencing for this alternative would be similar to that described for the Nantucket Sound alternatives. However, rather than the mechanical driving of the structure into the seabed as described for the monopiles, the caissons of the quad-caisson foundation would be set on the seabed and then suctioned into place to the appropriate depth.

The 115 kV transmission cable system for the South of Tuckernuck Island Alternative would consist of the same equipment as described in Section 2.3 of this document. The total length of the interconnect cable route, from the alternative site of the ESP to the Barnstable Substation, would be 33.4 miles (53.8 km). The location, WTG configuration, and interconnection routing for this alternative are provided in [Figure 3.3.5-3](#).

3.3.5.2.2 Comparison of Alternative with Proposed Action

Environmental impacts associated with the South of Tuckernuck Island Alternative would be greater than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, and essential fish habitat, and less than the proposed action with respect to impacts on visual resources. In the remaining resource impact categories, the South of Tuckernuck Island Alternative

would have comparable impacts to the proposed action (see [Table 3.3.5-1](#) for a full comparative listing of impacts relative to the proposed action).

With respect to avifauna, the South of Tuckernuck Island Alternative would have a greater potential for impacts to terrestrial, coastal, and marine birds than the proposed action, primarily because of the increased area in which the turbines would be located (the South of Tuckernuck Island Alternative would require an area of approximately 36 square miles (93.2 km²) versus the area of the proposed action, which is 25 square miles (64.7 km²).

With respect to subtidal resources, the additional pilings, cross-braces, and scour protection required at the South of Tuckernuck Island Alternative because of the greater depth at the site, substantially increase (by more than 10 times) the vertical habitat structure available for colonization by benthos for the life of the Project. However, anchoring impacts associated with construction at the South of Tuckernuck Island Alternative would be twice that of the proposed action and would result in greater overall impact to benthos including shellfish. The South of Tuckernuck Island Alternative also would have greater impacts on benthic resources as a result of the much longer interconnection line requirement compared to that of the site of the proposed action. The greater impacts on benthos also result in greater impacts on fish and fisheries and essential fish habitat, which utilize the benthic resources and would be affected due to greater duration of construction and turbidity impacts. The greater size of the foundations at the South of Tuckernuck Island Alternative would also attract greater numbers of fish at the site due to the larger increase in hard bottom structure than the proposed action.

With respect to non-ESA mammals, the South of Tuckernuck Island Alternative is in closer proximity to seal haul-out and breeding sites than the proposed action, and therefore, development at this site has a greater potential to impact seals both during construction and operation. In addition, there is greater potential to impact whales at the South of Tuckernuck Island Alternative than the site of the proposed action since the site is proximate to historical sightings of these mammals.

With respect to visual impacts, generally fewer viewers would see the project at the South of Tuckernuck Island Alternative site compared to the proposed action, because it would be beyond or close to beyond visible range from Cape Cod, which has the major population density in the area (see [Figure 3.3.5-4A and B](#)). As a result, there would be less visual impact associated with the South of Tuckernuck Island Alternative than the proposed action.

3.3.5.2.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the South of Tuckernuck Island Alternative would result in varying levels of impacts to the physical environment, biological resources, socioeconomics and land use, navigation and transportation. A summary of the impacts within these four major categories is provided below. [Table 3.3.5-1](#) summarizes the impacts of the proposed action with the alternatives analyzed.

Physical Resources

The South of Tuckernuck Island Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. The maximum predicted sound levels would occur during construction of the South of Tuckernuck Island Alternative and would be approximately 30 dBA (at the modeled receptor for the South of Tuckernuck Island Alternative at Madaket Beach on Nantucket Island). In addition to noise impacts, the South of Tuckernuck Island Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction,

decommissioning, and maintenance phases of the work. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation and removal of monopiles and undersea cables. These activities would be expected to meet the state water quality designation in the area, since there are no known major sources of pollutant input or other degrading factors. With respect to EMFs, the South of Tuckernuck Island Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which is not expected to adversely affect marine or human life.

Operation of the South of Tuckernuck Island Alternative is not anticipated to impact hydrodynamics or water quality. The South of Tuckernuck Island Alternative would require the storage of 40,000 gallons (151,400 liters) of naphthenic mineral oil for insulation and cooling of the four 115 kV transformers on the ESP. Based on analyses conducted, probabilities of a large spill are extremely small.

Biological Resources

The South of Tuckernuck Island Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the South of Tuckernuck Island Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone. With respect to avifauna, the South of Tuckernuck Island Alternative is located in close proximity to the South of Tuckernuck Island area, and construction and operation of the South of Tuckernuck Island Alternative would affect the avian resources in this area including impacts to eiders, scoters, long-tailed ducks, and pelagic species, such as shearwaters, storm-petrels, and jaegers.

Subtidal resources would be affected by the monopiles and additional pilings/cross-braces and scour protection associated with WTGs at the South of Tuckernuck Island Alternative, which would have to be designed using a quad-caisson foundation in some areas due to the greater water depths. This foundation design results in a substantial vertical habitat structure for colonization by benthos for the life of the South of Tuckernuck Island Alternative. The added structure is expected to attract a variety of finfish to the site. Anchoring impacts associated with construction and decommissioning would affect a large area of the seafloor causing temporary disturbance of the substrate, and to shellfish. The work would temporarily cause an increase in turbidity, which would result in finfish temporarily avoiding the area and a short term and limited impact to EFH.

With respect to Non-ESA marine mammals, the South of Tuckernuck Island Alternative is in close proximity to seal haul-out and breeding sites and therefore, development at this site has the potential to impact seals both during construction and operation. In addition, there is potential to impact whales at the South of Tuckernuck Island alternative during construction since the site is proximate to historical sightings of these mammals. With respect to T&E species, the South of Tuckernuck Island Alternative could result in temporary disturbance to listed species during construction and decommissioning, including: the federally-endangered roseate tern (*Sterna dougallii*), the federally-threatened piping plover (*Charadrius melodus*) and three federally protected sea turtle species: loggerhead, leatherback, and Kemp's Ridley sea turtles. During operations, impacts would most likely be limited, since these species occurrence in the area is also limited, and operational activities that could impact T&E species are limited.

Socioeconomic Resources and Land Use

The South of Tuckernuck Island Alternative would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the South of Tuckernuck Island Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

With respect to visual resources, the seascape from Tuckernuck Island southwest towards the South of Tuckernuck Island Alternative consists of panoramic open ocean views of the Atlantic Ocean. The South of Tuckernuck Island Alternative would be located close to Nantucket and the east end of Martha's Vineyard and would have visual impact from those locations. However, it would be far away from Cape Cod and would be rarely visible from that area (see [Figure 3.3.5-4A and B](#)).

With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the South of Tuckernuck Island Alternative area, and there are no shipwrecks charted in the vicinity of the alternative site. The South of Tuckernuck Island Alternative would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The South of Tuckernuck Island Alternative is located close to land (Nantucket Island) and the popular boating and recreational area around Nantucket Island. The South of Tuckernuck Island Alternative is not expected to affect overland transportation arteries or airport facilities (the South of Tuckernuck Island Alternative received FAA approval [see [Appendix E](#)]). With respect to navigation, the array would be located away from navigational channels and the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters, which would allow ample room for vessels including trawlers to navigate through the area.

3.3.5.3 Monomoy Shoals

3.3.5.3.1 Description

The Monomoy Shoals Alternative site is 3.5 miles (5.6 km) southeast of Monomoy Island, within the eastern approach to Nantucket Sound ([Figure 3.3.5-1](#)). Water depth within the Monomoy Shoals Alternative site ranges between 13 ft and 34 ft (3.9 and 10.4 m) below MLLW, with an estimated average depth of approximately 24 ft (7.3 m) (Navigational Chart No. 13237 – Nantucket Sound and Approaches. Ed. 38, March 3, 2001). This alternative would have the same generation capacity as the proposed action (130 WTG's, 3.6 MW machines plus and ESP), but would require a slightly larger area (25.9 square miles [67.1 km²]). The proposed turbine spacing for the Monomoy Shoals Alternative is a grid arrangement approximately 9.0 rotor diameters (0.62 mile [1,000 m]) by 6 rotor diameters (0.39 mile [629 m]).

The construction and decommissioning methods for the Monomoy Shoals Alternative would be similar to those presented in Section 2.3 of this document for the proposed action. Although driven monopile foundations and jet plow cable embedment are anticipated to be the proposed method of

construction, it is possible that bed rock outcroppings and shallow surface bedrock at the Monomoy Shoals Alternative site may necessitate surface laying of the cable or other alternative installation methods. In addition, it is anticipated that the construction and decommissioning time tables for this alternative would be significantly longer than the proposed action, due to more limited accessibility (primarily due to wave conditions).

The 115 kV transmission cable system for the Monomoy Shoals Alternative would consist of the same equipment as described in Section 2.1 of this document. As shown in [Table 3.3.5-2](#), the total length of the interconnect cable route, from the alternative site ESP to the Barnstable Substation, would be 29.8 miles (48 km). Of this amount, approximately 2.9 miles (4.7 km) of cable would be in Federal waters, 21.0 miles (33.8 km) would be in State waters, and 5.9 miles (9.5 km) of cable would be located in an upland transmission ROW. The interconnect cable would be routed from the ESP in a north-northwesterly direction for about 20.6 miles (33.2 km) and then turn north-northeast for about 3.3 miles (5.3 km) before making landfall. The transmission cable would be located approximately 3.0 miles (4.8 km) south of Monomoy Island. The total inner array length of 33 kV cable would be approximately 74 miles (119.1 km). The location, WTG configuration, and interconnection routing for this alternative are provided in [Figure 3.3.5-5](#).

3.3.5.3.2 Comparison of Alternative with Proposed Action

Environmental impacts associated with the Monomoy Shoals Alternative would be greater than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, essential fish habitat, and T&E species, and have less impact than the proposed action with respect to impacts on visual resources and impacts to cultural resources as they relate to visual impacts on historic structures.³ In the remaining resource impact categories, the Monomoy Shoals Alternative would have comparable impacts to the proposed action (see [Table 3.3.5-1](#) for a full comparative listing of impacts relative to the proposed action).

With respect to non-T&E avifauna, Monomoy Island (including the Monomoy National Wildlife Refuge) provides important resting, nesting and feeding habitat for migratory birds, and due to the proximity to Monomoy Island, the Monomoy Shoals Alternative would have greater potential impacts than the proposed action to terrestrial, coastal, and marine birds.

With respect to subtidal resources, construction and decommissioning impacts on benthic habitat would be more for the Monomoy Shoals Alternative than for the proposed action because of the additional interconnection line length, and the greater wave heights, which would prolong the construction time frame. The greater impacts on benthos also would result in greater impacts to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources and would be affected due to greater duration of construction and turbidity impacts.

With respect to non-ESA marine mammals, the Monomoy Shoals Alternative site is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat whereas the site of the proposed action is located away from this area (NOAA Chart No. 13200, 2005). Due to the location of this Critical Habitat, there is a greater likelihood of construction, decommissioning, and operational impacts to right whales in this area, than in the area of the proposed action. With respect to acoustical harassment, vessel harassment, water quality, and EMF the operational impacts to whales would be expected to negligible to minor. While improbable, an oil spill would have moderate to major impacts on

³ Under the Monomoy Shoals Alternative, the impact categories: subtidal offshore resources, fish and fisheries, and essential fish habitat, have impacts that would be greater than the proposed action but only with respect to construction and decommissioning. Operational impacts would be expected to be the same for these impact categories as for the proposed action.

cetaceans within Nantucket Sound. Of the whale species in the area, the right whale population should be considered at greatest risk to being negatively impacted by an oil spill because of the small population size and slow recovery of their numbers from earlier depletion events.

With respect to T&E species, six federally and/or state protected species have nested at the Monomoy National Wildlife Refuge (pied-billed grebe, northern harrier, piping plover, roseate tern, and arctic tern [USFWS, 2001]). As the Monomoy Shoals Alternative is located close to the avian T&E habitat associated with the Monomoy National Wildlife Refuge, avian T&E impacts would be greater than for the location of the proposed action.

With respect to impacts on visual resources, and visual impacts on historic structures, the Monomoy Shoals Alternative is located further from the populated and historic areas of Cape Cod and is thus expected to be beyond view of the most populated area and historic structures than the proposed action.

3.3.5.3.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Monomoy Shoals Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below. [Table 3.3.5-1](#) summarizes the impacts of the proposed action with the alternatives analyzed.

Physical Resources

The Monomoy Shoals alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Monomoy Shoals Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Monomoy Shoals Alternative. The quantities of these pollutants would be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Monomoy Shoals Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Operation of the Monomoy Shoals Alternative is not anticipated to impact hydrodynamics or water quality. The Monomoy Shoals Alternative would require the storage of 40,000 gallons (151,400 liters) of naphthenic mineral oil for insulation and cooling of the four 115 kV transformers on the ESP. Based on analyses conducted probabilities of a large spill are extremely small.

Biological Resources

The Monomoy Shoals Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the Monomoy Shoals Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Monomoy National Wildlife Refuge is located close to the Monomoy Shoals Alternative, which provides important resting, nesting and feeding habitat for migratory birds.

Specifically, Monomoy Island is an important staging area for roseate terns, provides habitat for roseate, common and least tern nesting colonies, harbors roseate and common tern restoration sites, and is a known piping plover nesting area (Perkins, et al., 2003). Due to the proximity to Monomoy Island, the Monomoy Shoals Alternative has the potential to negatively affect both non-T&E and T&E avian species as a result of disturbance during construction and as a result of the potential for collision into existing structures during operation. The Monomoy Shoals Alternative is also located in the vicinity of historic sitings of three federally and/or state protected sea turtle species (loggerhead, leatherback, and Kemp's Ridley sea turtles) and as such, has the potential to impact these T&E species.

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs at the Monomoy Shoal, which results in a hard bottom structure for colonization by benthos for the life of the Monomoy Shoals Alternative. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. Anchoring impacts associated with construction and decommissioning would affect a large area of the seafloor causing temporary disturbance of the substrate, and to shellfish. The work would temporarily cause an increase in turbidity, which would result in finfish temporarily avoiding the area and a short term and limited impact to EFH.

With respect to non-ESA Marine Mammals, the Monomoy Shoals Alternative site is due east and southeast of gray seal pupping grounds on Monomoy Island. This pupping ground is known to be used year round with the greatest use occurring during the winter and spring (Natural Heritage and Endangered Species Program [NHESP], 2002). Due to proximity to these areas, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels or harassment due to vessel activities. The Monomoy Shoals Alternative is outside of Nantucket Sound and in a region of greater occurrence of whale species and therefore has the potential to affect both ESA listed whales and well as others protected under the MMPA.

Socioeconomic Resources and Land use

The Monomoy Shoals Alternative would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in approximately 391 full-time jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Monomoy Shoals Alternative due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Monomoy Shoals Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the state, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

With respect to visual resources, the seascape from Monomoy Island east-southeast towards the Monomoy Shoals Alternative site consists of panoramic open views of the Atlantic Ocean. The site is located further from the more populated area of Cape Cod, and thus viewing of the alternative from Cape Cod would be limited. (See [Figure 3.3.5-6](#) for photo simulations of the Monomoy Shoals Alternative). However, the project is located relatively nearby to the Cape Cod National Seashore, and as such, could result in visual impacts to the heavy seasonal and tourism population that visits this area.

With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the Monomoy Shoals Alternative area. The Monomoy Shoals Alternative would be visible from historic structures and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

Fishing and boating (power and/or sail), seal-tours, bird watching, and beach-going are common activities among visitors to and off the waters off of Monomoy Island. The Monomoy Shoals Alternative is not expected to affect overland transportation arteries or airport facilities. With regard to navigation, the turbine array would be located on a shoal away from navigational channels where vessels are less likely to navigate. In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels including trawlers to navigate through the area.

3.3.6 Non-Geographic Alternatives Considered and Subject to Detailed Analysis Including No Action

This section evaluates the non-geographic alternatives including: Smaller Project Alternative and the Condensed Array Alternative.

3.3.6.1 Smaller Project

3.3.6.1.1 Description

The Smaller Project Alternative is located in the same area as the proposed action but contains only half the number of WTGs, and thus has half the generation capacity of the proposed action. Each monopile included in the Smaller Project Alternative is located within a footprint of a monopile of the proposed action. For the Smaller Project Alternative, the monopile locations along the north and south sides of the turbine array have been removed, making it further from Cape Cod and from Nantucket than the proposed action (see [Figure 3.3.5-1](#), which shows the Smaller Project Alternative superimposed over the proposed action). Further detail on the location of the Smaller Project Alternative is shown in [Figure 3.3.6-1](#). The transmission cable would be 29.7 miles (47.8 km) long, 23.8 miles (38.3 km) of which would be located under the sea.

3.3.6.1.2 Comparison of Alternative with Proposed Action

The Smaller Project Alternative has less impact than the proposed action in 13 impact categories: noise, air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, cultural resources (as they relate to visual impacts on historic structures) competing uses of waters and sea bed, and port facilities. In the remaining resource impact categories, the Smaller Project Alternative would have comparable impacts to the proposed action (see [Table 3.3.5-1](#) for a full comparative listing of impacts relative to the proposed action).

With respect to noise, construction related noise impacts to humans would be reduced under the Smaller Project Alternative as the alternative would be located further from both Cape Cod and from Nantucket than the proposed action, and because there would be half as many wind turbines to construct and decommission, and hence a shorter construction time than the proposed action. Operational noise would also be reduced due to the smaller number of turbines and their further distance from land.

Air quality impacts would be reduced under the Smaller Project Alternative as overall emissions from the construction and decommissioning vessels would be smaller than those under the proposed action. However, given the limited timeframe of the construction period, the impacts of air emissions from the construction and decommissioning of either alternative would be considered minor on a local and regional scale.

With respect to water quality, the temporary impacts to sediments related to the WTGs are reduced roughly proportional to the number of WTGs, though impacts related to the installation of the 115 kV

cable would increase by one mile (1.6 km) as the Smaller Project Alternative is further from shore. Because the number of vessels required to transit to and from the Project area during construction would decrease with the Smaller Project Alternative, the probability of marine vessels spilling fuel, lubricating oils or other substances would also decrease over that of the proposed action. In addition, the decrease in size of the ESP under the Smaller Project Alternative would result in a decrease in the total number of gallons of electrical insulating oil utilized on the ESP, and thus the potential size of an oil spill from the ESP would be reduced.

With respect to electric and magnetic field impacts, the Smaller Project Alternative would result in half the generation capacity of the proposed action and thus involve a smaller amount of electrical current in its interconnection cable and smaller EMFs than the proposed action. However, EMF impacts are negligible under the proposed action, and thus reductions in the levels result in no advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

With respect to avifauna, the number and size of the WTGs would decrease as a result of the revised layout, and thus the number of construction/decommissioning events that could potentially displace the birds would similarly decrease over that of the proposed action.

With respect to benthic impacts, the Smaller Project Alternative results in the number of WTGs being reduced to 65. As a result, the temporary impacts to benthic habitat and resources related to the WTGs are reduced roughly proportional to the number of WTGs. Impacts related to the installation of the 115 kV cable limit would increase in proportion to the additional one mile (1.6 km) of cable. During operation, the smaller number of WTGs would reduce the number of structures that would provide new localized hard-bottom habitats for benthic resources to inhabit. These benthic macro invertebrates and fouling organisms are anticipated to attract prey and finfish to the monopiles. Overall, the benthic impacts of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint and impact area. The reduced impacts on benthos from the Smaller Project Alternative would also result in less impact to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources.

With respect to non-ESA marine mammals, there would be some potential for reduction of impacts to marine mammals with the Smaller Project Alternative as there would be half as many WTGs and thus half as many vessel trips and chances for vessel strikes during construction.

With respect to T&E species, the Smaller Project Alternative would have a smaller affected area and would therefore reduce impacts to T&E species by limiting disturbance during construction compared to the proposed action. Disturbance associated with construction/decommissioning activities such as increased vessel traffic, presence of equipment, human presence, and noise would be reduced as a result of the smaller project scope and shorter duration of pile driving activities. The Smaller Project Alternative would also result in less interconnection disturbance between the individual WTGs and hence reduce the sediment plumes which could cause fish to avoid the construction site and displace some avian T&E species. The Smaller Project Alternative would reduce the number of wind turbines by half and thus could be expected to reduce the amount of avian T&E collisions predicted for the proposed action by half.

With respect to socio-economic conditions, the Smaller Project Alternative would offer less in terms of socio-economic benefits including number of construction jobs, electricity generated and revenues from taxes, than from the larger proposed action.

With respect to impacts to visual resources and impacts to historic structures, the views of the Smaller Project Alternative result in a somewhat reduced breadth of visual impacts when looking out at the

horizon from Cape Cod or Nantucket. In addition, the Smaller Project Alternative is also somewhat further away from Nantucket and Cape Cod (see [Figure 3.3.6-2](#) which shows visual simulations of the Smaller Project Alternative). Construction related visual impacts would also be reduced due to the shorter period of construction, and less time when large construction vessels would be visible.

With respect to competing uses, the Smaller Project Alternative is smaller than the proposed action and hence would have even less of a potential to impact competing uses in the area.

3.3.6.1.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

The following discussion is presented under the four categories of physical resources, biological resources, socioeconomic resources and land use, and navigation and transportation.

Physical Resources

The Smaller Project Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Smaller Project Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Smaller Project Alternative. The quantities of these pollutants would be very small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Smaller Project Alternative would generate a small EMF in the immediate vicinity of the undersea cables and onshore cables, which would not negatively affect marine or human life. Noise impacts from the Smaller Project Alternative would be limited to noise resulting from pile driving and vessel use. Noise during operation would result from the WTGs themselves.

Operation of the 65 WTG layout is not anticipated to impact hydrodynamics or water quality. The Smaller Project Alternative would require the storage of 20,000 gallons of oil on the ESP. Based on analyses conducted, probabilities of a large spill are extremely small.

Biological Resources

The Smaller Project Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts to terrestrial vegetation and terrestrial fauna other than birds would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no sea grass has been identified close to the footprint of the Smaller Project Alternative, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Smaller Project Alternative is in the Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins, et al., 2003). The types of avian resources affected for the Smaller Project Alternative are the same as those for the proposed action (refer to Section 5.3.2.4) though potential impacts would be less due to the smaller number of turbines.

Subtidal offshore resources would be affected by the monopiles and scour protection associated with WTGs at the Smaller Project Alternative, which results in a hard bottom structure for colonization by benthos for the life of the Smaller Project Alternative. The added structure is expected to attract a variety

of finfish to the site which could improve recreational fishing resources. Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact due to the WTG and ESP piles is 0.33 acres (1,335 m²) for the Smaller Project Alternative. In addition, the installation of the 33 kV cable needed to connect the WTGs to the ESP would require 29.7 miles (47.8 km) of cable and 258 acres of benthic impacts (1.04 km²). The temporary impacts to benthos would also result in temporary avoidance of the area by finfish and temporary impacts to EFH and shellfish.

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the vicinity include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Smaller Project Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels.

Socioeconomic Resources and Land use

The Smaller Project Alternative would cause an increase in the number of workers to fill the construction requirements of the alternative. The increase would result in numerous construction jobs during the 27-month period, with fewer workers required for decommissioning. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Smaller Project Alternative due to the relatively small number of workers relative to the population of the region, the relatively short duration of the work, and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Smaller Project Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population (refer to Section 4.3.3.3).

The alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the WTG array (refer to visual simulations at [Figure 3.3.6-2](#)). With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Smaller Project Alternative. The Smaller Project Alternative would be visible from historic structures and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Smaller Project Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Smaller Project Alternative is not expected to affect overland transportation arteries or airport facilities. The proposed action received FAA approval indicating WTGs in the area, which include WTGs under the Smaller Project Alternative, would not affect air navigation or associated communication systems (refer to [Appendix E](#)). With regard to navigation, the turbine array would be located on a shoal away from navigational channels where vessels are less likely to navigate. In addition, the turbines would be spaced in a grid of approximately 6 x 9 rotor diameters which would allow ample room for vessels including trawlers to navigate through the area.

3.3.6.2 Phased Development

3.3.6.2.1 Description

The Phased Development Alternative would utilize the same site as the proposed action and would employ the same transmission cable system layout (see [Figure 3.3.5-1](#)), but it would be constructed in two phases with time in between to allow monitoring of operations. The Phased Development Alternative could provide the potential to reduce impacts in the second phase based on evaluation of construction and operational impacts associated with the first phase. In order to facilitate the study of a phased approach to constructing 130 WTGs, it was determined that for illustrative purposes, a 50/50 split would be most effective. A split in the proposed action of 130 WTGs into two phases was accomplished by dividing the project into an eastern half and a western half; each containing 65 WTGs (see [Figure 3.3.6-3](#)). The initial 65 WTG phase would be designed to allow expansion to 130 WTGs with as little re-construction as possible. The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system cables) used in this Phased Development Alternative are the same as presented in the proposed action.

Phase I

The western half of this alternative would be constructed during the first phase primarily because the 65 westernmost turbine sites would be located in the shallower waters of Horseshoe Shoal and would be in closer proximity to each other allowing for the least amount of inner array 33 kV cable for interconnection to the ESP. This would be the least costly construction of the two phases, thereby reducing interest costs of financing during construction on the overall two phase project. Assuming that assurances were in place for the completion of both phases, the ESP and the complete 115 kV transmission system (both circuits for the offshore and upland components) would be completed during Phase I allowing for power from the first 65 WTGs to be transformed and transmitted into the regional power grid. Both the ESP structure and the complete 115 kV cable system (both circuits) would be the same as those for the proposed action; however some portion of the electrical equipment on the ESP would be delayed until the second phase. The construction of the ESP and the installation of the 115 kV transmission cable along the eastern edge of the first phase eliminates (to the greatest degree possible) the need to conduct Phase II installation activities (eastern half) within the area of the operating first phase of the project. Phase I would include 65 turbines connected in 7 full strings (each made up of 8 to 10 WTGs) and one partial string (3 WTGs), requiring approximately 32.7 miles of 33 kV inner array cable (see [Figure 3.3.6-3](#)).

Phase II

The eastern half of this alternative would be constructed during the second phase. In general, a project developer would seek to minimize the time between the construction of the first and second phases in order to minimize the lag time and costs associated with:

- Procurement of equipment
- Staging area acquisition and build out
- Mobilization of construction and installation equipment and labor
- At sea construction

For analysis purposes, phase two would be scheduled within a reasonable time frame of five to ten years to coincide with the state's continued desire for renewable energy sources should renewable energy still be mandated. Construction of Phase II within five years would not be considered a phased approach due to the short length of time between construction cycles. Construction of Phase II beyond ten years is not considered reasonable due to anticipated change to the underlying purpose and need for this project.

The balance of the ESP electrical equipment required for the additional 65 WTGs would be installed during Phase II. For the purposes of this analysis it is assumed that both circuits of the complete 115 kV cable system would be installed during the first phase. Phase II would include 65 turbines connected in 6 full strings (each made up of 9 or 10 WTGs) and the addition of 7 WTGs to one partial string of 3 WTGs that would have been installed in Phase I. Phase II would require approximately 34.0 miles of 33 kV inner array cable (see [Figure 3.3.6-3](#)).

Decommissioning

Because it is assumed that all of the WTGs would have the same effective useful life (approximately 20 years), the decommissioning of the Phased Development Alternative would also be conducted in phases to correspond to the phased construction and duration of lag time. Phase I of the decommissioning would remove the WTGs, scour protection and inner array cables that were installed 20 years prior during Phase I (western half of the Project). Following a period of time equal to the lag between construction phases, Phase II of the decommissioning would take place 20 years after the completion of the Phase II construction and would remove the eastern half WTGs, scour protection and inner array cables, along with the ESP and the interconnecting 115 kV transmission system. Similar to the construction phases, the decommissioning of the Phased Development Alternative would require multiple mobilizations/demobilizations and staging and is expected to have similar impacts as the phased construction.

3.3.6.2.2 Comparison of Alternative with Proposed Action

The Phased Development Alternative would have greater impact during construction and decommissioning than the proposed action for 10 of 28 impact categories (air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, and recreation and tourism). The impacts on these categories during operation would be similar to the impacts of the proposed action during operation. There would be no change in impacts for the other 18 impact categories for the Phased Development Alternative compared with the proposed action during construction, operation, or decommissioning (see [Table 3.3.5-1](#) for a full comparative listing of impacts relative to the proposed action).

With respect to air quality, construction and decommissioning under the Phased Development Alternative would have more impacts due to the multiple mobilizations, demobilizations and staging operations. In addition, the multiple phases would result in increased air emissions from the construction vessels and equipment due to the increased total number of vessel trips and/or the duration of deployment required to complete the project as compared to the proposed action. With respect to the operation of the Phased Development Alternative, the impacts to air quality would be similar to the proposed action.

With respect to water quality, construction and decommissioning under the Phased Development Alternative would have more impacts due to the multiple mobilizations, demobilizations and staging operations. The longer duration of deployment, increased number of vessel trips required to complete the project, and phased build-out of the ESP would result in a greater probability of a marine vessel spilling fuel, lubricating oils or other substances.

With respect to non-T&E avifauna, construction and decommissioning impacts would be greater for the Phased Development alternative than for the proposed action because of the longer timeframes of the additional mobilizations and demobilizations of major construction vessels for pile driving and WTG installation/decommissioning related to each distinct phase. The total number of vessels required to complete the construction and decommissioning would also be greater than required for the proposed

action, increasing potential impacts. With respect to the operation of the Phased Development Alternative, the impacts to non-T&E avifauna would be similar to the proposed action.

With respect to subtidal offshore resources, construction and decommissioning impacts on benthic habitat would be more for the Phased Development Alternative than for the proposed action because of the multiple mobilization and demobilizations that would be required and the multiple anchoring activities associated with the cable-laying and decommissioning activities. The greater impacts on benthos also would result in greater impacts to fish and fisheries (including shellfish) and essential fish habitat, which utilize the benthic resources and would be also affected by the multiple phases of construction and decommissioning. With respect to the operation of the Phased Development Alternative, the impacts to benthic habitat and resources, fish and fisheries would be similar to the proposed action.

With respect to non-ESA marine mammals, construction and decommissioning under the Phased Development Alternative would have more potential impacts due to the multiple mobilizations and demobilizations. The number of vessels required for each phase would increase, creating a greater potential for vessel strikes and underwater noise associated with the operation of the construction vessels. With respect to the operation of the Phased Development Alternative, the impacts to non-ESA marine mammals would be similar to the proposed action.

With respect to T&E species, impacts would be increased under the Phased Development Alternative due to the longer construction and decommissioning timeframes resulting from multiple mobilizations, demobilizations and staging operations. With respect to the operation of the Phased Development Alternative, the impacts to T&E avifauna and marine species would be similar to the proposed action.

With respect to visual resources and recreation and tourism, construction and decommissioning under the Phased Development Alternative would have more impacts due to the extended construction/decommissioning timeframe, multiple mobilizations, demobilizations and staging operations and increased construction vessel traffic. With respect to the operation of the Phased Development Alternative, the impacts to visual resources and recreation and tourism would be similar to the proposed action (see [Figure 5.3.3-5](#)).

3.3.6.2.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Phased Development Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and landuse, and navigation and transportation. A summary of the impacts within these four major categories is provided below.

Physical Resources

The Phased Development Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Phased Development Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Phased Development Alternative. The multiple mobilizations and demobilizations would result in an increase in air emissions from the construction vessels and equipment required for the Phased Development Alternative but would still be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. The potential for oil spills during construction is greater

due to the overall construction duration, the number of vessel trips to and from the site. In addition, the Phased Development Alternative would delay the installation of some portion of the electrical equipment on the ESP until the second phase, presenting a potential of oil spill during installation and transfer. With respect to EMFs, the Phased Development Alternative would generate a small EMF in immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Biological Resources

The Phased Development Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Phased Development Alternative is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins, et al., 2003). With respect to avian T&E species, information on the piping plover suggest that collision mortality associated with the Phased Development Alternative would result in minor adverse impacts but would not jeopardize the Atlantic coast population. With respect to the roseate tern, information shows that a low level of WTG collisions can be expected but would only have a minor affect on the roseate tern population.

Subtidal resources would be affected by the impacts to soft-bottom benthic communities that would occur during the cabling activities of the construction and decommissioning periods. Temporary impacts to benthic resources would be caused by anchoring activities associated with the cable-laying activities (anchors, anchor line sweep, jet plow pontoons), the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of the scour control structures that would occur over both phases of the Phased Development Alternative. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings and scour protection for the WTGs and ESP, which would result in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site, which could improve recreational fishing resources. The total area of permanent benthic impact for the Phased Development Alternative once fully constructed is the same as the proposed action. The WTG and ESP piles would result in 0.67 acres (2,711 m²) of impact and the total area of temporary impact for the cable that connects the WTGs to the ESP would be 580 acres (2.3 km²). The temporary impact of the area disturbed from installation of the transmission cable system from the ESP to the shore would be 86 acres (0.3 km²).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the Phased Development Alternative include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Phased Development Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels which is further augmented by the multiple mobilizations, demobilizations and staging operations required for the Phased Development Alternative.

Socioeconomic Resources and Land use

The Phased Development Alternative would cause an increase in the number of workers to fill the construction requirements. Limited impacts to Urban and Suburban Infrastructure would be anticipated as a result of the Phased Development Alternative due to the relatively small number of workers relative

to the population of the region and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Phased Development Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population.

The Phased Development Alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the Phased Development Alternative. Visual impacts would be the same once the Phased Development Alternative was operational. With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Phased Development Alternative. The Phased Development Alternative would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Phased Development Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Phased Development Alternative is not expected to affect overland transportation arteries or airport facilities. The Phased Development Alternative received FAA approval indicating WTGs in the area, which include WTGs under the Phased Development Alternative, would not affect air navigation or associated communication systems. With regard to navigation, the turbine array would be located on a shoal away from navigational channels, where vessels are less likely to navigate. The multiple mobilizations, demobilizations and staging operations required for the Phased Development Alternative would result in a greater number of vessels for an extended period of time impacting the local navigation; however these impacts would still be minor. In addition, the turbines would be spaced in a grid of approximately 6 x 97 rotor diameters which would allow ample room for vessels, including trawlers, to navigate through the area.

3.3.6.3 Condensed Array

3.3.6.3.1 Description

In designing an offshore wind energy project, turbine spacing is considered which effectively balances the capture of the wind resource (and ultimately the power production), with a number of site specific physical and economic constraints such as water depth and watersheet use. Wind turbines need to be spaced far enough apart to reduce adjacent row wind wake effects (in order to optimize wind park efficiency) and to reduce structural fatigue from turbulence created by the wake effect. As a general rule, manufacturers of the WTGs recommend a minimum spacing of greater than 5 rotor diameters in order to avoid catastrophic structural fatigue and guarantee efficiencies (Seifert and Kronig, 2003).

In order to facilitate the study of a Condensed Array Alternative with 130 WTGs, a 6 x 6 rotor diameter spacing was chosen as a reasonable example that falls within the range of some existing offshore wind energy projects (see [Table 3.3.6-1](#)). The Condensed Array Alternative would maintain the same ESP location as the proposed action, and therefore the interconnecting 115 kV transmission cable system would remain the same in all aspects of design, length, installation and routing as the proposed action (see [Figure 3.3.5-1](#)). Both the ESP structure and the complete 115 kV transmission cable system (both circuits) would be the same as those proposed for the proposed action. The WTG locations in the proposed action currently are spaced approximately 6 rotor diameters apart in the north-south "columns" of the array. The 130 WTGs of the Condensed Array Alternative have been arranged with the same

central column of WTGs as the proposed action’s “F” column (WTGs F1 through F14) (see WTG array in proposed action at [Figure 2.1.2-1](#)), all maintaining the same location with 6 rotor diameters separation. The WTGs of the proposed action are separated by 9 WTGs within the east-west “rows.” To reduce the spacing within these rows to 6 rotor diameters for the Condensed Array Alternative, the WTGs to the west of the ESP and the “F” column have been shifted to the east, and WTGs to the east of the ESP and the “F” column have been shifted to the west, providing for a 130 WTG array with 6 x 6 rotor diameter spacing condensed around a similar ESP location as the proposed action.

The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system) used in this Condensed Array Alternative are the same as presented in the proposed action. The WTGs in the Condensed Array Alternative have been arranged in similar interconnecting strings (14 strings of 8 to 10 WTGs each) as the proposed action (see [Figure 3.3.6-4](#)). The overall inner array 33 kV cable lengths would be reduced slightly to 58 miles (from 66 miles for the proposed action). The reduction (approximately 12 percent) would not be proportionate to the 25-30 percent east – west reduction of the condensed array because the inner array cables of the proposed action have been arranged to minimize overall length by maximizing the use of the shorter north – south transects and minimizing the cabling east to west.

The footprint area of the Condensed Array Alternative is approximately 16 square miles (41.4 km²) (as compared to 25 square miles [64.7 km²] for the proposed action). The distances to shore are presented in [Table 3.3.6-2](#). If the Project’s spacing were reduced to a 6 x 6 grid, modeling shows that the power production for the proposed 130 WTGs would be measurably reduced. The reduction in power is especially important in the summer months because of the typically high spot prices of electricity that occur in the summer compared to the rest of the year.⁴ As a result, even a small loss of power from a denser configuration in the summer months compared to other months of the year would produce a disproportionately greater reduction in revenue for the applicant even though on an annual production basis the reduction in MWs produced might be considered minor. The assessment can be quantified as follows:

$$X = (((P1 - P2) \times ((L1 \times R2) + ((1-L1) \times R1))) / (((P1 \times (1-L2) \times R1) + (P1 \times L2 \times R2)) \times Y)) \times 100\%$$

Where:

- P1 = production from a 6 X 9 array [configuration of the proposed action]
- P2 = production from a 6 X 6 array [denser configuration]
- L1 = percent of (P1 – P2) during peak power pricing hours
- L2 = percent of year yielding peak power pricing (assumed to be large enough to consume all losses created by L1)
- R1 = average rate/megawatt hour (MWHr) – during non-peak power pricing periods
- R2 = average rate/MWHr – during peak power pricing periods
- Y = percentage of net revenue to gross revenue
- X = percentage loss in net revenue due to denser (6 X 6) configuration

3.3.6.3.2 Comparison of Alternative with Proposed Action

The Condensed Array Alternative would have greater impact than the proposed action for the competing uses impact category during construction, operation, and decommissioning. Additionally, the Denser Configuration Alternative would have less impact during construction for eight impact categories:

⁴ The spot market for electricity is calculated on an hourly basis and can vary widely just within the span of a single hot summer day. While it is known that power costs are highest in the summer, it is not possible to predict future summer electricity prices.

noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. Of these impact categories noise and water quality would be expected to have similar impact as the proposed action during decommissioning while the other 6 would have a lesser impact. There would be greater expected impact compared to the proposed action during operation for the avifauna and threatened and endangered species impact categories. The remaining 19 impact categories would have the same level of impact as the proposed action during construction, operation, and decommissioning (see [Table 3.3.5-1](#) for a full comparative listing of impacts relative to the proposed action).

With respect to construction noise, impacts to humans would be slightly less under the Condensed Array Alternative because of the increased distance to shore from the perimeter WTG pile driving. Impacts from operational noise, both above and below water, from the Condensed Array Alternative are expected to be the same as those of the proposed action.

The distance the construction and maintenance vessels must travel from the proposed staging area in Quonset RI to reach the furthest WTGs on the eastern edge of the Condensed Array Alternative is slightly less than the proposed action. This minor reduction is offset by the increased travel distances to reach the nearest WTGs on the western edge of the Condensed Array Alternative from Quonset. As a result, there would be no significant change in air emissions between the two alternatives during construction.

With respect to water quality, water quality impacts related to construction of the Condensed Array Alternative would be less than the proposed action due to the eight mile (12.9 km) reduction in the amount of 33 kV cabling required.

With respect to avifauna, the eight mile (12.9 km) reduction in inner-array cable installation would slightly reduce impacts during construction and decommissioning. With respect to operations, the denser spacing is expected to have a greater “barrier” effect due to the higher concentration of structures, thereby increasing the potential for avoidance, collision or other impacts during operation.

With respect to subtidal offshore resources, the Condensed Array Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts during construction and decommissioning to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km²). The decrease in length of the 33 kV cable would also decrease temporary impacts to fish and fisheries, and EFH as a result of decreased area of turbidity and disturbed sea bottom. Impacts to T&E species would also be slightly less than for the proposed action as the shorter construction timeframe for the 33 kV cable would result in less disturbance to T&E avian species that could be in the vicinity.

With respect to marine mammals, there is a slightly reduced chance for vessel strike due to the shorter inner-array cabling activities involved with the Condensed Array Alternative compared to the proposed action. With respect to visual resources, visual impacts during construction and decommissioning activities would not be expected to be significantly different than construction related visual impacts of the proposed action. With respect to visual impacts during operations, the overall breadth of impact of the Condensed Array Alternative would have less of a visual impact than the proposed action. However, the concentration of structures would be increased for the Condensed Array Alternative, and thus the visual intrusion of the portion of the Condensed Array Alternative that is visible, would create more of an impact than the proposed action.

With respect to competing uses, vessels involved in commercial fishing within the area of the proposed action would experience increased competing use impacts due to the tighter spacing between the WTGs, which would make navigation more difficult.

3.3.6.3.3 Summary of Impacts on Physical, Biological, Socioeconomic Resources and Land Use, and Navigation and Transportation

Construction, decommissioning and operation of the Condensed Array Alternative would result in varying levels of impacts to the physical environment, biological resources, socio-economics and land use, and navigation and transportation. A summary of the impacts within these four major categories is provided below.

Physical Resources

The Condensed Array Alternative would result in impacts to above water and underwater ambient sound levels as a result of construction and decommissioning activities and to above water sound levels as a result of operation. In addition to noise impacts, the Condensed Array Alternative would result in air quality impacts from vessels and equipment involved in the pre-construction G&G investigations, and construction, decommissioning, and maintenance phases of the Condensed Array Alternative. The multiple mobilizations and demobilizations would result in an increase in air emissions from the construction vessels and equipment required for the Condensed Array Alternative but would still be small in relation to other air pollution sources in the general region and would not have a noticeable effect on air quality. With respect to water quality, impacts would be temporary and localized and result from installation of monopiles and undersea cables. With respect to EMFs, the Condensed Array Alternative would generate a small EMF in the immediate proximity to the undersea cables and onshore cables, which would not negatively affect marine or human life.

Biological Resources

The Condensed Array Alternative would affect terrestrial vegetation and terrestrial fauna via its upland portion of the interconnection line. The upland portion of the interconnection line would be located within an existing previously disturbed and maintained utility ROW, and thus impacts would be limited. Impacts to coastal and intertidal vegetation, would also be limited since no seagrass has been identified close to the footprint of the proposed action, and HDD technology would be used at landfall to avoid impacts to vegetation along the intertidal zone.

With respect to avifauna, the Condensed Array Alternative is in Nantucket Sound which is in the general vicinity of Monomoy National Wildlife Refuge and other locations where there are important staging areas and habitat for roseate terns, and least tern (Perkins et al., 2003). The denser array associated with the alternative may result in impacts to avian populations as a result of disturbance or collisions with the WTGs.

Subtidal resources would be affected by the impacts to soft-bottom benthic communities that would occur during the cabling activities of the construction and decommissioning periods. Temporary impacts to benthic resources would be caused by anchoring activities associated with the cable-laying activities (anchors, anchor line sweep, jet plow pontoons), the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of the scour control structures that would occur over both phases of the Condensed Array Alternative. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings and scour protection for the WTGs and ESP, which would result in a hard bottom structure for colonization by benthos. The added structure is expected to attract a variety of finfish to the site which could improve recreational fishing resources. The total area of permanent benthic impact for the Condensed Array Alternative due to the WTG and ESP piles is 0.67 acres (2,711 m²). The length of the 33 kV cable under the Condense Alternative that would connect the WTGs to the ESP would be 58.0 miles (93.3 km), which would result in temporary impacts to 504 acres (2.0 km²) of benthic habitat. The temporary impact of the area

disturbed from installation of the transmission cable system from the ESP to the shore is 86 acres (0.3 km²).

Marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the Condensed Array Alternative include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. Due to possible proximity to these marine mammals under the Condensed Array Alternative, there is potential for impact to these species during construction and decommissioning as a result of collisions with vessels which is further augmented by the multiple mobilizations, demobilizations and staging operations required for the Condensed Array Alternative.

Socioeconomic Resources and Land use

The Condensed Array Alternative would cause an increase in the number of workers to fill the construction requirements. Limited impacts to urban and suburban infrastructure would be anticipated as a result of the Condensed Array Alternative due to the relatively small number of workers relative to the population of the region and capacity of existing infrastructure including housing, emergency services and transportation to address the needs of the Condensed Array Alternative.

With respect to environmental justice, a socioeconomic analysis was conducted and showed that the counties within the area of impact had a lower percent minorities than the rest of the Commonwealth, and a lower percentage of people living under the poverty level than the rest of the Commonwealth, and thus the area of impact is not within an environmental justice population.

The Condensed Array Alternative would result in visual impacts to areas along the south coast of Cape Cod as well as areas along the shorelines of Nantucket and Martha's Vineyard that are oriented toward the Condensed Array Alternative. With respect to cultural resources, no submerged historic properties or archaeological sites are recorded in the area of the Condensed Array Alternative. The Condensed Array Alternative would be visible from historic properties and thus would affect cultural resources as a result of such visual impacts.

Navigation and Transportation

The area of the Condensed Array Alternative is used for fishing and boating (power and/or sail), and the shoreline areas are used for bird watching, and beach-going and other general recreational activities. The Condensed Array Alternative is not expected to affect overland transportation arteries or airport facilities. The Condensed Array Alternative in the same general vicinity as the proposed action which received FAA approval indicating there would not be an affect on air navigation or associated communication systems. Thus the Condensed Array Alternative would also be expected to not affect air navigation or associated communication systems. With regard to navigation, the turbine array would be located on a shoal away from navigational channels, where vessels are less likely to navigate, though the 6 x 6 rotor diameter grid spacing would require mariners to navigate more carefully in the area to avoid collisions with the WTGs.

3.3.6.4 No Action

3.3.6.4.1 Description and Comparison with Proposed Action

Under the No Action Alternative, the resulting environmental effects from taking no action are compared with the environmental effects of authorizing the proposed action or selected alternative. The opportunity for development of a wind power generating facility would not occur or be postponed. The potential environmental impacts resulting from the proposed action would not occur or would be

postponed. All impacts, positive and negative, associated with the proposed action would be eliminated. The incremental contribution of any of the proposed action to cumulative effects would also not occur. Strategies that could provide replacement resources for the loss of potential energy production and their associated impacts are discussed in detail in Section 5.4.6.

3.3.6.4.2 Summary of Impacts Under the No Action Alternative

Under the No Action Alternative, the proposed action would not be constructed and the associated impacts detailed in Section 5 would not occur. The No Action Alternative evaluated other strategies for addressing the demand for electricity in New England if the proposed action were not constructed and the viability of those strategies and impacts associated with those other strategies. In general, other than wind energy, only fossil fueled generating technologies would be able to address the electric generation output level of the proposed action within the same timeframe of the proposed action. As a result, impacts associated with the No Action Alternative would come from the burning of fossil fuels for energy production. Specific impacts would depend on the type of fossil fuel used (natural gas, oil, coal) the technology and pollution control systems chosen, and site specific issues associated with individual electric generation facilities.

For a gas fired facility, the principal pollutant of concern is NO_x. Emissions of NO_x result from the combustion of nitrogen contained in fuel and the air supplied for combustion. NO_x contribute to the formation of ground level ozone and acid rain. Natural gas facilities also emit VOC and carbon monoxide (CO) as a result of incomplete fuel combustion, which occurs to some degree even in state-of-the-art combined cycle combustion turbines (CCCT) systems being installed today. Although efficient combustion techniques employed in today's combustion turbines combined with the use of relatively clean burning natural gas reduce VOC and CO emissions below any other fossil fuel fired combustion technology, large quantities of these pollutants would still be emitted. In addition to the emissions of criteria pollutants, a gas-fired facility would also emit non-criteria pollutants and CO₂. Non-criteria pollutants include Hazardous Air Pollutants (HAPs), which the EPA considers of special concern and for which the EPA has developed national emission standards for specific source categories such as combustion turbines. Some of the HAPs emitted by a natural gas fired combustion turbine include formaldehyde, xylene, toluene, and benzene.

Oil and Coal facilities would also emit the previously referenced pollutants, and in addition would emit substantial quantities of SO₂, which contributes to acid rain, sulfate deposition and can react with other compounds in the atmosphere to form particulates. Particulate Matter also forms through incomplete combustion of fuels or using fuels with high noncombustible content (ash). Elevated particulate levels have been attributed to a variety of health effects such as respiratory ailments, especially in the young and the elderly. Finally, all fossil fuel facilities would emit CO₂, a greenhouse gas.

In addition to air pollution, fossil fuel fired electric generation can use large quantities of water for cooling and may result in water quality impacts or other localized impacts depending on siting such as impacts to wetlands, rare and endangered species, visual impacts, etcetera. A more detailed cost benefit analysis describing impacts under the No Action Alternative is provided in Section 5.4.6.

3.4 TRANSMISSION CABLE SYSTEM SITING ALTERNATIVES

On September 17, 2002, the applicant and NSTAR jointly filed a petition with the EFSB and a petition with the DPU to construct, operate and maintain two new 115 kV electric transmission cables to interconnect the proposed action with the regional electric grid in New England.

As part of its review process, the EFSB was required to evaluate whether there is a need for additional transmission resources and evaluate the proposed action in terms of its consistency with providing a

reliable energy supply to the Commonwealth with a minimum impact on the environment at the lowest possible cost. A project proponent must present to the EFSB alternatives to its planned action which may include: (a) other methods of generating, manufacturing, or storing electricity or natural gas; (b) other sources of electrical power or natural gas; and (c) no additional electric power or natural gas.

The applicant identified and presented four alternatives to the EFSB that would potentially meet its project need, each of which could provide reliable service for the applicant's proposed action. These approaches included connecting the proposed action: (1) to NSTAR's 115 kV Barnstable Switching Station; (2) to NSTAR's 115 kV Harwich Substation; (3) to NSTAR's 115 kV Pine Street Substation in New Bedford; and (4) to a new 115 kV substation on Martha's Vineyard, then proceeding on to the mainland.

Upon its review, the EFSB concluded that the Martha's Vineyard Alternative did not warrant further consideration because of the magnitude of increased cost over the Barnstable Interconnect without any offsetting benefits. Although the Harwich and New Bedford Alternatives would be somewhat less costly than the Martha's Vineyard Alternative, each would cost approximately \$50 million more than the Barnstable Interconnect. Because the Barnstable Switching Station is the major bulk substation on Cape Cod, with six 115 kV transmission lines available to carry energy to various parts of Cape Cod, interconnection at this location would provide high reliability in that energy from the proposed action could be reliably delivered to the grid even if one of the lines emanating from the Barnstable Switching Station is out of service. Therefore, the EFSB determined that, all other considerations being equal, a direct connection at the Barnstable Switching Station provides greater reliability than an indirect connection through another, smaller substation at a greater distance from the Barnstable Switching Station.

The EFSB found that the Barnstable Interconnect was preferable to both the Harwich and New Bedford Alternatives with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost. In addition, the EFSB found that, with the implementation of the proposed mitigation and conditions, the environmental impacts of the proposed facilities along the primary route would be minimized with respect to marine construction impacts, land construction impacts and permanent impacts. Therefore, the EFSB approved the applicant and NSTAR's proposal to construct two approximately 18 miles (29 km), 115-kV underground electric transmission cables along the primary route identified by the applicant.

The applicant has conducted a comprehensive analysis to identify the best route to provide the needed transmission interconnection from the facility to the mainland electrical grid system. A detailed assessment of alternative routes was conducted that concluded that the route proposed would be preferable to alternative routes with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost (EFSB, 2004).

4.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 PHYSICAL RESOURCES

For purposes of describing the physical resource characteristics of the proposed action area, this material is presented in the following seven subsections: geology, noise, physical oceanography, climate and meteorology, air quality, water quality, and electrical and magnetic fields.

4.1.1 Regional Geologic Setting

The site of the proposed action is located in the Atlantic Coastal Plain physiographic province. The geomorphologic setting can best be described as glacially produced. The surficial expression of Cape Cod and Nantucket Sound were formed during the advance and retreat of the last continental ice sheet in the northeastern United States, part of the Laurentide glaciation, and the subsequent erosion and reworking of the glacial deposits during the Holocene (10,000 years ago to the present) sea-level rise. [Figure 4.1.1-1](#) presents an interpretation of the glacial processes that formed Cape Cod and Nantucket Sound.

In the area of the proposed action, the maximum advance of the last continental glaciation is marked by the advance of the Cape Cod ice lobe, and the formation of terminal moraines on Martha's Vineyard and Nantucket, estimated at approximately 20,000 years ago. During this advance, it is thought that subglacial tunnel valleys carrying meltwater and sediment, extended south from Cape Cod to the ice margin near Martha's Vineyard and Nantucket, and eroded into the underlying fine grain sediments (Uchupi, E. and Mulligan, A.E., 2006).

As the continental ice sheet retreated, a proglacial lake formed in Nantucket Sound, resulting in the deposition of clays and fine sand. During this retreat, the ice sheet stalled along the southern shore of Cape Cod, depositing unstratified, poorly-sorted, ice-contact deposits of silt, clay, sand, gravel, and boulders (see area "III" in [Figure 4.1.1-1](#)). As ice-sheet retreat continued, this unstratified glacial deposit formed a dam and a second glacial lake formed to the north (see area "IV" in [Figure 4.1.1-1](#)). Fine-grained sediments were deposited into this second glacial lake. As the ice-sheet continued to retreat, this second dam, located along the southern shore of present day Cape Cod, failed, and the glacial lake on Cape Cod joined glacial Lake Nantucket. This event was followed by failure of the dam that formed Lake Nantucket, resulting in extreme erosion of the glacial lake and basement sediments. As the ice-sheet continued to retreat, fluvial deposition resulted in the formation of outwash plains on Cape Cod and Nantucket Sound (U.S. Geological Survey [USGS], 2006a; Uchupi, E. and Mulligan, A.E., 2006).

As the ice-sheet continued to retreat, another glacial lake formed to the north, in Cape Cod Bay, north of the present day Cape Cod outwash plains and the moraine that formed in central Cape Cod. The water level in this glacial lake was higher than today's sea-level, and groundwater seeps formed on the outwash plain. The unique combination of sand and gravel outwash plains and plenty of source water emanating from the seeps resulted in the formation of straight fluvial valleys that flowed south across the present day Cape Cod outwash plains and Nantucket Sound (Mulligan, A.E. and Uchupi, E. 2004; USGS, 2006a).

During this glacial event, world-wide sea-level was hundreds of feet lower than current levels, and the Earth's crust was depressed by continental glacial loading. As the Laurentide ice sheet continued to melt, sea-level continued to rise, ultimately transgressing over the present day offshore sediments in the project area, drowning the lower reaches of the straight fluvial valleys that had formed, eroding and reworking the glacial deposits along the southern Cape Cod coastline and in Nantucket Sound, a processes that continues today (USGS, 2006a).

Figure 4.1.1-2 presents the present day regional onshore surficial geology of Cape Cod, Martha's Vineyard, and Nantucket. Figure 4.1.1-3 presents the present day regional surficial geology of Nantucket Sound. Figure 4.1.1-4 presents surface sediment types in the proposed action area of Nantucket Sound.

To further understand the regional sedimentary features, two regional geologic cross sections were constructed. Figure 4.1.1-5 presents the locations of two cross sections, identified as A-A' and B-B'. Figure 4.1.1-6 presents the geologic cross section A-A', which begins onshore in southwestern Cape Cod, extends through the site of the proposed action in Nantucket Sound, and continues to Nantucket Island. Figure 4.1.1-7 presents geologic cross section B-B', which begins on Martha's Vineyard, extends through the site of the proposed action, and continues onshore in the mid-Cape Cod region.

4.1.1.1 Site-Specific Studies Analysis

Field studies were completed to further refine the understanding of the geology at the site of the proposed action as it relates to the seafloor, sub-seafloor, and onshore cable route. Studies were targeted to detail water depths, surface and sub-surface sediment types, seafloor morphology, sub-seafloor stratigraphy, and natural or man-made obstructions as they relate to installation, operation, and decommissioning of the proposed facilities. Benthic and archaeological samples were incorporated into the geotechnical field programs, where applicable (Report No. 4.1.1-1). Integrated marine geophysical/hydrographic surveys and geotechnical/sediment sampling programs were conducted in 2001, 2002, 2003, 2004, and 2005 on Horseshoe Shoal and along the proposed transmission cable route from the ESP to the proposed landfall location in Yarmouth.

Numerical modeling and engineering analysis of site specific data related to oceanographic processes was performed to assess, simulate, and predict potential impacts to geologic resources for installation and operation of the proposed action. The studies included: Report No. 4.1.1-2 *Simulation of Sediment Transport and Deposition from Cable Burial Operations in Nantucket Sound for the proposed energy Project*; Report No. 4.1.1-3, *Estimates of Seabed Scar Recovery from Jet Plow Cable Burial Operations and Possible Cable Exposure on Horseshoe Shoal from Sand Wave Migration*; Report No. 4.1.1-4, *Analysis of Effects of Wind Turbine Generator Pile Array of the Project in Nantucket Sound*; Report No. 4.1.1-5, *Revised Scour Report*; Report No. 4.1.1-6, *Conceptual Rock Armor Scour Protection Design*; Report No. 4.1.1-7, *Hydrodynamic Analysis of Scour Effects Around Wind Turbine Generator Piles, Use of Rock Armor and Scour Mats, and Coastal Deposition and Erosion*; and, in Report No. 4.1.1-8, *Seabed Scour Control Systems Scientific Design Station Report*. A detailed summary of these studies is presented in Section 5.3.1.1.

As detailed in Section 5.3.1.1, if the proposed action is authorized, the applicant would conduct additional geophysical/hydrographic surveys, geotechnical/sediment sampling vibracore sampling, and cone penetration test samples along the proposed 115 kV cable routes and along the inner-array 33 kV cable routes to finalize design parameters.

4.1.1.1.1 Marine Geophysical/Hydrographic Surveys

The marine geophysical/hydrographic surveys were designed to collect remote sensing data to evaluate wind tower installation feasibility, gather data to support the foundation design process, and to support the analysis of the surface and subsurface sediments on Horseshoe Shoal and the proposed submarine transmission and inner-array cable routes. Surveys included:

- Hydrographic measurements with a fathometer to determine water depths;
- Side-scan sonar to evaluate surface sediments, seafloor morphology and potential surface obstructions;

- Seismic profiling with high frequency (HF) (high resolution; limited penetration below the seafloor) and low frequency (low resolutions; deeper penetration beneath the seafloor) acoustic sources; and
- Magnetometer surveys to identify ferrous objects at the surface or shallow subsurface areas; combined with a differential Global Positioning System (GPS) to document the precise location of anomalies.

Figure 4-1.1-8 illustrates the locations of the 2001, 2003, and 2005 marine geophysical and hydrographic vessel tracklines, as they relate to the proposed action facilities.

Following completion of the field survey, the digital data files were processed at the surveyor's mainland facility, then reviewed and interpreted by staff and a marine archaeologist (for potential cultural resources). Digital hydrographic files were corrected for tidal fluctuations to report water depths at MLLW. Side scan sonar and magnetic intensity data were interpreted to delineate acoustic targets and magnetic anomalies.

4.1.1.1.2 Geotechnical Investigations

Two marine sediment sampling methods, vibracoring and sediment boring were used to advance sediment sampling devices below the seafloor surface to collect, sample, and analyze representative sediments from the site of the proposed action. The information gathered during these studies was used to correlate the geophysical data collected to actual sediment characteristics where WTG foundations are proposed in deep sediment (85 ft [26 m] below the seafloor) and along shallow electrical inner-array cable routes in shallow sediment depths (targeted for 6 ft [1.8 m] below the seafloor).

In addition, soil borings and test pits were completed along the onshore transmission cable route to confirm the surficial materials expected to be encountered during transmission cable installation.

Figures 4.1.1-8 and 4.1.1-9 illustrate the offshore locations of the marine vibracores, the geotechnical/sediment sampling, and the wind turbine locations.

Figure 4.1.1-10 illustrates the geotechnical boring and test pit locations along the onshore cable route.

4.1.1.1.3 Marine Vibracore Sampling

A total of 87 vibracores were advanced to confirm geophysical survey interpretations, to visually characterize the sediment, and to collect representative samples for physical property and chemical constituent analysis. Three of the vibracores collected were used to support the marine archaeological investigation.

Vibracores were advanced and collected from a ship. The cores were labeled and capped on the ship and transported to shore for analysis. Cores were advanced up to 30 ft (9.1 m) below the seafloor in the wind turbine field grid and typically to 10 ft (3 m) below the seafloor along the transmission cable route. Onshore, cores were opened, photographed, and were described in accordance with the Unified Soil Classification System.

4.1.1.1.4 Deep Sediment Marine Borings

A total of 22 deep sediment marine borings were advanced, to a maximum depth below the seafloor of 150 ft (45.7 m), to collect geotechnical information as it relates to the below seafloor depths of the proposed wind turbine foundations.

Deep sediment borings were advanced from a ship. Sampling devices, split spoons, were driven ahead of drilling tools to collect representative sediment samples. Standard penetration test blow counts were recorded. Sediment recovered in the split spoons was characterized, and at various applicable locations, field tests included pocket penetrometer and torvane tests to estimate the un-drained shear strength of the cohesive soils encountered. Grain size and Atterberg Limits analyses were performed on sediment samples and pressuremeter tests were performed at select locations to measure the in situ strength and deformation characteristics of the sediment. The pressuremeter tests can be used to assess the bearing capacity and settlement of foundations.

4.1.1.1.5 Upland Geotechnical Boring and Test Pitting

Four soil borings and three tests pits were completed along the pre-existing roadway ROWs and the NSTAR ROW to confirm the existing upland soil conditions.

4.1.1.2 Offshore Geology

The offshore portion of the area of the proposed action is located primarily in the central region of Nantucket Sound with the two transmission cables extending northward into Lewis Bay and the southern shoreline of Cape Cod.

4.1.1.2.1 Seafloor Geomorphology

The area of the proposed action is located in Nantucket Sound, a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha's Vineyard, and Lewis Bay, a coastal embayment along the south coastline of Cape Cod. The foundations for the WTGs and the ESP are proposed for installation on Horseshoe Shoal, located within Nantucket Sound.

In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this basin. A combination of NOAA nautical charts and project-specific hydrographic surveys were used to assess existing bathymetric conditions.

On Horseshoe Shoal where the WTGs and the ESP are proposed, hydrographic surveys indicate water depths are as shallow as 0.5 ft (0.15 m) (MLLW), with depths of up to 60 ft (18.3 m) (MLLW) occurring between the northern and southern legs of the shoal. The WTGs and ESP would be located in water with depths between 12 and 50 ft (3.7 and 15.2 m) (MLLW).

Water depths between Horseshoe Shoal and the Cape Cod shoreline have an average depth of approximately 15 to 20 ft (4.6 to 6.1 m) (MLLW). Along the proposed transmission cable system route, water depths range from 16 to 40 ft (4.9 to 12.2 m) (MLLW), with an average depth of approximately 30 ft (9.1 m) (MLLW).

In Lewis Bay, water depths range from 8 to 16 ft (2.4 to 4.9 m) (MLLW) in the center of the bay to less than five ft (1.5 m) (MLLW) along the perimeter. Water depths along the proposed transmission route in Lewis Bay range from 2 to 16 ft (0.61 to 2.4 m) (MLLW).

Marine geophysical surveys present a seafloor that ranges from flat and barren to rolling with areas of varying height sand waves. Localized areas of glacial erratics (pebble to boulder size rock fragments carried by glacial ice), and a concentrated outcrop of possible till (an unstratified glacial deposit that can include clay, silt, sand, cobbles, and boulders) were observed. This possible till deposit has been avoided during the selection of the final proposed transmission cable alignments. In addition, the side scan geophysical imagery revealed surface reflectors indicative of man-made debris (generally from 1 to 5 ft [0.3 to 1.5 m] in size) on the seafloor in the west central part of the proposed action.

Sand Waves and Sediment Transport

The sand waves observed during the geophysical surveys are wave-like seabed features, with elongated, more or less parallel crests. Typically, sand waves are not static, rather they are migrating bedforms and evidence of active sediment transport along the seabed. Sand waves in this shoal environment are morphologically dynamic, with sand waves moving, appearing, disappearing, and changing shape over time as a result of tidal and storm influences. This sand wave process is not unique to Nantucket Sound, but rather occurs in coastal settings wherever the appropriate hydrodynamic conditions exist along with a predominance of sandy, non-cohesive sediments.

Sand waves of varying heights characterize the areas of active sediment transport, generally in the center of the Horseshoe Shoal. However, a large field of sand waves extends across the southern half of the shoal, and several smaller fields are located to the north within the area of the proposed action. [Figure 4.1.1-11](#) presents the location and maximum observed heights of sand waves identified during geophysical surveys completed in 2003 and 2005, and includes the locations of the proposed WTGs and the electrical transmission cable routes.

The sand wave crests are oriented generally in a north-south direction, with long period wavelengths ranging from 100 to 600 ft (30.5 to 182.9 m). Short period sand waves are located between the larger crests. The average sand wave height observed was 4 to 5 ft (1.2 to 1.5 m), but waves as high as 15 ft (4.6 m) were present. Smaller wave heights from 1 to 2 ft (0.3 to 0.61 m) were often observed between the larger wave crests.

Tidal currents flow east and west across the Nantucket Sound, with the eastward-flowing flood tide more dominant than the westward-flowing ebb tide. The symmetry of the sand waves indicates migration to the east or west, depending on where they formed on the Horseshoe Shoal. Sand waves forming on the west flank of the shoal tend to migrate easterly. Sand waves forming on the east flanks of the shoal tend to migrate to the west. Sand waves across the crest of the shoal have a symmetrical profile, suggesting an equal force in both the ebb and flood tidal phases. Not all bed forms exhibit a clear migration direction, indicative of multiple processes impacting sediment transport in Nantucket Sound, include storm events.

Analytical sediment transport modeling was completed to determine the extent to which existing wave and current conditions are likely to lift and move sand at the site of the proposed action. A two-dimensional sediment transport model was developed to simulate 26 current and wave conditions across the site of the proposed action. The model inputs included a grid of wave heights and ambient currents for the site of the proposed action. The model then calculates near bottom velocities and shear stresses associated with waves and ambient currents. The model results represent whether and where sediment transport is likely to occur and potential rates of bed load and suspended load sediment transport ([Report No. 4.1.1-9](#)).

Ten tidal and wind driven current scenarios were run for Horseshoe Shoal. The conditions were selected to represent a range of tidal currents, locally-generated wind waves within Nantucket Sound, ocean waves, and wind-generated currents in the sound. Extreme conditions, such as storms, were not modeled. The results of the model runs are useful in understanding the dynamics of sediment transport in Nantucket Sound under different conditions. However, qualitative sediment transport rates and net sediment flux within Horseshoe Shoal are not possible without field measurements for model verification ([Report No. 4.1.1-9](#)).

The results of the modeling indicate that active sediment transport occurs at Horseshoe Shoal under typical wave and tidal current conditions. The highest sediment transport rates are focused locally on the shallowest portions of the shoal, and there is relatively little sediment transport in the deeper regions of

the shoal (particularly the east side) under typical conditions. Bed load transport is typically an order of magnitude greater than suspended load transport. The range of sediment transport volume from the energy flux calculation for mean flood tide conditions and commonly occurring waves (height = 1.3 ft (0.4 m), period = 2.3 seconds) is 0 to 3.0 m³/m-day (0 to 32.3 ft³/ft-day), though the authors recognize that the model cannot account for erosion and equilibration of the seafloor and likely the rates predicted are overstated ([Report No. 4.1.1-9](#)).

Spring tidal currents and typical wind-driven currents (wind speeds ranging from 15 to 20 mph [6.7 - 8.9 m/s]) initiate approximately 20 percent more transport than mean tidal currents. The greatest impact on sediment transport initiation is wave action. Larger locally generated waves within Nantucket Sound can result in a significant increase in sediment transport. Storm generated ocean swells reaching the sound can greatly increase sediment transport rates, as much as one-hundred fold ([Report No. 4.1.1-9](#)). Jet-plowing operations would not be scheduled during or prior to any predicted extreme storm events and therefore were not included in the modeling. Additionally, jet-plowing would be suspended during any unanticipated extreme storm events.

4.1.1.2.2 Subseafloor Geology

The sediment below the seafloor was characterized by completing geophysical surveys at some of the WTG locations and along electrical transmission cable runs, and the collection, characterization, and analysis of samples collected from 84 vibracores (not including three archeological cores) and 22 deep borings on Horseshoe Shoal. On Horseshoe Shoal, vibracores were advanced up to 20 ft below the seafloor. Geotechnical borings were advanced below the proposed depth of the WTG foundations (85 ft) though one was extended to 150 ft below the seafloor. Geophysical surveys characterized shallow and deep sediments, with bottom profiler gathering data to 200 ft below the seafloor at some locations. In general, geotechnical surveys indicate that subsurface soil conditions within the WTG array on Horseshoe Shoal consist primarily of sands and glacial till deposits to greater than 100 ft below the seafloor.

Shallow sediment samples collected from vibracores (extended up to 20 ft [6.1 m] below the seafloor) between the WTGs indicates the shallow surficial sediments are primarily medium sand in shallow water and fine sand in deeper water. Characterization via bulk physical analysis was completed on composite samples collected from the upper 4 to 5 ft (1.2 to 1.5 m) of sediment collected from the vibracores. The samples collected from shallow water indicated the presence of well sorted sands with less than 5 percent fines. In the deeper waters, well sorted sand to silty sand was present. Detailed cross sections across Horseshoe Shoal are presented as [Figures 4.1.1-12](#) and [4.1.1-13](#); the plan view for cross section locations are presented in [Figure 4.1.1-5](#).

Along the proposed transmission cable route in Nantucket Sound, sediment characterization samples were collected and analyzed and were found to be very similar to those in the WTG array area. Within Lewis Bay, a higher percentage of silt and clay were identified with the sands. In addition, thin layers of organic material, including thin (0.5 ft [0.15 m] thick) layers of peat, were observed. The geophysical sub-bottom profiles approaching Lewis Bay contain inconsistent (continuous, discontinuous) acoustic subsurface reflectors, which may be evidence of the fluvial erosion (during sea-level fall) and then wave erosion (during sea-level rise) that has occurred on the Cape Cod southern coastline (OSI, 2002 and 2003).

These shallow sediments are representative of the material to be disturbed (suspended during jet plow embedment) during the WTG inner-array cable installation, which is targeted for a depth of 6 ft (1.8 m).

Figure 4.1.1-9 presents vibracore sample locations and a plan view of a geologic cross section location along the 115 kV Cable Route from the WTG array to landfall. The cross section is presented in Figure 4.1.1-14.

Deeper sediments were characterized as re-worked fine to medium sands. Locally, intermittent beds of organics are located within and below this re-worked sediment. This is presented on the cross section presented in Figure 4.1.1-12 with boring SB-01-2002. This intermittent zone of organics may be a soil horizon marking land surface exposed during the sea level low-stand prior to the marine transgression and sea-level rise that continues today. The lack of a broad soil horizon is likely related to the erosion and re-working of the sediment during this marine transgression.

In addition, limited areas of Horseshoe Shoal contained near-surface gaseous sediments derived from organic material which was identified by acoustical penetration restrictions during the geotechnical seismic profiling. This is a common occurrence in shallow near-shore sediments. Signs of high biogenic gas content, such as sea-bed pockmarks, were not identified during the geophysical surveys.

In addition to the organic soil horizon, a thin but distinct sedimentary facies of interbedded clay was locally observed at the same location and others, but at a greater depth. Though not widespread, this may be evidence of a former glacial lake. Analysis of the sub-bottom geophysical results and the deep boring data indicates this intermittent clay horizon has been eroded, a geologic unconformity. This is best illustrated on the cross section presented in Figure 4.1.1-13 comparing the silty-clay horizon of SB-03 and the fine sand and clay horizon of SB-02-2002, with the sandy sediment in SB-01.

A correlation between the geophysical and geotechnical soil boring results indicates the subsurface sediment is dominated by fine to coarse-grained sand interbedded with deposits of clay, silt, gravel and/or cobbles. An example of this geologic setting is illustrated on the geophysical trackline profile G-13, correlated to marine boring GZA-SB-02 in Figure 4.1.1-15.

Evidence of diapirism, a fairly common type of soft sediment deformation in continental shelf sediments, was assessed for the area of the proposed action. Diapirs can be composed of salt or mud depending on the source sediments. Sediments undergo compaction as younger sediments are deposited over them, leading to increasing pressure on fluids within the sediments. The pressurized fluids can start to flow, mobilizing the sediments to zones of lower pressure at or near the seafloor. This process may also be associated with methane-producing organic content in the sediments (Kennett and Fackler-Adams, 2000).

In the process of flowing upward, the diapirs deform the overlying sediments in a doming or piercing fashion. Diapirs are discrete features that can be identified on geophysical subbottom profiler data and can be avoided. They can be active or inactive, exhibit a range of sizes, and may or may not intersect the seafloor.

Researchers reviewing geophysical data collected on outer continental shelf-upper continental slope margins around the world, including along the U.S. Mid Atlantic outer continental margin, have observed a number of features that may be caused by the release to the seafloor of pressurized subsurface fluids, possibly coupled with pore gas in the sediments (Hill et al., 2004). Water/gas expulsion from sediments can cause pockmarked depressions in the seafloor, and slumping and landslides of fine-grained marine sediments in areas of steep unstable slopes (such as on continental slopes in deep water). Potential large-scale mass wasting of marine sediments on continental slopes has been speculated to trigger tsunamis, though few have been reported throughout the world (Driscoll et al., 2000).

A review of geologic literature did not result in evidence of salt or methane hydrate diapirism in Nantucket Sound.

Some small nearshore features have been interpreted as sediment diapirs in western Nantucket Sound (Swift, 2006) and a possible diapir is also exposed along the eroding cliffs along the Outer Cape (Oldale et al., 1993).

In addition, limited evidence of mud diapirism deforming sediment in Nantucket Sound, outside of the area of the proposed action in Waquoit Bay, is available in geologic literature. The processes that control the nature and extent of these geologic features are not well understood. Researchers further speculate that mud diapirism may be widespread beneath land and the seafloor of Nantucket Sound. In the Waquoit Bay area, at least one diapir appears to be actively deforming the seafloor upward in a region of active tidal sediment transport. The study suggests that the presence of such features in Nantucket Sound may present a hazard to permanent offshore structures emplaced in the area (Swift, S. A. and Mulligan, A., 2003).

No evidence of diapirism has been identified to date in the Nantucket Sound areas surveyed for the proposed action, based upon the review of the shallow and deep subbottom profiler records completed for the proposed action (TRC, 2007).

The area of the proposed action is on the shallow inner continental shelf, approximately 125 miles (200 km) landward of the deep-water outermost continental shelf and upper slope margin, where the mass sediment slumps and the possible water/gas expulsion features have been observed along the eastern United States coast. Although the proposed action is located on the low-relief topographic high that is Horseshoe Shoal, slopes are gradual and the potential for mass wasting of sediments along the shoal's edges is low. Nonetheless, the presence/absence of diapirs and shallow gaseous sediments, as well as slope stability, would be evaluated within the proposed action's Area of Potential Effects (APEs) during the shallow hazards survey and the supplemental post-lease geotechnical program.

Bedrock was not encountered during the geophysical investigation. The depth to bedrock beneath the seafloor is estimated at greater than 300 to 900 ft (91.5 to 274.4 m) below the seafloor across the area of the proposed action, sloping to the southeast. The estimated depth to bedrock is below the deepest foundation proposed (USGS, 1983; USGS, 1990; USGS, 2006d).

4.1.1.2.3 Onshore Geology

The two 115 kV AC submarine transmission cables are proposed for landfall at the end of New Hampshire Avenue in the Town of Yarmouth. From this landfall, an onshore 115 kV transmission cable system would be installed in an underground conduit system within existing roadways for approximately 4.0 miles (6.4 km) until it intersects the existing NSTAR Electric transmission line ROW at Willow Street in Yarmouth. From that point, the onshore transmission cable system would proceed west, and then south in an underground conduit system approximately 1.9 miles (3.1 km) along the existing NSTAR Electric ROW to the Barnstable Switching Station. See [Figure 4.1.1-16](#) which illustrates the onshore cable route and anthropogenic features.

The overland run, from landfall to just before Willow Street, is located beneath an existing roadway over thick Harwich Outwash Plain deposits, see [Figure 4.1.1-16](#). The Harwich Outwash Plain consists of unconsolidated sand and gravel, with localized silt and clay (USGS, 2006a). From that point to the Barnstable Switching Station, the transmission corridor traverses the Sandwich Moraine along existing roadway, then an existing utility ROW. The Sandwich Moraine contains thick unconsolidated, poorly-sorted, sand, silt, and clay, and includes cobbles and boulders (USGS, 2006a).

To further evaluate the subsurface conditions along the onshore cable route, four borings and three test pits were completed. Below the shallow fill material, where present, unconsolidated glacial sediments were penetrated along the entire onshore cable route including the fluvial outwash sediments on the Harwich Outwash Plain, and the unstratified glacial sediments on the Sandwich Moraine. Bedrock was not encountered.

To illustrate the materials encountered and relative increase in topography from landfall, through the Harwich Outwash Plain, and along the Sandwich Moraine, two cross sections were completed. Cross section D-D', completed from four soil borings advanced in existing roadways from landfall to the mid-Cape Highway is presented on [Figure 4.1.1-17](#) (plan view of the cross section locations are presented on [Figure 4.1.1-16](#)). Cross section D'-D'', completed from three test pits advanced within the existing utility ROW, runs from the mid-Cape Highway to the Barnstable Switching Station is presented on [Figure 4.1.1-18](#).

4.1.1.3 Seismic Setting

In general, Cape Cod and Nantucket Sound are considered a relatively stable tectonic setting, distantly located from a tectonic plate boundary, where frequent high energy earthquakes are typically more common. This intraplate setting is not a seismic-free location. The seismic activity here is less frequent than at plate boundaries, but low intensity earthquakes are common in New England, with an average of 30-40 occurring each year, but with most never felt by residents. In Massachusetts, 316 earthquakes were recorded between 1627 and 1989. In Rhode Island, only 32 earthquakes were recorded between 1766 and 1989 (NESEC, 2006).

Compared to the mainland of New England, it is recognized that Nantucket Sound is relatively less seismically active. However, on October 24, 1965, the residents of Nantucket Island felt a moderate earthquake. Very slight damage was recorded, mostly to ornaments and doors. Windows and dishes rattled, and house timbers creaked (USGS, 2006b). This recent example indicates that the area of the proposed action is not earthquake free but that seismic activity is low energy.

Occasionally, higher energy earthquakes could occur in Massachusetts, such as the largest earthquake recorded in Massachusetts, the Cape Ann earthquake of 1755. With an intensity value of VIII on the Modified Mercalli scale (magnitude 6+ on the Richter Scale), very strong shaking and moderate structural damage were recorded in Boston and the North Shore (USGS, 2006b).

Seismic waves travel out from an earthquake epicenter through the surrounding rock. Ground motion is higher closer to the location of the event. In general, ground motion decreases away from the epicenter, though the amount of ground motion at the surface is related to more than just distance from the epicenter. Some natural materials can amplify ground motion, for instance ground motion is generally less on solid bedrock and greater on thick deposits of clay, sand, or artificial fill.

Seismic hazards defined in building codes are typically based on peak ground acceleration. During an earthquake, a particle attached to the earth would move back and forth irregularly. The horizontal force a structure must withstand during an earthquake is related to ground acceleration. Peak ground acceleration is the maximum acceleration experienced by a particle during an earthquake.

The USGS produces probabilistic Seismic Hazard Maps for the United States with peak ground acceleration values represented as a factor of "g". One g is equal to the force on an object at the surface of the earth due to gravity. Engineers utilize these probabilistic ground motion values, representing hard rock beneath site soils, when designing earthquake resistant structures.

The USGS Seismic Hazard Maps were reviewed for the area of the proposed action. The maps show a 10 percent probability of a 2-3 percent g exceedence in 50 years (see [Figure 4.1.1-19](#)). In addition, there is a 2 percent probability of a 6-10 percent g exceedence in 50 years (see [Figure 4.1.1-20](#)) (USGS, 2002a).

4.1.1.3.1 Liquefaction

Liquefaction is a process whereby the strength and stiffness of a soil and/or sediment is reduced by earthquake shaking or other rapid loading. The result is a transformation of soil and/or sediment to a liquid state. Typically, three general factors are necessary for liquefaction to occur. They are (USGS, 2006c):

- Young (Pleistocene) sands and silts with very low or no clay, naturally deposited (beach, river deposits, windblown deposits) or man-made land (hydraulic fill, backfill).
- Soils and sediments must be saturated. The space between individual particles is completely filled with water. This water exerts a pressure on the soil and sediment particles that influences how tightly the particles themselves are pressed together. This is most commonly observed at or near bodies of water such as rivers, lakes, bays, and oceans, and associated wetlands.
- Severe shaking. This is most commonly caused by a large earthquake. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. This factor is limited by the distance from the large earthquake epicenter. That is, liquefaction potential decreases as distance increases from the epicenter of a large earthquake.

Based on the USGS Seismic Hazard Maps for the area of the proposed action, the risk of a large earthquake resulting in severe shaking of the young, saturated sand deposits of Horseshoe Shoal is low. Site specific assessments would be completed following completion of the permitting process.

4.1.1.3.2 Faults

A fault is a fracture surface within the Earth's lithosphere along which displacement has occurred.

No active (younger than about 10,000 years) shallow or deep faults have been identified within the area of the proposed action based upon geologic literature review. Older in-active faults, including those likely associated with what is believed to be a nearby failed Triassic-Jurassic rift basin, are likely present in the area (see possible evidence of the failed rift via the basalt found at approximately 1,400 ft [426.8 m] below ground surface in boring USGS, 6001 on [Figure 4.1.1-6](#).)

4.1.2 Noise

Noise could affect the local environment during the construction, operation and decommissioning of the proposed action. The ambient sound level of a region is defined by the total noise generated within the specific environment, and is usually comprised of sound emanating from natural and artificial sources. At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. A noise assessment was performed based on the collection of background sound levels and comparing them to the various noises that would be produced during project construction, operation, and decommissioning.

4.1.2.1 General Information on Noise

4.1.2.1.1 Above Water Noise

Sound results from vibrations in the air. The range of pressures that cause the vibrations that create sound is large. Sound is therefore measured on a logarithmic scale, expressed in decibels (dB). The frequency of a sound is the “pitch” (high or low). The unit for frequency is hertz (Hz). Most sounds are composed of a composite of frequencies. The normal human ear can usually distinguish frequencies from 20 Hz (low frequency) to about 20,000 Hz (high frequency), although people are most sensitive to frequencies between 500 and 4000 Hz. The individual frequency bands can be combined into one overall dB level.

When sound energy is concentrated at a single frequency, the peak in the spectrum may be audible as a “pure tone.” Generally this condition occurs when a particular 1/3-octave band has a sound level higher than the average level of the two adjacent bands by 5 to 15 dB (with the 15 dB threshold used for low frequencies below 125 Hz). This is the definition of a pure tone condition that was used in this analysis.

Sound is typically measured on the A-weighted scale (dBA). The dBA has been shown to provide a good correlation with the human response to sound and is the most widely used descriptor for community noise assessments (Harris, 1991). The lowest sound that is usually found in rural environments is about 30 dBA, while an uncomfortably loud sound is about 120 dBA. In order to provide a frame of reference, some common sound levels are provided in [Table 4.1.2-1](#).

Common terms used in this noise analysis are defined as follows.

- L_{eq}** – The equivalent noise level over a given period. It is a single value of sound that includes all of the varying sound energy in a given duration.

- L₉₀** – The dBA sound level exceeded 90 percent of the time, and is always less than the L_{eq}. The L₉₀ is utilized by the MassDEP to characterize the background or residual noise level. This descriptor generally excludes extraneous intrusive sounds such as an aircraft overflight or occasional vehicular traffic.

- L_{max}** – The near instantaneous maximum sound level measured during a given period. It is therefore always greater than the L_{eq}.

Two measures often used by Federal agencies to relate the time-varying quality of environmental noise to its known effect on people are the 24-hour equivalent sound level (L_{eq(24)}) and the day-night sound level (L_{dn}). The L_{eq(24)} is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. The L_{dn} takes into account the duration and time the noise is encountered. The L_{dn} is the L_{eq(24)} with 10 dB on the dBA added to nighttime sound levels between the hours of 10 p.m. and 7 a.m., to account for people’s greater sensitivity to sound during nighttime hours.

4.1.2.1.2 Below Water Noise

Similar to above water noise, in the underwater environment, acoustic energy moves through the water as sound waves, which are minute variations in water pressure. The main difference is the medium in which the sound vibrations pass through (water instead of air). The underwater sound pressure level is defined on a dB scale, similar to the familiar above water decibel scale, but the reference pressure is different. As a result, an identical sound pressure wave in air and underwater is recorded differently in the two fluids. For example, a sound pressure of 80 dB in air is equivalent to 106 dB underwater, i.e., the

underwater scale is shifted 26 dB higher than the air scale. There are also substantial differences in ambient (background) sound levels in air and in the ocean, and in the frequency weighting that is used in water versus air. Thus, the reader should not try to equate dB levels reported for water with those in air, or vice-versa.

The existing sound in the sea comes from many sources, natural and man-made, including turbulence in ocean currents, tides, surface waves, cavitations (collapse of air bubbles) in near-surface waves, low-level seismic activity, sea animals, and ship traffic. The hearing capabilities of and the frequency responses of marine mammals vary widely. Therefore, underwater sound levels are presented as unweighted or linear decibels (dBL). As with airborne sound, the frequency component of the underwater sound is important in this analysis.

Underwater sound levels are commonly measured as either the L_{eq} or the L_{max} . For underwater sound, the typical measurement range at sea is from 80 dB (still water conditions) to 180 dB. The ambient underwater sound level is highly variable in time and by location. For example, a one-knot current can produce turbulent pressure changes (sound waves) of 116 dB. Typical ambient underwater sound levels in Nantucket Sound are from L_{eq} 95 to 115 dB for surface winds of five to 30 mph (2.2 to 13.4 m/s).

4.1.2.2 Regulatory Requirements

In 1974, the USEPA published, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for state and local governments to use in developing their own ambient noise standards. The USEPA has determined that to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an L_{dn} of 55 dBA.

The MassDEP has a noise standard (310 CMR 7.10). Although the proposed action would be located outside of the Massachusetts territorial limit (3.5 miles [5.6 km] from shore), and the standard would not technically be applicable to the proposed action, the Secretary of the EOEA included a requirement in the MEPA Certificate that required that the standard be addressed for informational purposes.

Noise is regulated in the Commonwealth of Massachusetts under regulation 310 CMR 7.10. The regulation limits sound as follows:

- (1) No person owning, leasing, or controlling a source of sound shall willfully, negligently, or through failure to provide necessary equipment, service, or maintenance or to take necessary precautions cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise.

This “Noise” definition is described quantitatively in MassDEP Noise Policy 90-001 as follows:

- Increases in broadband sound may not exceed 10 dBA above ambient at the property line and nearest residence.
- A source may not produce a “pure tone” condition. A pure tone is defined as any octave band center frequency sound pressure level that exceeds the two adjacent center frequency sound pressure levels by 3 dB or more.

These criteria are applied both at the property line and at the nearest inhabited residence. Ambient sound is defined as the background dBA sound level exceeded 90 percent of the time (L_{90}). This type of measurement essentially excludes short term, intrusive noise sources, such as aircraft overflights or

occasional traffic. The MassDEP standard does not apply to construction activities. There are no local or Federal noise standards applicable to the proposed action.

4.1.2.3 Existing Conditions

4.1.2.3.1 Offshore Locations

Ambient noise monitoring programs were conducted at two offshore locations, near navigation buoys where recreational boaters travel: at Buoy G5 in the North Shipping Channel about 1 mile (1.6 km) north of the edge of the Proposed Alternative location of the proposed action, and at Buoy R20 at the edge of the Main Channel about 1/3 mile (0.5 km) south of the Proposed Alternative location ([Report No. 4.1.2-1](#)). These data were collected on October 22, 2002 between 10 a.m. and 12 noon. The weather conditions were clear skies, light winds (4 mph [1.8 m/s] average), and light seas (0.5 to 1.5 ft [0.15 to 0.46 m] waves). The boat engine was shut-off during the measurements and the dominant sounds were wave interaction with the boat hull (the boat was allowed to drift), periodic over flying aircraft and distant boat traffic. [Figure 4.1.2-1](#) is a map showing the locations of Buoys G5 and R20, as well as all onshore monitoring locations and modeling receptors.

The background (L_{90}) sound levels were 35 and 37 dBA, respectively, at Buoys G5 and R20. The corresponding average (L_{eq}) sound levels were 46 and 51 dBA. To estimate existing average sound levels for the design wind speed condition of the proposed action, the measured levels were increased by 14 dBA, the average observed difference between the two wind conditions for long term monitoring done at three shoreline locations (see Section 4.1.2.3.2 of this document). The frequency spectrum for existing condition sound levels at the two buoy locations are given in [Figure 4.1.2-2](#).

4.1.2.3.2 Onshore Locations

Baseline sound monitoring locations were chosen to satisfy the MEPA certificate that required monitoring at “the nearest representative locations along the south coast of Barnstable and Yarmouth and the east coast of the Vineyard.” Along the coasts, there is a wide variety of existing land use and population density. If representative locations were targeted at areas with the most people, then logical choices would be Hyannisport, the shore along Lewis Bay in Yarmouth and Edgartown harbor. These areas, however, have high levels of human activity and motor vehicle traffic, and baseline sound levels are higher than those found at uninhabited areas along the coast. To ensure the measured sound levels are a conservative (i.e., low) estimate of baseline conditions along the entire coast, secluded areas along the coast were sought out ([Report No. 4.1.2-1](#)). In the same vein, measurements were taken in November and December 2002, a time of year with little or no beach traffic (cars, trucks and boats). Measurements made in the summer would have been higher. The three monitoring sites were located on the coast at Point Gammon in Yarmouth (4.7 miles [7.6 km]) from the closest WTG at the northeast corner of the Proposed Alternative location of the proposed action), at Oregon Beach, Cotuit in Barnstable (5.5 miles [8.9 km]) from the closest WTG at the northwest corner of the Proposed Alternative location of the proposed action), and at Cape Poge Wildlife Refuge at the tip of Cape Poge on Martha’s Vineyard (5.4 miles [8.7 km]) from the closest WTG at the southwest corner of the Proposed Alternative location of the proposed action).

Point Gammon is on a private peninsula (Great Island) in Yarmouth that sticks out into Nantucket Sound. The monitoring location was above a south-facing beach on the south tip of Great Island. The equipment was located 100 ft (30.5 m) from the high water mark where the grade is 20 ft (6.1 m) above the beach. The microphone (with wind screen) was mounted 7 ft (2.1 m) above grade. The principal sounds at this site were the wind and ocean waves, periodic over-flying aircraft, and an occasional passing ferryboat. There was no vehicle or pedestrian access to this location during the measurement program that lasted seven days (November 15 - 22, 2002).

Oregon Beach is a public beach located off Main Street and Oregon Way, south of Cotuit Center in Barnstable. The coast generally faces southeast at this point on the Cape. The equipment was located 80 ft (24.4 m) from the high water mark where the grade is a few feet above the beach. The microphone (with wind screen) was mounted 7 ft (2.1 m) above grade. The principal sounds at this site were the wind and ocean waves, sea birds, periodic over-flying aircraft, and occasional motor vehicles and pedestrians accessing the beach area. Monitoring lasted more than four days (November 14 - 18, 2002).

Cape Poge Wildlife Refuge on Chappaquiddick Island, Martha's Vineyard is a wildlife refuge and recreational area with facilities for swimming and shore fishing. It is a very isolated location, travel to which requires a four-wheel drive vehicle. The coast faces east towards the ocean at the monitoring location that was setup near the lighthouse above the beach. The equipment was located 40 ft (12.2 m) from the high water mark on a sand dune where the grade is 20 ft (6.1 m) above the ocean. The microphone (with wind screen) was mounted 8 ft (2.4 m) above grade. The principal sounds at this site were the wind and ocean waves, and sea birds. Measurements were taken for seven days (November 25 - December 2, 2002).

The baseline measurements of existing sound conditions were examined in detail for the two wind conditions for which the proposed action's acoustic effects were quantified in Section 5.3.1.2 of this document : the cut-in wind speed of the WTGs (a steady wind speed of 8 mph at hub height, equivalent to 5 mph at 9.8 ft [3 m] above the ground) and the design wind speed of the WTGs (a steady wind speed of 30 mph [13.4 m/s] at hub height, equivalent to 16 [7.2 m/s] mph at 9.8 ft [3 m] above the ground). The WTGs would not operate under hub height wind speeds below 8 mph (3.6 m/s).

Background (L_{90}) and average (L_{eq}) sound level measurements are summarized for three separate meteorological conditions in [Table 4.1.2-2](#): (1) the cut-in wind speed for the turbines; (2) the design wind speed for the turbines (on-shore flow); and (3) the design wind speed for the turbines (off-shore flow). The distinction between on-and off-shore winds at the design wind speed condition is important for two reasons: (1) baseline sound levels are lower for off-shore winds as discussed below; and (2) sound from the proposed action would be reduced by 27 dBA under off-shore winds due to the wind shadow effect. The frequency spectrums for these measurements are given in [Figures 4.1.2-3 through 4.1.2-11](#).

The baseline measurements of existing sound conditions covered a full range of meteorological conditions from calm to high winds, with wind directions blowing both onshore and offshore and average wind speeds of 0 to 28 mph (0 to 12.5 m/s). The monitoring equipment was located on elevated land above and back from the high water mark to minimize the influence of surf sound yet still provide a quiet environment removed from highway and street noise. Surf sound is not an important factor except under high wind conditions, when surf sound can be heard anywhere along the coast. The baseline measurements, summarized in [Table 4.1.2-2](#), reveal background (L_{90}) sound levels as low as 27 dBA (at Point Gammon) and in the 30s at the other two sites, which are representative of very quiet rural areas. Since the measurements also covered periods of time when steady winds were up to 28 mph (12.5 m/s) (wind gusts were higher), higher baseline sound levels are expected, and these higher levels would be measured at any location, whether it was along the shore where there might be surf sound in the background or inland where noise from wind flow around buildings and trees occurs.

At Point Gammon (November 15 - 22), measured background (L_{90}) levels ranged from 27 to 66 dBA, and average (L_{eq}) levels were 35 to 71 dBA. At Oregon Beach (November 14 - 18), measured background (L_{90}) levels ranged from 34 to 57 dBA, and average (L_{eq}) levels were 41 to 61 dBA. At Cape Poge (November 25 - December 2), measured background (L_{90}) levels ranged from 37 to 70 dBA, and average (L_{eq}) levels were from 40 to 73 dBA. At all three sites, existing sound levels are directly correlated to surface wind speed, and on-shore winds produce slightly higher sound levels than offshore

winds, which is expected because offshore winds both suppress wave action at the shoreline and shield the coast from the sound of ocean waves by the wind shadow effect.

The long term monitoring conducted demonstrated also that ambient sound levels increase with increases in wind speed. On average, ambient sound levels during the design wind speed were 14 dBA greater than during the cut-in speed.

4.1.2.3.3 Underwater Noise Levels

Short-term noise level measurements were collected of underwater noise at Buoy G5 in the North Shipping Channel and at Buoy R20 at the edge of the Main Channel. Measurements were conducted on October 22, 2002 between the hours of 10 a.m. and 12 noon. Meteorological conditions included clear skies, light winds averaging 4 mph (1.8 m/s) and light seas (0.5 to 1.5 ft [0.15 to 0.46 m] waves), which are conservative conditions (e.g., lower underwater noise levels would be expected under these types of meteorological conditions). The boat engine was shut off during the measurements. The dominant noise sources were the wave interaction with the boat hull, aircraft, and distant boat traffic.

Measured L_{eq} underwater sound levels were found to be 90 dB and 93 dB at Buoys G5 and R20, respectively. The sound level at Buoy R20 is slightly higher due to the shallower water and greater current. The depth at this location is also more representative of the water depth on Horseshoe Shoal, and accordingly, the Buoy R20 data were used as a baseline for the proposed action.

Underwater sound levels with higher wind speeds (as would occur with proposed action operation) would be higher. Studies conducted in other coastal water areas indicate that the sound level increases 7.2 dB per doubling of wind speed. Accordingly, the estimated underwater L_{eq} sound level for the design wind speed of the proposed action would be 107.2 dB. The frequency spectrum for the existing condition is provided in [Figure 4.1.2-12](#).

The applicant further reviewed baseline underwater sound level measurements conducted over a 9-month period at the North Hoyle, United Kingdom wind farm site. Shoal depths at this location are similar to those at the site of the proposed action. This long term monitoring program revealed that underwater sound levels are nearly constant regardless of the time of day, with the exception of some peaks during midday hours caused by passing boat traffic. Measured baseline levels at the North Hoyle site were in the range of 100 to 105 dB. The 90 to 93 dB sound levels measured at the site of the proposed action are therefore relatively low compared to the measured North Hoyle site, even when scaled up to 107.2 dBA to account for the design wind speed condition. The short term measurements conducted at the site of the proposed action are considered to be adequate to characterize the existing underwater noise environment at the site of the proposed action.

4.1.3 Physical Oceanography

This section provides a characterization of existing conditions for currents, waves, salinity, temperature, sediment transport, and water depth/bathymetry in Nantucket Sound. These same parameters are also discussed for Lewis Bay.

4.1.3.1 Existing Conditions

The proposed action is located within Nantucket Sound, with electric transmission cable installation continuing into the waters of Lewis Bay on the south shore of Cape Cod. Nantucket Sound is a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha's Vineyard. It is approximately 23 miles (37 km) long (east-west direction), and between 6 and 22 miles (9.7 and 35.4 km) wide. The Sound has depths up to 70 ft (21.3 m) below MLLW. The

depths relative to MLLW shallow up to 2 ft (0.6 m) on Horseshoe Shoal. WTGs that have a diameter of 16.75 ft (5.1 m) would be set in water depths ranging from 12 to 39 ft (3.6 to 12 m), while WTGs with a diameter of 18 ft (5.5 m) would be set in water depths ranging from 40 to 50 ft (12.2 to 15.2 m). The spacing between the WTGs is proposed to be 0.39 mile (0.63 km) in a northwest/southeast direction and 0.62 mile (1 km) in an east/west direction. The Horseshoe Shoal area is a dynamic system with strong tidal currents (1.6 to 3.1 ft/s [0.5 to 1.0 m/s]) and shifting bed forms consisting mainly of sand. The Sound's tide range is approximately 3 ft (0.9 m). Lewis Bay is a coastal embayment along the south coastline of Cape Cod. It is northeast of Hyannis Harbor, and is separated from Nantucket Sound by Point Gammon and Great Island. Oceanographic conditions for each area are discussed in the sections that follow.

4.1.3.1.1 Currents and Tides

An empirical analysis based on current Acoustic Doppler Current Profiler (ADCP) data and historical data was used to determine tidal current speeds and direction for the site of the proposed action; and modeling by Woods Hole Group (Trowbridge, 2002 as referenced in [Report No. 4.1.1-9](#)) was used to determine wind-driven currents on Horseshoe Shoal.

Currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-driven currents are only moderate because of the sheltering effect of Nantucket and Martha's Vineyard, however, the southwesterly winds during the summer produce eastward flow through Nantucket Sound (Wilkin, 2006). The tidal range and diurnal timing are variable because of the semi-enclosed nature of the Sound and the regional variations in bathymetry. Typical tidal heights are in the range of 1 to 4 ft (0.3 to 1.2 m), with tidal surges of up to approximately 10 ft (3 m) having been recorded during hurricanes (Bumpus et al., 1973; Gordon and Spaulding, 1979). Times of high and low tides vary across the Sound by up to two hours.

Tidal flow and circulation within the Sound generate complex currents, the directions of which form an ellipse during the two tidal cycles each day. The complex bathymetry of Nantucket Sound forces the tidal ellipses to take different shapes in different regions of the Sound. Just off the coast of the south shore of Cape Cod, there is a strong rectilinear, semi-diurnal tidal flow approximately parallel to the coast (Goud and Aubrey, 1985). Tides around the Nantucket Shoals produce a strong anticyclonic circulation (Wilkin, 2006). The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Higher speeds occur between islands with a relatively uniform speed (1 knot [0.5 m/s]) in the Sound, although speeds and directions vary as bathymetry changes. Speeds on Horseshoe Shoal range higher, up to 2 knots (1 m/s). Nearing shore, the speeds reduce and directions are oriented by local bathymetry or shorelines ([Report No. 4.1.1-2](#)). The intensity of tidal flow, in general, decreases from west to east. There is a slow net drift of the water mass toward the east in the Sound. The net drift is about 2,153 ft² (200 m²) per tidal cycle, or roughly five percent of the total easterly and westerly tidal flows (Bumpus et al., 1971).

To characterize site-specific tidal and wind-driven currents at the site of the proposed action in Nantucket Sound, analytical models were applied by the applicant, with the results summarized as follows.

- Flood currents on the shoals are generally directed easterly, with ebb currents generally directed westerly. The average direction of the ebb current was 230 degrees with average speeds between 0.6 and 1.9 knots (0.31 and 0.98 m/s), and the average direction of the flood current was 50 degrees with average speeds between 0.6 and 1.2 knots (0.31 and 0.62 m/s).

- Local changes in tidal current direction occur on Horseshoe Shoal due to its bathymetric features, with currents diverted slightly around the shallowest portion of the shoal.
- Flood currents are generally stronger than ebb currents, and spring tidal currents are approximately 15 to 20 percent stronger than mean tidal currents.
- Tidal current velocities were calculated to be approximately 0.61 m/s (2 ft/s) at Horseshoe Shoal.
- Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities, and were found to be concentrated over the crest of the shoal.
- Current speed and direction were found to vary more with location than water depth.

The tide range in Lewis Bay is 3 ft (0.9 m) with no variation in range. The tidal currents are highly variable in Lewis Bay although typically weak. At the cable landfall location the currents are very weak, less than 0.05 knots (0.03 m/s) during both maximum flood and ebb. At the location west of Egg Island the maximum speed is between 0.30 and 0.35 knots (0.15 and 0.18 m/s) during ebb.

4.1.3.1.2 Waves

There is no extensive source of wave data within Nantucket Sound, so available wind data and wave data taken from ADCP devices deployed between May 2003 and September 2004 were used to characterize wind-generated waves at the site of the proposed action ([Report No. 4.1.3-1](#)). The major factors affecting the magnitude and period of wind-generated waves in this area are: the fetch length (the distance over which wind acts on the water surface), average water depth, and wind speed. The wave model applied used these factors to estimate wave height and period under different conditions. Fundamentally, larger waves are generated as wind speed, water depth, and fetch length increase. Fetch is restricted within Nantucket Sound due to surrounding landforms including Cape Cod, Monomoy Island, Nantucket Island, and Martha's Vineyard.

Wave model simulations were performed using the USACE's *Wind Speed Adjustment and Wave Growth* model (USACE, 1992) to estimate significant wave height (i.e., the average height of the highest 1/3 of waves in a sea state); peak period (i.e., the period that characterizes the majority of the waves in the sea state); and peak direction. The results represent wave conditions near the center of the proposed action at Horseshoe Shoal. Generally, the model indicates that Horseshoe Shoal is exposed to the largest waves from the easterly directions. Wind-generated significant wave heights generally range from less than 1 to nearly 4 ft (0.3 to 1.2 m), with relatively short spectral peak wave periods (between 2 and 4 seconds). Individual wave heights can be higher, and substantially higher waves would be present during storms.

Using the model results, a shoaling coefficient and wave breaking criteria were applied to obtain a distribution of the wave heights over the shoals. Generally, wave height changes in the shallow portions of the shoal due to wave shoaling and breaking, while wave period remains constant. [Figure 4.1.3-1](#) shows the significant wave height distribution for the largest calculated significant wave height at the site of the proposed action.

It is also possible that longer period waves enter Nantucket Sound from the Atlantic Ocean. Therefore, a conservative estimate of long period swell conditions was developed for the site of the proposed action. The average wave height of offshore waves approaching from easterly through southeasterly directions east of Monomoy within the Atlantic Ocean was used for this analysis. The

average height for these offshore waves is 4.5 ft (1.4 m), and the average wave period is eight seconds. Average ocean waves were selected for this analysis to capture potential effects for longer period waves. Although significantly higher and longer period waves occur in the ocean (e.g., heights greater than 20 ft (6.1 m) with periods exceeding 12 seconds), it was not judged appropriate to assume such large waves occur in Nantucket Sound given the presence of the numerous relatively shallow shoals. A shoaling coefficient was used to modify the ocean swell and provide an estimate of resulting wave heights and distribution at Horseshoe Shoal. Offshore waves are also likely to be modified substantially by the complex and shallow shoal structure separating Nantucket Sound from the Atlantic Ocean, as well as by the relatively narrow gaps between Monomoy Island and Nantucket Island to the east and between Nantucket Island and Martha's Vineyard to the south. These factors were not included in the analysis because these features would typically serve to dissipate ocean swell effects. Therefore, the analysis is relatively conservative, reflecting higher wave levels than would likely occur. The results are shown in [Figure 4.1.3-1](#).

External analysis was performed to estimate wave height and period characteristics for the 2-, 10-, 50- and 100-year return periods. These were estimated for both locally generated and offshore waves using a computer model entitled "Extrm2: Extremes Program." The extreme storm wave for the proposed action is defined as the average height of the highest 1 percent of all waves in the spectrum (for the 50-year return the extreme storm wave at Horseshoe Shoal was estimated to be 17.3 ft (5.3 m).

Data was collected at the SMDS tower between April 2003 and September 2004 using an ADCP. The wave data indicated that the maximum recorded significant wave height reached 6.6 ft (2.0 m) while the maximum wave height reached 8.2 ft (2.5 m). The majority of wave patterns had a significant wave height between 1 ft (0.3 m) and 1.3 ft (0.4 m). The wave period varied depending on whether wind-generated waves (2 to 6 second periods) or swell (6 to 12.8 seconds) determined the shape of an individual wave spectrum. The highest waves had periods of approximately six seconds, slightly longer (about one second longer) than periods predicted by wave modeling.

Waves having periods between 2.6 and 3.4 seconds were the most frequently recorded in the data set. The long-period portion of the histogram reveals a subtle maximum in wave period distribution at periods of about seven seconds. This suggests that many of the swell 'cases' did not represent distinctive swell waves but were rather a result of noise in the data. Swell amplitudes were higher for the periods of time of high water, suggesting that the probability of swell penetration in the Sound increases as the sea level increases.

Typically, winds with speeds of 8.8 knots (15 m/s) generated waves with a significant wave height of 3.9 ± 0.7 ft (1.2 ± 0.2 m). This relationship varied slightly, depending on water depth. Measured waves were approximately ten percent higher during the periods of high water. A comparison with model results indicates that the observed wave height/wind speed relationship fits well with the results of the model. Wind and wave directions correlated well with a tendency for waves to propagate along the east-west axis of Nantucket Sound.

4.1.3.1.3 Salinity

Salinities in Nantucket Sound are near oceanic, and salinity gradients are small due to strong lateral and vertical mixing. River runoff into Nantucket Sound is low, so there is little dilution of ocean waters with fresh water. Surface and bottom water salinities vary seasonally and spatially from about 30 parts per thousand (ppt) to 32.5 ppt (Bumpus et al., 1973). Surface water salinities throughout the Sound are just over 31 ppt during the summer, and are uniformly about 32 ppt in the winter (Limeburner et al., 1980).

4.1.3.1.4 Temperature

The annual cycle of surface and bottom water temperatures in Nantucket Sound encompasses a range of about 45°F (7.2°C), from nearly 30°F (-1°C) in the winter to as high as 75°F (24°C) in the late summer (Bumpus et al., 1973). During ADCP data collection at the SMDS between April 2003 and September 2004, the recorded water temperature varied from 30.2°F (-1°C) (recorded in February) to 72.5°F (22.5°C) (recorded in August). Temperature extremes are greatest in coastal ponds and estuaries, and the seasonal temperature cycle is smallest in the deeper parts of the Sound. However, because the Sound is shallow and well mixed, there is little lateral temperature variation and vertical temperature stratification. There is a tendency in the summer for surface water temperature to increase from east to west in Nantucket Sound. In the winter, a slight gradient develops in the opposite direction (Limeburner et al., 1980). This change is caused by the intrusion of warmer continental shelf water into the Sound from the east during the summer months.

Bottom water temperature varies less and changes more slowly on a seasonal basis than surface water temperature. The highest bottom water temperature in Nantucket Sound during summer is in the range of 61°F to 66°F (16 to 19°C) (Theroux and Wigley, 1998). Warmest bottom water temperatures are near the coast of the south shore of Cape Cod, and temperature decreases with distance offshore. Coolest bottom water temperatures in Nantucket Sound (during winter) are in the range of 32°F to 35.6°F (0 to 2°C), and become warmer with distance from the Cape Cod and Nantucket shorelines.

4.1.3.1.5 Sediment Transport

A comprehensive analytical two-dimensional sediment transport model developed by Woods Hole Group based on a theory by Madsen and Grant 1976 was used to conduct 26 simulations, addressing a range of current and wave conditions for the site of the proposed action. For each condition, the model calculated wave-induced bottom current velocities, near-bottom tidal current velocities, a qualitative representation of where and whether sediment transport would be likely to occur, and quantitative estimates of potential bed load, suspended load, and total sediment transport rates. The analytical sediment transport modeling was performed to determine the extent to which existing wave and current conditions are likely to lift and move sand at the site of the proposed action. Generally, the analysis found that active sediment transport occurs at all areas of Horseshoe Shoal, even under typical wave and tidal current conditions. The highest potential for sediment transport is along the shallow portions on the northwest corner, with little potential for sediment transport along the deeper east side of the shoal. The largest wind-generated waves in the wave distribution within Nantucket Sound can cause a significant increase in sediment transport.

Spring tidal currents initiate approximately 20 percent more transport than mean tidal currents, and wind-driven currents from a sustained 15 knot westerly wind have a similar effect. The greatest impact on sediment transport initiation is due to waves. Larger locally generated waves within Nantucket Sound can cause a significant increase in sediment transport. If swell waves from the ocean impact the site at Horseshoe Shoal, sediment transport rates can increase as much as 100 fold, even for typical swell waves propagating from the Atlantic Ocean (e.g., 4 to 5 ft [1.2 to 1.5 m] height with an 8 second period). Since flood currents are stronger than ebb currents, there is a long-term forcing mechanism to cause the net transport of sediment to the east, particularly at Horseshoe Shoal.

Bed load transport (sediment movement along the sea bottom) on Horseshoe Shoal is typically an order of magnitude greater than suspended load transport. This is expected at the Horseshoe Shoal Site, where sediments are relatively coarse ([Report No. 4.1.1-2](#)). The level of wave and current energy under typical conditions is not sufficient to lift and suspend large volumes of sediment within the water column. The bed load flux on Horseshoe Shoal is between 0.18 and 25 ft³ (0.005 and 0.7 m³) per day.

The south central portion of Horseshoe Shoal is an area in which sand waves have been identified. Sand wave crests on Horseshoe Shoal were oriented in the north-south direction in general, with long period wavelengths ranging between 100 and 600 ft (30.5 and 183 m). Short period sand waves were located between the larger crests. Sand wave heights averaged 4 to 5 ft (1.2 to 1.5 m), but waves as tall as 15 ft (4.6 m) were found. The size of the sand waves is attributed to the dynamic shallow water environment on Horseshoe Shoal. The symmetry of the sand waves indicates a migration to the east or the west, depending on where they formed on Horseshoe Shoal. (USACE, 2004 as referenced in [Report No. 4.1.1-3](#)). Other areas of Horseshoe Shoal contain few significant topographical features and are dominated by smooth sandy bottoms (OSI, 2002).

The existing sediment transport in Lewis Bay is not directly known. However, the bottom sediments are generally finer in Lewis Bay (up to 12 percent clays and silts) than in Nantucket Sound, consistent with the lower energy environment in the Bay. Lewis Bay is thus likely a depositional area which implies that the sediment transport is low since sediment would accumulate if there were sufficient sediment sources supplying material.

4.1.3.1.6 Water Depth/Bathymetry

In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this glacially formed basin. Charted water depths in the Sound range between 1 and 70 ft (0.3 and 21.3 m) at MLLW. A combination of NOAA nautical charts and project-specific hydrographic surveys were used to assess existing bathymetric conditions.

The site of the proposed action is located on Horseshoe Shoal, a prominent geological feature in the center of the Sound. Depths on Horseshoe Shoal have been mapped over the years as shallow as 0.5 ft (0.15 m) at MLLW, although this depth can vary from year to year. Measured depths of 60 ft (18.3 m) at MLLW occur between the northern and southern legs of the shoal. An east-west trending natural channel feature exists on the southern leg of the shoal, with measured water depths approaching 50 ft (15.2 m) at MLLW.

Water depths between Horseshoe Shoal and the Cape Cod shoreline are variable, with an average depth of approximately 15 to 20 ft (4.6 to 6.1 m) at MLLW. Along the transmission cable system corridor, depths vary from about 16 to 40 ft (4.9 to 12.2 m) at MLLW, with an average depth of approximately 30 ft (9.1 m) at MLLW.

Water depths in Lewis Bay and Hyannis Harbor are variable, ranging from approximately 8 to 14 ft (2.4 to 4.3 m) at MLLW in the center of the bay to less than 5 ft (1.5 m) at MLLW along the perimeter and between Dunbar Point and Great Island. There are three navigation channels in Lewis Bay: the Federal Navigation Channel providing access to Hyannis Inner Harbor (authorized depth -13 ft [-4.0 m] MLLW); one privately maintained channel into Mill Creek (reported depth of -2 ft [-0.6 m] MLLW in 1983); and one privately maintained channel northeast of Great and Pine Islands (approximately 7 ft [2.1 m] deep at MLLW).

The submarine transmission cable system route would extend outside the eastern edge of the Federal channel into Lewis Bay, and would then turn east north of Egg Island to make landfall between Mill Creek and the privately maintained channel northeast of Great and Pine Islands. Water depths along this route in Lewis Bay range from 5 to 10 ft (1.5 to 4.6 m), with an average of approximately 10 ft (3 m). The shallowest portions of Lewis Bay/Hyannis Harbor along this route exist between Great Island and Dunbar Point and at the landfall, with depths of 1 to 4 ft (0.3 to 1.2 m) at MLLW.

4.1.4 Climate and Meteorology

This section describes the existing climate and meteorological conditions for the site. The Massachusetts climate is characterized by frequent and rapid changes in weather, large daily and annual temperature ranges, large variations from year to year, and geographic diversity. The National Climatic Data Center (NCDC), which is part of the NOAA defines distinct climatological divisions to represent areas that are, as nearly as possible, climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. The site of the proposed action is located within the Massachusetts coastal division.

4.1.4.1 Ambient Temperature

The NCDC provided data that shows for the Massachusetts coastal division the average annual temperature is 49.8°F (9.9°C), the average winter (December - February) temperature is 30.9°F (-0.6°C), and the average summer (June through August) temperature is 69.0°F (20.6°C). The average daily maximum temperature in the coastal division is approximately 57.0°F (13.9°C) and the average daily minimum temperature is approximately 42.1°F (5.6°C) based on data collected in Hyannis, Massachusetts from 1971 through 2000. Average temperatures at the individual stations in the general area at or near the site are summarized in [Table 4.1.4-1](#), along with the climatological division average where available. Data for some stations reflect different periods of record, but they show the lack of any major temperature differences in the area.

[Table 4.1.4-2](#) provides information on the monthly ambient air temperatures within the Massachusetts coastal division. Data presented in [Table 4.1.4-2](#) was collected at the Buzzard Bay Buoy Tower from 1985 through 2001 and is representative of the monthly temperature variations found in this climatological division.

4.1.4.2 Wind Conditions

Wind conditions in the Massachusetts coastal division have been summarized in [Tables 4.1.4-3](#) and [4.1.4-4](#) using data collected at the Buzzard Bay Buoy Tower, which is located northwest of the Nantucket Sound, from 1985 through 2001. [Table 4.1.4-3](#) presents the monthly and annual average wind speeds, monthly average peak wind gusts, and the maximum hourly peak wind gust recorded during this time period at the Buzzard Bay Buoy Tower and [Table 4.1.4-4](#) presents the monthly and annual percent frequency of the wind directions recorded at the tower. The monthly average wind speeds range from a low of 13.7 mph (6.1 m/s) in August to a high of 20.4 mph (9.1 m/s) in December with an annual average of 17.3 mph (7.7 m/s). The average monthly peak wind gust was 22.9 mph (10.2 m/s) and the peak hour wind gust was recorded to be 88.8 mph (39.7 m/s). Wind directions are variable throughout the year as shown in [Table 4.1.4-4](#); however, during the summer months (June through August) the predominant winds are from the southwest, while during the winter months (December through February) the predominant winds are from the northwest.

Mean wind speeds within the Nantucket Sound area, at the height of the proposed wind rotor height of 257 ft (78.3 m), were estimated using AWS Truewind's proprietary algorithm and vary from a low range of 15.7 to 16.8 mph (7 to 7.5 m/s) in the nearshore areas to a high range of 20.1 to 21.3 mph (9 to 9.5 m/s) in the southern and eastern portions of the Sound that lack the sheltering effects from the islands (see [Figure 4.1.4-1](#)). An average wind speed of 19.75 mph (8.8 m/s) was recorded at the Nantucket Sound meteorological tower over the three years of data collected.

4.1.4.3 Precipitation and Fog Events

Data from the NCDC shows the annual average precipitation is 47.16 in (119.79 centimeters [cm]) in the Massachusetts coastal division. Monthly variations in average precipitation in the division are shown in [Table 4.1.4-5](#) with a high of 4.38 in (11.12 cm) in November and a low of 3.39 in (8.61 cm) in July.

Fog is a fairly common occurrence over the area. Fog is especially frequent and persistent at times in areas south of Cape Cod resulting in significant restricted visibility. On average, the Nantucket area experiences fog on approximately one day out of six as shown in [Table 4.1.4-6](#). Also shown in [Table 4.1.4-6](#) is that almost all of the days with low visibility can be attributed to fog.

Although snowfall can vary significantly over small distances, representative monthly and annual snowfall amounts for the Massachusetts coastal division are presented in [Table 4.1.4-7](#). These data were recorded in Hyannis, Massachusetts from 1971 through 2000 and indicate that the highest average monthly snowfall is 6.9 in (17.5 cm) in January and the annual average is 18.4 in (46.7 cm).

General information concerning the frequency of freezing precipitation is available in “A Climatology of Freezing Rain, Freezing Drizzle, and Ice Pellets across North America” (Cortinas et al., 2000). Isoleths presented in this paper indicate that freezing rain occurs from 0 to 10 hours per year.

4.1.4.4 Hurricanes

There have been 10 hurricanes that have impacted Massachusetts in the last 154 years (NHC, 2005). Five of the hurricanes were Category One hurricanes on the Saffir-Sampson Hurricane Scale, two were Category Two hurricanes, and three were Category Three hurricanes. No Category Four or Five hurricanes have been recorded in Massachusetts in the last 154 years.

A Category One hurricane has winds 74 to 95 mph (33 to 42.5 m/s) and a storm surge 4 to 5 ft (1.2 to 1.5 m) above normal. Damage due to a Category One storm is primarily to unanchored mobile homes, shrubbery, and trees. Some coastal flooding and minor pier damage could also be expected. A Category Two hurricane has winds 96 to 110 mph (43 to 49.1 m/s) and a storm surge generally 6 to 8 ft (1.8 to 2.4 m) above normal. Category Two hurricane damage may include roofing material, doors, and windows of buildings and considerable damage to mobile homes, shrubbery, trees, poorly constructed signs, and piers. Coastal and low-lying flooding is expected before the arrival of the hurricane center. A Category Three hurricane has winds 111 to 130 mph (49.6 to 58.1 m/s) and a storm surge 9 to 12 ft (2.7 to 3.7 m) above normal. Some structural damage to small residences and utility buildings, damage to shrubbery and trees with foliage blown off and trees blown down, mobile homes and poorly constructed buildings are destroyed, and coastal and low-lying flooding are possible damages due to a Category Three hurricane.

4.1.4.5 Mixing Height

Average seasonal mixing height data within the Massachusetts coastal division are presented in [Table 4.1.4-8](#). As shown in the table, the minimum average mixing height in the division is 1,276 ft (389 m), while the maximum average mixing height in the division is 4,662 ft (1,421 m). The minimum average mixing height is much higher than the height of top of the proposed rotors (440 ft [134.1 m]).

4.1.5 Air Quality

One measure of air quality within a region is whether background ambient air concentrations are in attainment with National Ambient Air Quality Standards (NAAQS). The NAAQS were developed by the USEPA for criteria pollutants to protect human health and welfare. The attainment status of an area is determined through an evaluation of available air quality data. The MassDEP and Rhode Island

Department of Environmental Management collect ambient air quality data from a network of monitors located within their respective states. The network is designed to provide data representative of pollutant concentrations over large areas and also to determine concentrations in areas where they are expected to be the highest.

4.1.5.1 Existing Air Quality

The MassDEP and monitoring data show that Massachusetts and Rhode Island are in attainment with the NAAQS for all criteria pollutants except ozone. Available monitoring data show that the 8-hour NAAQS for ozone has been exceeded at several monitors across each of the states, and all of Massachusetts and Rhode Island have been classified as moderate non-attainment areas with respect to the 8-hour NAAQS for ozone. [Figure 4.1.5-1](#) graphically depicts the non-attainment areas within Massachusetts and Rhode Island. Ground level ozone is created through chemical reactions involving precursor pollutants (NO_x and volatile organic compounds [VOCs]) in the presence of sunlight. Motor vehicles and fossil fuel fired power plants are among the major contributors to ozone precursor emissions.

The USEPA regulations, published as “General Conformity Rule” (58 FR 63214, November 30, 1993) to implement section 176(c) of the CCA for non-attainment areas and maintenance areas, require that Federal actions, unless exempt, conform with the Federally approved state implementation plan (SIP). Air emissions, within nonattainment areas, that are not covered by an air permit and that exceed the minimal levels require a conformity analysis.

4.1.5.2 Regional Air Quality

The entire Commonwealth of Massachusetts and State of Rhode Island have been classified as being in attainment with NAAQS for all criteria pollutants, with the exception of ozone. However, some local variations in air quality may exist due to differences in meteorological conditions and emission sources. Local air quality has been evaluated by examining data obtained from individual monitoring stations. Qualitative assessments of influences on local air quality have also been made based on a consideration of air emissions generating activities and operations conducted in each local area.

Recent ambient air quality data (2004-2006) from the MassDEP and the DEM monitoring stations in the study area have been summarized and presented in [Table 4.1.5-1](#). In accordance with USEPA policy, highest second high monitored concentrations, as opposed to maximum concentrations, are presented in [Table 4.1.5-1](#) for pollutants with short-term standards, since one exceedence of the standard is allowed per year.

These data were recorded at monitoring stations closest to the site of the proposed action and are considered representative of air quality conditions at the onshore portions the site of the proposed action. Where multiple sites were approximately equal in distance to Nantucket Sound, all were evaluated and the highest value was presented in [Table 4.1.5-1](#). [Table 4.1.5-2](#) provides some summary information concerning the nearest monitors and their intended purpose, while [Figures 4.1.5-2 through 4.1.5-7](#) show the locations of the monitoring sites.

As shown in [Table 4.1.5-1](#), there have been exceedences of the 8-hour ozone NAAQS recorded at the Oak Bluffs, Massachusetts, and Narragansett, Rhode Island, monitors over the last three years (2004-2006). At the Oak Bluffs ozone monitor a total of 8 days had an 8-hour ozone NAAQS exceedence during this period with 4 days during 2005 and 4 days during 2006. [Table 4.1.5-3](#) presents the dates of these monitored exceedences and the recorded 8-hour ozone concentration. An examination of the wind direction data for these 8 days of exceedences reveals that winds were predominately from the west and southwest indicating probable regional transport of ozone or its precursors from areas west to southwest

of New England. [Figures 4.1.5-8 through 4.1.5-15](#) show 8-hour ozone contours for each of the days with a recorded exceedence of the 8-hour ozone standard and the weather conditions during each of the days.

Information in the *Commonwealth of Massachusetts 2005 Air Quality Report* (MassDEP, 2006) and the *2004 Air Quality Summary, State of Rhode Island* (DEM, 2006) were reviewed to obtain information on how air quality, as measured at the air quality monitors, varied within the study area over recent years. In general, the information in these air quality reports indicates that the air quality in the study area has been improving over the durations monitored for each pollutant. [Figure 4.1.5-16](#) presents a graph of the recorded annual SO₂ concentrations from 1985 through 2005. As the graph shows, there has been a slight decrease in the annual SO₂ concentrations recorded throughout Massachusetts over the last 21 years.

The annual PM₁₀ concentrations recorded in Rhode Island over the last 10 years are presented in [Figure 4.1.5-17](#). The highest PM₁₀ levels measured each year through 2001 were at the Allens Avenue site, which was located immediately adjacent to Route I-95 in Providence. That site reflected worst-case levels and was not representative of neighborhood exposures. Monitoring at the Allens Avenue site was discontinued in 2002 due to extensive construction and demolition activity in the area associated with a highway relocation project. Since the discontinuation of the Allens Avenue site, the monitor at the Vernon Street site, which is located near Route I-95 in Pawtucket, consistently records the highest annual mean PM₁₀ levels in the State. The annual mean PM₁₀ concentrations at the Vernon Street site in 2004, as in the two previous years, were approximately 3 micrograms per cubic meter (µg/m³) higher than at the other urban sites and approximately double that of the rural West Greenwich site. However, over the last ten years the monitored PM₁₀ concentrations show a slight decrease.

Recorded annual NO₂ concentrations from 1985 through 2005 are shown in [Figure 4.1.5-18](#) and indicate that, similar to annual SO₂ and PM₁₀ concentrations, the annual NO₂ concentrations have decreased slightly since 1985 at all the monitors in Massachusetts. [Figure 4.1.5-19](#) shows the 8-hour CO concentrations recorded in Rhode Island from 1992 to 2004. Maximum 8-hour CO concentrations at the Dorrance Street site, the only site that has operated continuously since 1990, decreased during the period. The CO concentrations at the East Providence site remained roughly constant between 1998 and 2002, but decreased in 2003 and 2004. Previously, the CO levels at the Dorrance Street site were significantly higher than those in East Providence, but due to the steady decrease in the monitored concentrations at the Dorrance Street site, the CO concentrations at the two sites have been similar since 2002.

The Oak Bluffs, Massachusetts, ozone monitor has only been in operation since 2004, so no trends of ozone concentrations can be inferred from this monitoring location. However, MassDEP does have a network of other ozone monitors throughout the State with the nearest ones being the Truro, Easton, and Fairhaven monitors. [Figure 4.1.5-20](#) presents a graph of the number of 8-hour ozone NAAQS exceedences recorded per year from 1985 through 2005 at these three ozone monitors. As the graph shows, the number of recorded exceedences is variable from year-to-year, but overall there has been a slight decrease in the number of exceedences recorded.

According to the *Commonwealth of Massachusetts 2005 Air Quality Report* (MassDEP, 2006), the MassDEP PM_{2.5} sampling network has been operating only since January 1999 and an ambitious program of sampler replacement has been accomplished since December 2004 in conjunction with a rigorous preventative maintenance program to improve overall data capture. The report provides no trend information, apparently because there has been too short a record of consistent quality. However, examining the 3 years of PM_{2.5} concentrations presented in [Table 4.1.5-1](#) shows that the 24-hour PM_{2.5} concentrations have been variable over this time period, while the annual PM_{2.5} concentrations have decreased each year.

Nantucket Sound

There are no air quality monitoring stations in Nantucket Sound. Emissions from onshore and upwind are transported and dispersed over the Sound. Additionally, emissions from mobile sources within the area, including recreational and commercial vessels, and low flying aircraft contribute to the air quality impacts offshore.

4.1.6 Water Quality

Under Massachusetts Surface Water Quality Standards (314 CMR 4.06(3)), Lewis Bay and the surface waters adjacent to Nantucket Island are categorized as Class SA coastal and marine water bodies. (Other waters of Nantucket Sound in the area of the proposed action are not classified.) According to the MassDEP standards, Class SA waters are designated as “an excellent source of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.” In approved areas, Class SA waters are suitable for shellfish harvesting without the need for depuration (that is, removal of contaminants) (Open Shellfish Areas).

4.1.6.1 Freshwater Resources

4.1.6.1.1 Groundwater

No sites associated with releases/spills of petroleum products or hazardous substances that have been reported to the appropriate agencies identified in the Environmental First Search Report (ESS, 2005) appear to be located within the proposed on land cable route. Also, based on review of the Federal CERCLIS list dated 4/14/2005, and the National Priorities List (NPL) dated 5/17/2005, there are no CERCLIS or NPL sites located within 0.25 mile (0.4 km) of the proposed on land cable route.

The environmental conditions on the known state-listed oil and/or hazardous material release and spill sites identified in close proximity to the proposed on land cable route do not appear to have impacted soil and/or groundwater quality conditions within the proposed cable route.

The MassDEP regulations (310 CMR 22.21(1)(b)(5)) state that current and future land uses within the Zone I shall be limited to land uses directly related to the public water system or to other land uses which the public water system has demonstrated would have no adverse impact on water quality. The regulations also state that no new underground storage tanks for petroleum products shall be located within Zone I. According to the MassDEP regulations, Zone II is defined as: that area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at the approved yield, with no recharge from precipitation).

4.1.6.1.2 Freshwater Streams

Under Massachusetts Surface Water Quality Standards (314 CMR 4.06(2)(b)), the water resources located along the onshore route are classified as Class B, High Quality Water by MassDEP. According to the MassDEP standards, Class B waters are designated as “habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.” In approved areas, Class B waters are suitable as a source of public water supply with appropriate treatment.

Thornton Brook is mapped as a perennial stream on the current USGS map, and it is presumed to be perennial under 310 CMR 10.58(2)(a)(1)(a). However, the stream channel was observed completely dry during fieldwork conducted in October 2001 and December 2002.

4.1.6.1.3 Freshwater Wetlands

In addition to establishing wetland setbacks, the Yarmouth Wetlands Protection Regulations (WPR) govern work within Lake and Pond Recharge Areas. These areas are defined under Section 3.05 as wetland and upland landforms that contribute surface and subsurface water to the lakes and ponds of the towns and are mapped within a “Water Resources Protection Study” prepared for the Town of Yarmouth (Figure 4.1.6-1). Conservation Commission jurisdiction is restricted to mapped areas within 300 ft (91.4 m) of a lake or pond. The proposed onshore transmission cable system route would be located within the mapped recharge areas of Jabinettes Pond (Wetland 2) and Long Pond (Wetland 6). The regulations at Section 3.05(3) prohibit land use practices that present serious threats to the quality of lake and pond recharge areas, including: outdated underground storage tanks, landfills, stump dumps, road salt storage, package treatment plants, and automotive and construction equipment repairs. The proposed transmission cable system is not a land use that is specifically prohibited under these regulations.

4.1.6.2 Coastal Waters

4.1.6.2.1 Estuaries and Bays

On December 14, 2004, sampling was conducted within Lewis Bay at the proposed temporary cofferdam location for the potential HDD drill exit points. Sediment samples from vibratory cores (vibracores) were collected and analyzed to determine bulk chemical and physical characteristics of the material to be dredged from Lewis Bay. The sampling protocol and testing analyses were performed in accordance with the MassDEP-DWPC Regulations 314 CMR 9.001.

A total of four vibracores were advanced in the vicinity of the proposed action’s landfall. Three of the vibracores (VC04-01, VC04-02, and VC04-03) were advanced within the area of the proposed temporary cofferdam dredging. The fourth vibracore was advanced near the seawall at the end of New Hampshire Avenue. Figure 4.1.6-2 shows the locations of the vibracores.

The sample results of the bulk chemical and physical analyses were compared with the MassDEP-DWPC classification criteria found in 314 CMR 9.07 for dredging and dredged material disposal. Table’s 4.1.6-1 and 4.1.6-2 show the classifications of the sediment samples based on chemical constituents and physical characteristics as established in the regulations. Note that results from only the three vibracores located within the proposed dredge footprint are provided since this data set would be what is reviewed by MassDEP as part of the 401 WQC process. Based on MassDEP criteria, the dredge material was classified as Category 1, Type A.

Methods for dredging and disposal activities that the MassDEP-DWPC may approve are dependent upon the chemical and physical classification of the sediment to be removed. Approvable options for various sediment types are summarized in Table 4.1.6-3. Sediment types identified in this sample analysis are approvable for either hydraulic or mechanical dredging methods. Unconfined in-harbor disposal (in the case of this Project; replacement of dredged material) is normally approvable by MassDEP as determined from the sediment constituents.

The sampling protocol was based on the following references:

- Quality Assurance/Quality Control for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods, dated March 1987 (USEPA 430/9-86-004).

¹ MassDEP Regulations Effective 3/1/95.

- Analytical Methods for USEPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments, dated May 1986 and prepared by Tetra Tech (USEPA 68-01-6938), TC-3953-03 Final Report.
- User's Guide to Contract Laboratory Program, dated December 1988 (USEPA/540/8-89/012).
- Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual, dated February 1991 (USEPA 503/8-91/001).
- 401 WQC For Discharge of Dredged or Fill Material, Dredging, and Dredging Material Disposal in Waters of the United States Within the Commonwealth, dated March 1, 1995 (314 CMR 9.00).
- Guidance for Performing Tests on Dredged Material in Open Waters, dated May 15, 1989 (USEPA Region 1 and USACE, New England Division).
- Technical Guidance for Screening Contaminated Sediments, dated January 1999 (New York State Department of Environmental Conservation).

The primary surface waterbodies in the area of the proposed action are Nantucket Sound, Hyannis Harbor, and Lewis Bay. As mentioned above, these waterbodies are categorized as Class SA by MassDEP. Lewis Bay and Hyannis Harbor are listed on the Massachusetts Section 303(d) List of Waters as impaired due to the presence of pathogens in water quality samples. However, no specific sources of pathogen pollution were reported by the Commonwealth in its 304(b) report to USEPA (USEPA, 2002).

The Barnstable County Department of Health and Environment and the Towns of Yarmouth and Barnstable collect additional information on the water quality of Lewis Bay and Hyannis Harbor. The waters offshore of Cape Cod's bathing beaches are sampled during the summer for the bacterial indicator organisms *E. coli* and enterococci. The beaches sampled as part of this program that are closest to the proposed action landfall are Englewood Beach in Yarmouth; and Veterans Beach, Keys Beaches and Kalmus Beach in Barnstable. None of the results of these samples exceeded established local and Massachusetts Surface Water Quality Standards at 314 CMR 4.06(2)(b) (Barnstable County, 2002).

4.1.6.3 Offshore Waters

4.1.6.3.1 Continental Shelf

The area of the proposed action is situated in a dynamic environment that is subject to naturally high suspended sediment concentrations in near-bottom waters as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoal areas.

When the approach of average waves (2.6 second period, 1.6 ft [0.49 m] height) is aligned with running tidal currents, near-bottom suspended sediment concentrations in Nantucket Sound are estimated to be approximately 71 milligrams per liter (mg/L). When average waves (2.2 second period, 1.3 ft [0.40 m] height) approach perpendicular to running tidal currents, near-bottom suspended sediment concentrations in Nantucket Sound are estimated to be approximately 45 mg/L (Woods Hole Group, 2003, 2004, 2005).

Analysis from the sediment core samples obtained from the area of the proposed action indicated that sediment contaminant levels were below established thresholds in reference to sediment guidelines (see [Tables 4.1.6-4 thru 4.1.6-7](#)). Specifically, all of the chemical constituents detected in the sediment core samples obtained from the WTG array site and along the submarine transmission cable route had concentrations below Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine sediment

quality guidelines (Long et al., 1995). To assess the relative environmental quality of the sediments collected from the area of the proposed action, the analytical laboratory results for targeted chemical constituents were compared to established guidelines for marine and estuarine sediments, particularly Long et al., 1995. To aid in the identification of contaminants of potential ecological concern, federal and state agencies (such as NOAA, MADEP) use these site-related sediment data to compare established screening level criteria. These guidelines were not promulgated as regulatory criteria or standards as they were not intended as cleanup or remediation targets, discharge attainment targets or intended as a pass-fail criterion for dredged material disposal decisions or any other regulatory purpose. They were intended as an informal guideline for use in interpreting chemical data from analyses of sediments.

The Long et al. (1995) marine/estuarine ER-L screening values represent a concentration at which adverse benthic impacts are found in approximately 10 percent of studies. A level greater than the ER-M indicates a greater than 50 percent incidence of adverse effects to sensitive species and/or life stages. A concentration between the ER-L and ER-M therefore indicates an expected impact frequency between 10 percent and 50 percent. The ER-L and ER-M values were not derived as toxicity thresholds. That is, there is no assurance that there would be a total lack of toxicity when chemical concentrations are less than the ERL values. Similarly, there is no assurance that samples in which ER-M values are exceeded would be toxic. Toxicity, or a lack thereof, must be confirmed with empirical data from toxicity tests. The ERL values were intended and should be used primarily as estimates of the concentrations below which toxicity is least likely. The ERM values are better indicators of concentrations associated with effects than the ERLs.

4.1.7 Electrical and Magnetic Fields (EMF)

4.1.7.1 Introduction

The information on EMFs contained in this section was obtained from review of existing data available for the area of the proposed action, the EMF monitoring and modeling conducted by the applicant, and review of the scientific literature on EMF. This introduction provides an overview of EMF; discusses potential sources of EMF; and summarizes the current status of research, in order to provide a context for the proposed action discussion. The assessment of EMF impacts anticipated is provided in Section 5.3.1.7.

Electric power transmission and distribution (T&D) lines create EMFs because they carry electric currents at high voltages. The voltages and currents are produced by electric charges. Electric charges (electrons and protons) are present in all matter, and can give rise to electrical effects. Most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, electrical effects result such as the attraction between a comb and our hair, the drawing of sparks after walking on a synthetic rug in the wintertime, or the presence of EMFs from power lines. The work put into separating electric charges is measured by *voltage*. The units of work-per-unit-charge are *volts* (V) or *kilovolts* (kV; 1 kV = 1000 V). Voltage is the “pressure” of electricity, and is analogous to the pressure of water in a plumbing system.

Electric charges push and pull on other charges and, therefore, each electric charge generates an *electric field* that exerts a force on nearby charges. Opposite charges (i.e., + and -) attract, and like charges (i.e., + and +) repel. Electric fields are equal to the “force per unit charge” and are measured in units of *volts/meter* (V/m) or *kilovolts/meter* (kV/m).

The movement of electric charges is called *electric current* and is measured in *amperes* (amps). Current measures the “flow” of electricity, which is analogous to the flow of water in a plumbing system. The moving charges in an electric current produce a *magnetic field* which exerts force on other moving

charges. Wires carrying currents running in parallel attract, while wires carrying currents in opposite directions repel. This is the principle by which electric motors generate force.

The magnitude of a magnetic field, or magnetic flux density, is measured in *gauss* (G) or *tesla* (T) (1 T = 10,000 G). Smaller fields are measured in *milligauss* (1 milligauss (mG) = 0.001 G) or *microtesla* (1 μ T = one-millionth of a tesla). Milligauss is the unit most often used to measure the strength of magnetic fields in electric transmission lines. Permanent magnets contain electrical currents at the atomic level that can generate strong magnetic fields, approximately 100 to 500 G (i.e., 100,000 to 500,000 mG). Thus, magnetic fields from permanent magnets can exert forces on electric currents, or on other magnetic objects, as for example, when a compass needle orients toward a magnet.

The strength of power line EMFs diminish with distance from the source similar to the light from a candle grows dimmer as you move away from it. The field strengths are constantly varying and decrease as the inverse square of the distance from the source. For an electric transmission line, the EMF levels are highest next to the transmission lines (typically near the center of the ROW) and decrease as the distance from the transmission corridor increases. Electric fields are attenuated by objects, such as trees and walls of structures, and are completely shielded by electrically conducting material such as metal, the earth, or the surface of the body. Magnetic fields, on the other hand, penetrate most materials.

Characteristic	Electric Fields	Magnetic Fields
Unit of Measurement	Volts/meter	Weber/meter ² (Tesla or Gauss)
Attenuated by Objects	Yes	No
Field Results from	Strength of Electric Charge	Motion of Electric Charge
Primary Determinant	Voltage	Current Flow

Humans are exposed to a wide variety of natural and man-made electric and magnetic fields. The earth's atmosphere produces slowly-varying electric fields (about 0.1 to 10 kV/m) that occasionally manifest themselves as lightning. The earth's core produces a steady magnetic field, as can easily be demonstrated with a compass needle. The earth's magnetic field ranges in strength from about 470 mG to 590 mG over the United States, and is about 560 mG in the Northeast. Knowing the strength of the earth's fields provides a perspective on the size of the magnetic field measurements from an electric transmission line.

Man-made magnetic fields are common in everyday life. Many childhood toys contain magnets, and many of us use magnets to hold items on the metallic surface of refrigerators. These permanent magnets typically have fields (magnetic flux density) in excess of 100,000 mG. An increasingly common diagnostic procedure, magnetic resonance imaging, uses fields of 20,000,000 mG on humans and is considered safer than X-rays.

Electric transmission line currents are AC, because they change size and direction 60 times per second (60 cycles per second = 60 Hertz or 60 Hz). The AC currents produce AC magnetic fields; however, aside from the variation in time (60 Hz) that characterizes electric transmission line fields, they are identical in nature to steady fields, such as those due to the earth's atmosphere, or geomagnetism. Moreover, as human bodies move, the direction of the earth's magnetic field relative to this movement experiences a time-varying magnetic field, similar to AC magnetic fields.

Electric power transmission lines, distribution lines, and the electric power lines that come into our homes and workplaces are sources of electric and magnetic fields that vary in time at a frequency of 60 Hz (in North America) or 50 Hz (abroad). Magnetic fields are proportional to the current, and electric fields are proportional to the voltage on the wires; both decrease as distance from the electrical wires increases. EMFs from different sources (e.g., adjacent wires) may partially cancel or may add to the EMF

level at any location. For residences, typical baseline 60 Hz magnetic fields in the middle of rooms range from 0.5 to 2.0 mG. These fields are, to a large extent, produced by outdoor distribution wiring, indoor wiring, and electric currents in ground return pathways.

In the home, 60 Hz EMFs can also be found in the vicinity of electric appliances, including fans, electric ranges, microwave ovens, refrigerators, clothes washers and dryers, fluorescent lights, televisions, toasters, vacuum cleaners, etc. Appliances produce magnetic flux densities in the range of 40 to 80 mG at distances of 1 ft, but the density quickly diminishes with distance. Personal electric appliances such as shavers, electric toothbrushes, hair dryers, massagers, electric toys, and electric blankets can produce magnetic flux densities measuring 100 mG or more in the vicinity of the appliance.

[Table 4.1.7-1](#) summarizes the magnetic flux density associated with various devices and phenomena and several guidelines established by various organizations for certain occupations, individuals, and the general public. [Table 4.1.7-2](#) further summarizes maximum allowable electric and magnetic field intensities at the edge of transmission line ROWs.

Power frequency EMF are part of a spectrum that encompasses frequencies that range from very high ionizing energy, such as gamma rays with frequencies of billions of cycles per second, to very low non-ionizing energy below that of power frequencies. Visible light is also included in this spectrum at the threshold between ionizing and non-ionizing electromagnetic waves. The greater the frequency of the electromagnetic energy source, the shorter the wavelength and the higher the energy. Lower frequency sources have longer wavelengths and correspondingly lower energy.

Power frequency fields are very low frequency fields (60 Hz in North America) with extremely long wavelengths of around 3,100 miles (5,000 km). Because of the extremely long wavelength, fields associated with power frequency are experienced as separate electric and magnetic fields and are therefore not considered radiation or emissions. They carry very little energy and cannot break chemical bonds or heat living tissue.

4.1.7.1.1 Sources of Electric and Magnetic Fields Exposure

Electric and magnetic fields are common and exist in a wide variety of natural and man-made forms. Natural fields are associated with items used, such as the geomagnetic field of the earth and magnets. These natural fields are static and therefore do not switch back and forth like power frequency fields. Like electric appliances, overhead T&D lines are a common source of exposure to electric and magnetic fields. High voltage transmission lines can generate relatively high electric fields. However, because high voltage transmission lines are constructed along ROWs, and because electric fields drop off quickly with distance and are shielded by cable shields and physical obstacles, electric fields experienced by people within dwellings are typically dominated by the internal wiring and the use of appliances. Magnetic fields from transmission lines, although not able to be shielded by structures, also drop off quickly with distance. Therefore, magnetic fields within dwellings are also typically dominated by nearby distribution system wiring, house wiring, or appliance use. Electric and magnetic fields from different sources (e.g., adjacent wires) may partially cancel or be additive at a given location. Results of studies have shown that electric fields in the home, on average, range from zero to ten volts per meter and magnetic fields range from 0.6 to 3 mG (NIEHS, 2002).

Power frequency electric and magnetic fields can also be found in the vicinity of electric appliances, including fans, electric ranges, microwave ovens, can openers, refrigerators, clothes washers and dryers, fluorescent lights, televisions, toasters, vacuum cleaners, hair dryers, alarm clocks, electric blankets, and computers. Appliances produce magnetic fields that can range from one to 150 mG at distances of 1 ft

(0.3 m) (NIEHS, 2002). These fields decrease in strength much more quickly with distance than do power line fields.

4.1.7.2 Onshore Environment Pre-Project

Baseline measurements of power frequency (60 Hz) magnetic flux density were made on June 5 and 6, 2002, along the proposed onshore transmission cable route. Based upon these measurements and physical characteristics of the planned cable system, projections of the magnetic flux density were developed that would be representative of worst-case existing conditions during times of peak electrical loads. The baseline measurements were made along the street section of the route, and at representative locations along the NSTAR Electric 115 kV ROW.

Calculations were performed using the “ENVIRO” computer program, developed by the EPRI, to determine the magnetic flux densities expected along the onshore route as a result of the operation of the proposed transmission cable system, taking into account the effects of existing sources as well as the new transmission facilities. Calculations were performed with the proposed action generating at a maximum delivered output of 454 MW and at the annual average output of 168 MW. All measurements and calculations were performed at 3.3 ft (1 m) above grade.

Electric fields were not measured nor studied in any detail for the following reasons:

- The electric field of the proposed 115 kV cables would be effectively contained within the body of each cable (i.e., shielded) by its grounded metallic shield;
- Electric field strength is a function of power line voltage and the operating voltage of NSTAR Electric’s existing overhead T&D lines would not be changed by the proposed facilities (and thus, the resulting electric field strengths would not change);
- The focus of potential health effects of power frequency fields has been primarily with magnetic rather than with electric fields; and
- Calculations performed to determine existing electric field strengths and those expected after any proposed modifications to NSTAR Electric’s 115 kV transmission lines show that the existing and predicted electric field levels at the edge of NSTAR Electric’s ROW are well below 0.55 kV/ft (1.8 kV/m), which has been used as a guideline by the Commonwealth of Massachusetts EFSB. The maximum electric field strength in and adjacent to the streets along the proposed route of the onshore transmission cable system is on the order of 0.03 kV/ft (0.1 kV/m).

4.1.7.2.1 Landfall to NSTAR Electric ROW

The primary sources of existing power frequency EMF along the street portion of the proposed onshore transmission cable system route are the existing overhead distribution lines. Their nominal operating voltage is 23 kV phase-to-phase/13.2 kV phase-to-ground. They are fed radially from Distribution Line 92, which emanates from Hyannis Junction Substation. Proceeding in a southerly direction down the route (away from the substation and towards the landfall location), the load current on the lines decreases as the trunk circuit extends along the route branching to other distribution circuits. At New Hampshire Avenue, the line changes from 3-phase to single phase. Measured magnetic flux density at the edge of the pavement closest to the overhead line ranged from 1 to 21 mG along the length of the route, generally increasing in a northerly direction consistent with increasing current. Representative measurements directly under the lines did not exceed these values by more than 1 mG. At the time of the measurements, total load on Line 92 was about 14 MW. Line 92 experienced a 27 MW load during the historical system peak on August 9, 2001 ([Report No. 4.1.7-1](#)). Extrapolating to these load levels

produces maximum magnetic flux density in the range of 2 to 40 mG, although local field strengths may vary depending on conductor geometry and individual loads. The measured field strength directly under the lines in front of the Marguerite E. Small School was 5 mG or 9 mG when extrapolated to peak load.

Calculated existing electric field strengths in and adjacent to the streets along this route range between 0.032 and 0.29 kV/ft (0.01 and 0.09 kV/m).

4.1.7.2.2 Within the NSTAR Electric Right-of-Way

Magnetic flux density was measured under existing 115 kV lines 118 and 119 and existing 23 kV lines in the NSTAR Electric ROW where it crosses Willow Street at the low point in the lines. The highest field strength measurements were found at this location. The location is representative of the field strengths on the existing ROW between Harwich Tap and Barnstable Switching Station. Current flow at the time of the measurements was 296 Amps in line 118 and 143 Amps in Line 119. The magnetic flux density was highest under the 118/119 lines, at 26 mG, falling to 18 mG at the north edge of the ROW, and 6 mG at the south edge of the ROW. Using the same line geometry (which is much better defined and more consistent than for the in-street distribution circuits), the corresponding magnetic flux densities were calculated at NSTAR Electric's forecast peak loading (without the proposed action) of 643 Amps on line 118 and 311 Amps on line 119. This resulted in 127 mG directly under the lines, 56 mG at the north edge of the ROW, and 12 mG at the south edge of the ROW.

Calculated existing electric field strength directly under the 115 kV overhead lines 118 and 119 is 2.0 kV/m. At the north edge of the ROW, this falls to 0.2 kV/m, and is less than 0.1 kV/m at south edge of ROW.

4.1.7.3 Offshore Environment Pre-Project

4.1.7.3.1 Conditions in Nantucket Sound

There are no known power facilities in the waters of Lewis Bay or Nantucket Sound in the vicinity of Horseshoe Shoal, with the exception of the existing Nantucket cable that runs from Nantucket to Cape Cod, which may also have low levels of EMF associated with its operation. Further to the west of the site of the proposed action are existing electric cables that run between Falmouth and Martha's Vineyard. The only other pre-project magnetic field existing in the location of the proposed 115 kV submarine transmission cable is the natural geo-magnetic field of the earth, which is a static DC field that is oriented toward the North and downward into the earth.

4.2 BIOLOGICAL RESOURCES

4.2.1 Terrestrial Vegetation

The terrestrial vegetation associated with this proposed action is located along the onshore transmission cable system route starting at the landfall location in Yarmouth, Massachusetts and heading to Barnstable Switching Station. The proposed onshore transmission cable system route runs north from the landfall at New Hampshire Avenue in Yarmouth for approximately 4 miles (6.4 km) along Berry Avenue, Higgins Crowell Road, and Willow Street. The route leaves the roadways for approximately 2 miles (3.2 km) then heads west and then south along the existing NSTAR Electric ROW to the Barnstable Switching Station.

The information contained in this section was obtained from literature review, agency consultations, site investigations, and review of existing site investigation data. This section provides characterization of salt marsh, freshwater wetland, and upland vegetation that occurs along the on land transmission cable

route, including mapping of wetland boundaries and buffer zones, and an explanation of the significance of each wetland area to the interests enumerated in the WPA.

4.2.1.1 Woodlands

The upland vegetated communities located adjacent to the roadway portion of the proposed transmission cable system route are primarily pitch pine-oak forests dominated by white oak (*Quercus alba*), pitch pine (*Pinus rigida*), scrub oak (*Quercus ilicifolia*), lowbush blueberry (*Vaccinium angustifolium*), and sassafras (*Sassafras albidum*). Soils in these areas were observed to be sandy and are mapped as Carver coarse sand and Carver loamy coarse sand (NRCS, Dec. 15, 2006). The woodland vegetation adjacent to the project terrestrial path is typical of Cape Cod consisting of trees of various age classes and distribution.

4.2.1.2 Fields and Open Space

The on land transmission cable corridor does not intersect any naturally occurring field or open space areas. The managed NSTAR Electric ROW contains upland vegetation that is maintained as scrub/shrub community, with the primary cover consisting of interspersed woody and herbaceous species that vary in density along the ROW. The ROW is managed in compliance with NSTAR's vegetation management plan. Common species observed include black oak (*Quercus velutina*), sassafras, greenbrier (*Smilax glauca*), bearberry (*Arctostaphylos uva-uri*), poison ivy (*Toxicodendron radicans*), and knapweed (*Centaurea jacea*). Soils along the ROW consist of medium to coarse sands, and are mapped as Plymouth-Barnstable complex. (NRCS, Dec. 15, 2006). In addition to the scrub/shrub community of the ROW there are also residential yards adjacent to the roadways that could be considered open spaces with vegetation consisting of mowed grasses and ornamental landscaping.

4.2.1.3 Freshwater Wetlands

Wetlands in the area of the proposed action were characterized based on review of mapped resources, wetland field investigations, and related studies completed as part of the proposed action siting and permitting process. The following sources were reviewed as part of this characterization:

- USGS Topographic Map, Dennis and Hyannis Quadrangles
- USGS Aerial Photos dated March 5, 1995 and April 3, 1995
- MassGIS data on mapped wetland resources, open space mapping, endangered species
- Lake and Pond Recharge Areas Map, prepared for Town of Yarmouth by IEP, Inc. (August 1988)
- MassDEP SAV Mapping Inventory for 1995, and 2001
- SAV Diver Survey, Woods Hole Group, Inc. July 2003
- SAV Investigation Cape Wind Energy Project Nantucket Sound, Massachusetts, August 2006
- Ocean Surveys, Inc. (OSI) Plan Drawing 01ES047.2, Sheet 1 of 7
- Massachusetts NHESP records
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM), Town of Yarmouth, Barnstable County, Community Panel Numbers 250015 003C (June 17, 1986) and 250015 005D (July 2, 1992)

- FEMA FIRM, Town of Barnstable, Barnstable County, Community Panel Number 250001 0005C (August 19, 1985)
- National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database for Barnstable County, Massachusetts (December 15, 2006)
- NOAA Published Bench Mark Data, Hyannis Harbor, Massachusetts (September 29, 1989)
- Coastal Watersheds Map, prepared for Town of Yarmouth by IEP, Inc. (August 1988)
- Town of Yarmouth GIS database
- Town of Yarmouth Comprehensive Plan, Chapter 7 Coastal Resources (March 20, 1997)

Wetlands have been identified in the vicinity of the area of the proposed action seaward and within the state territorial limit of Nantucket Sound and Lewis Bay, and along the onshore transmission cable route. Portions of the submarine and onshore transmission route fall within the town boundaries of Barnstable and Yarmouth. Wetlands in the area of the proposed action are generally defined and regulated according to the following Federal, State, and local wetland regulations:

- Section 10 of the Rivers and Harbors Act of 1899 (U.S.C. 403)
- Section 404 of the CWA (33 U.S.C. 1344)
- ESA of 1973 (16 U.S.C. 1531-1543)
- WPA (M.G.L. c. 131, §40), Rivers Protection Act (Ch. 258 of the Acts of 1996), and regulations (310 CMR 10.00)
- Section 401 WQC (33 U.S.C. 1251, et seq.) and regulations (314 CMR 9.00)
- Coastal Wetlands Restriction Act (M.G.L. c. 131, §105)
- Coastal Zone Management Act of 1972 (16 U.S.C. §1451 to 1465), and regulations (301 CMR 20.00-21.00)
- Chapter 91 Waterways License (310 CMR 9.00)
- Massachusetts ESA (M.G.L. c. 131 §40) and regulations (321 CMR 10.00)
- Cape Cod Commission Act (Ch. 716 of the Acts of 1989 and Ch. 2 of the Acts of 1990)
- Cape Cod Atlas of Tidally Restricted Salt Marshes, Cape Cod, Massachusetts (December 2001)
- Yarmouth Wetlands Protection By-law and Regulations (Chapter 143)
- Barnstable Wetlands Protection Ordinance (Article 27)

There are several freshwater wetlands located adjacent to the proposed terrestrial route. These wetlands include Jabinettes Pond, Thornton Brook, red maple swamps, an Atlantic white cedar swamp, and a coastal plain pond. All areas potentially subject to Federal, state, or local jurisdiction within 200 ft (61 m) of the onshore transmission route were field investigated in October 2001, August 2002, and December 2002. Wetlands were delineated in December 2002, in accordance with criteria established by

the USACE, MassDEP, and the Yarmouth WPR. It should be noted that there are no wetland resource areas located along or within 100 ft (30.5 m) of the onshore transmission route within Barnstable. Vegetated wetland boundaries were surveyed using GPS.

Six freshwater wetland systems, as shown on [Figure 4.2.1-1](#), were identified within approximately 100 ft (30.5 m) of the proposed onshore transmission cable route in Yarmouth. A locally regulated isolated wetland north of Water Street and east of Berry Avenue was also identified during field investigations. Because this wetland area is slightly more than 100 ft (30.5 m) from the transmission cable route, it is not within the jurisdiction for this proposed action. The following provides a description of those six wetland resource areas, as shown on [Figure 4.2.1-1](#), within 100 ft (30.5 m) of the onshore transmission cable route.

- **Wetland 1 – Bordering Vegetated Wetland (BVW), Bank, Waters of the U.S. (local, State, and Federal jurisdiction)** is an Atlantic white cedar (*Chamaecyparis thyoides*) swamp located on the east and west sides of Higgins Crowell Road in Yarmouth. The wetland is within approximately 60 ft (18.3 m) of the road, and is located at a well-defined break in slope. A 12-inch (30.5 cm) concrete culvert beneath the road appears to connect the east and west wetland areas, and this wetland is therefore regulated as Bank and Waters of the United States. On the east side of the road, the wetland is relatively undisturbed and consists of a mixed cedar, tupelo (*Nyssa sylvatica*), and red maple (*Acer rubrum*) canopy. There is also a shrub layer with highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), green briar (*Smilax rotundifolia*), fetterbush (*Leucothoe racemosa*), and swamp azalea (*Rhododendron viscosum*). On the west side of the road, the majority of the mature Atlantic white cedars are dead or in decline. Vegetation includes live sapling Atlantic white cedars, red maple, tupelo, inkberry (*Ilex glabra*), sweet pepperbush, green briar, highbush blueberry, water willow (*Decodon verticillatus*), and wool grass (*Scirpus cyperinus*). This wetland is regulated as BVW and Bank, and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. Wetland 1 is regulated as Waters of the United States by the USACE.
- **Wetland 2 – BVW, Bank, Land Under Waterbodies and Waterways (LUWW), Riverfront Area, Waters of the United States** (local, State, and Federal jurisdiction) consists of Jabinettes Pond, on the east side of Higgins Crowell Road, and Thornton Brook, located on both the east and west side of the road. A vegetated wetland abutting Jabinettes Pond is located within 100 ft (30.5 m) of the proposed onshore transmission cable route. It is dominated by red maple, tupelo, highbush blueberry, sweet pepperbush, spicebush (*Lindera benzoin*), green briar, and sensitive fern (*Onoclea sensibilis*). Jabinettes Pond discharges into Thornton Brook, which appears to flow west and crosses beneath Higgins Crowell Road via a buried culvert. Road runoff is also channeled via paved swales on both sides of Higgins Crowell Road into Thornton's Brook. The stream briefly appears aboveground on the west side flows in a culvert beneath an old vegetated road. An unused concrete flow control structure with a slot for flashboards was observed on the east end of the west side culvert. The stream finally appears aboveground into a defined channel with steep man-altered banks and flows southwest.

Thornton Brook is mapped as a perennial stream on the current USGS map, and it is presumed to be perennial under 310 CMR 10.58(2) (a) (1) (a). Wetland 2 is regulated as BVW, LUWW, and Bank. A 100 ft (30.5 m) Buffer Zone and 200 ft (61

- m) Riverfront Area from Bank is jurisdictional under the Massachusetts WPA. The Yarmouth WPR regulate Wetland 2 as Vegetated Wetland, LUWW, and Bank with a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer. Wetland 2 is regulated as Waters of the United States by the USACE.
- **Wetland 3 – BVW, Bank, Waters of the U.S.** (local, state, and Federal jurisdiction) is a forested wetland located approximately 50 ft (15.2 m) west of Higgins Crowell Road in Yarmouth. The wetland is dominated by red maple, sweet pepperbush, highbush blueberry, inkberry, swamp azalea, fetterbush, cinnamon fern (*Osmunda cinnamomea*), and Sphagnum mosses. An intermittent stream channel flows west through the wetland and into Little Sandy Pond, located approximately 700 ft (213.4 m) west of Higgins Crowell Road. The intermittent stream channel was observed dry in areas in the vicinity of the wetland delineation in December 2002. Wetland 3 is regulated as BVW and Bank with a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.
 - **Wetland 4 – BVW, Waters of the United States** (local, State, and Federal jurisdiction) is a large forested swamp located approximately 30 ft (9.1 m) east of Higgins Crowell Road in Yarmouth. The wetland has an open understory consisting of sweet pepperbush, highbush blueberry and Sphagnum mosses and canopy dominated by red maple. The wetland is defined by an obvious topographic break in slope. A headwall with a partially buried culvert is located on the wetland's edge, adjacent to the roadway, but does not appear to be functioning. Wetland 4 is regulated as BVW and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.
 - **Wetland 5 – BVW, Bank, Waters of the United States** (local, State, and Federal jurisdiction) is located on the west side of Higgins Crowell Road in Yarmouth and is separated from the road by a strip of upland dominated by pitch pine and sheep laurel (*Kalmia angustifolia*). The wetland consists of a roughly circular wet meadow dominated by asters, little bluestem (*Schizachyrium scoparium*), rushes (*Juncus* spp.), umbrella-sedges (*Cyperus* spp.), St. John's wort (*Hypericum* spp.), cranberry (*Vaccinium oxycoccos*), spike rush (*Eleocharis* spp.), and sundews (*Drosera* spp.). The east side of the wet meadow area abuts a 30 ft (9.1 m) wide shrub swamp, densely vegetated with green briar, inkberry, highbush blueberry, pitch pine, and fetterbush. A manmade intermittent channel on the west side of the wetland flows west into Hawes Run. Both the wetland and intermittent channel were dry at the time of inspection in December 2002. The USGS map shows the wet meadow as an open waterbody meeting the 10,000 ft² (929 m²) size requirements for a Pond under the Massachusetts WPA. However, observations of the area dry during non-drought periods indicates that it does not meet the definition of Pond under the Massachusetts WPA (310 CMR 10.04) or the Yarmouth WPR (Section 1.04). Wetland 5 is regulated as BVW and Bank with a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA. Under the Yarmouth WPR, a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer is established from the wetland boundary. Wetland 5 is regulated as Waters of the United States by the USACE.

Wetland 5 is located within PH 40 and EH 188 a known area to contain the Plymouth Gentian (*Sabatia kennedyana*) a species of special concern according to NHESP.

From Willow Street in Yarmouth, the onshore transmission cable system route leaves the roadway and extends west and south for approximately 2 miles (3.2 km) along the NSTAR Electric ROW to the Barnstable Switching Station. One freshwater vegetated wetland area bordering the south shore of Long Pond in Yarmouth is present along the existing ROW immediately west of Willow Street.

- **Wetland 6 – BVW, Bank, LUWW, Waters of the United States** (local, state, and Federal jurisdiction) consists of Long Pond, which is situated on the northern edge of the ROW just west of Willow Street. The pond contains open water, surrounded by a fringe of emergent marsh and shrub swamp dominated by highbush blueberry, sweet pepperbush, swamp azalea, and leatherleaf (*Chamaedaphne calyculata*). The wetland is located at the base of a steep slope; however, many of the wetland plants, including swamp azalea and sweet pepperbush, are growing significantly upslope. Therefore, the boundary of the wetland was delineated using evidence of hydrology and hydric soils, under criteria established by the MassDEP. Wetland 6 is regulated as BVW, Bank, and LUWW and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.

Wetland 6 is located within PH 88 and EH 187 a known area to contain the Plymouth Gentian a species of special concern according to NHESP. Wetland 6 is also identified as Coast Plain Pondshore Natural Community according to the NHESP Natural Communities GIS data layer. The MassGIS data layer currently has 92 different Coastal Pain Pondshores mapped. Coast Plain Pondshore vegetation has zonation that is correlated with a flooding regime (Swain and Kersley, 2001). Coastal Plain Pondshores typically have a characteristic zonation pattern from dry to waterline, as follows:

- Upland oak forest;
- Shrub border dominated by highbush blueberry (*Vaccinium corymbosum*) associated with sweet pepperbush (*Clethra alnifolia*), and green briar (*Smilax rotundifolia*);
- Emergent exposed pondshore dominated by coastal plain flat-topped goldenrod (*Euthamia tenuifolia*), pondshore rush (*Juncus pelocarpus*), rose coreopsis (*Coreopsis rosea*) and golden pert (*Gratiola aurea*), with beaksedge (*Rhynchospora* spp.), lance-leaf violet (*Viola lanceolata*), and dwarf St. John's-wort (*Hypericum mutilum*);
- Semi-permanently flooded zone characterized by one or more of the following: bayonet rush (*Juncus militaris*), spike-sedge (*Eleocharis* spp.), pipewort (*Eriocaulon aquaticum*); and
- Hydromorphic rooted vegetation in deeper water including yellow water-lily (*Nuphar variegata*), white water-lily (*Nymphaea odorata*), and Robbins' spike-sedge (*Eleocharis robbinsii*).

4.2.2 Coastal and Intertidal Vegetation

Coastal wetlands as classified under the Massachusetts Wetland Protection Act were identified along the sections of the proposed submarine transmission cable route inside the state territorial limit in Lewis Bay to the proposed landfall location at New Hampshire Avenue in Yarmouth, and the coastal portions of the onshore transmission cable system route abutting Lewis Bay. The proposed landfall location is a rectangular embayment beach surrounded by a concrete headwall. Residences with associated yards are located directly adjacent (east and west) to the rectangular embayment, and their ocean frontage is fortified by concrete retaining walls and riprap.

4.2.2.1 Flora

The shoreline at the New Hampshire Avenue landfall is a concrete revetment. The landfall location is devoid of flora. Residences with associated yards are located directly adjacent (east and west) to the rectangular embayment, and their ocean frontage is fortified by concrete retaining walls and riprap. There are no known significant populations of coastal flora present at the proposed landfall location.

4.2.2.2 Barrier Islands, Beaches, and Dunes

The shoreline at the landfall does not serve as a sediment source for coastal beaches or coastal dunes; however, it provides a vertical buffer that is significant to storm damage prevention and flood control. There are two coastal beaches associated with this proposed action. One is Coastal Beach 1 in which the proposed transmission cable system comes ashore. The other is Coastal Beach 2, which is located approximately 60 ft (18.3 m) east of the proposed transmission route and is known as Englewood Public Beach.

- **Coastal Beach 1** (state and local jurisdiction) is defined under the Massachusetts WPA as unconsolidated sediment subject to wave action, tidal and coastal storm action that forms the gently sloping shore of a body of water. Coastal Beach extends from the mean low water line landward to the coastal bankline or seaward edge of existing manmade structures. Coastal Beach 1 is a gently sloping, sandy area that extends from mean low water line to the concrete revetment that comprises Coastal Bank at the proposed landfall location. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Beach. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Beach and establish a 35 ft (10.7 m) Vegetated Buffer.
- **Coastal Beach 2** (state and local jurisdiction) is Englewood Public Beach, located approximately 60 ft (18.3 m) east of New Hampshire Avenue. The beach extends from the mean low water line west to the edge of a paved parking lot adjacent to New Hampshire Avenue. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Beach. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Beach and establish a 35 ft (10.7 m) Vegetated Buffer.

4.2.2.3 Brackish and Saline Wetlands

The transmission cable system corridor intersects coastal wetland resources and their buffer zones, some of which are jurisdictional under the Massachusetts WPA and some through the CWA under the USACE. Jurisdictional and coastal wetland resource areas observed to occur between the 3.5 mile (5.6 km) limit and the proposed landfall location, (see [Table 4.2.1-1](#)), include the following:

- **Salt Marsh 1** (state and local jurisdiction) is defined as vegetated wetlands located in the intertidal zone dominated by herbaceous plants adapted to varying levels of salinity. Salt Marsh 1 is located approximately 200 ft (61 m) west of the proposed landfall location, between Lewis Bay and Shore Road in Yarmouth. This salt marsh is vegetated by poison ivy (*Toxicodendron radicans*), salt meadow cordgrass (*Spartina patens*), rushes (*Juncus* spp.), and seaside goldenrod (*Solidago sempervirens*). This salt marsh is positioned between the residences at 43 and 37 Shore Drive. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Salt Marsh. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Salt Marsh and establish a 35 ft (10.7 m) Vegetated Buffer.
- **Salt Marsh 2** (state and local jurisdiction) is located approximately 85 to 120 ft (26 to 36.6 m) west of the proposed transmission cable system route on New Hampshire Avenue. It is bordered by residences to the east and west, Shore Road to the south, and Broadway to the north. According to the Cape Cod Atlas of Tidally Restricted Salt Marshes (2001), a 12-inch (30.5 cm) wide culvert connecting this salt marsh to Lewis Bay is consistently clogged, causing regular tidal flooding over Shore Road between Salt Marsh 1 and Salt Marsh 2 (Cape Cod Commission, 2001). Salt Marsh 2 is vegetated by high tide bush (*Iva frutescens*), bayberry (*Morella caroliniensis*), poison ivy, salt meadow cordgrass, rushes, and seaside goldenrod. A defined channel is visible in the center of the salt marsh. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Salt Marsh. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Salt Marsh and establish a 35 ft (10.7 m) Vegetated Buffer.
- **Navigable Waters of the United States** (Federal jurisdiction) are defined as waters seaward of the high water line of navigable waters under Section 10 of the Rivers and Harbors Act of 1899. Navigable Waters of the U.S. encompass and extend beyond the state-regulated Land Under the Ocean. Since the landward boundary of navigable waters of the U.S. extends to the MHW elevation, this resource area partially overlaps with the Federally-regulated Waters of the United States and State-regulated Land Subject to Tidal Action, Land Containing Shellfish, and Coastal Beach.
- **Waters of the United States** (Federal jurisdiction) are defined as waters seaward of the highest annual tide line in tidal waters. The seaward limit of jurisdiction extends to the Massachusetts 3.5 mile (5.6 km) limit. When adjacent wetlands are present, such as salt marshes, the limit of jurisdiction extends to the boundary of the wetland. Waters of the United States overlap with the Federally-regulated Navigable Waters of the United States and the State-regulated Land Under the Ocean, Land Subject to Tidal Action, Land Containing Shellfish, Coastal Bank and Coastal Beach. This resource area also includes Salt Marsh 1 and 2, described below. It should be noted that although Salt Marsh is identified herein there are no direct impacts to Salt Marsh from the proposed action, as presented above.

- **Land Under the Ocean** (State and local jurisdiction) is defined under the Massachusetts WPA as the land extending from the mean low water line seaward to the boundary of the municipality's jurisdiction, and includes land under estuaries. Land Under the Ocean along the route consists of Lewis Bay and portions of Nantucket Sound within the 3.5 mile (5.6 km) state territorial limit. All work proposed in Land Under the Ocean includes Nearshore Areas, which extend to the municipality's jurisdiction but not beyond the point where the land is 80 ft (24.4 m) below the level of the ocean at mean low water. Most of the proposed work in Land Under the Ocean would be within the Town of Yarmouth; however, a small portion of the work would occur within the Town of Barnstable. The Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Land Under the Ocean. The Barnstable Wetlands Protection Ordinance provides no additional regulations for Land Under the Ocean beyond those in the Massachusetts WPA.
- **Coastal Bank** (State and local jurisdiction) is defined as the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland. The Coastal Bank at the New Hampshire Avenue landfall is a concrete revetment. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Bank. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Bank and establish a 35 ft (10.7 m) Vegetated Buffer.
- **Land Subject to Tidal Action** (State and local jurisdiction) is defined as land subject to the periodic rise and fall of a coastal waterbody, including spring tides. The Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Land Subject to Tidal Action.
- **Land Subject to Coastal Storm Flowage** (State and local jurisdiction) is defined as an area that extends upgradient or landward from the ocean and the ocean's estuaries to a point where the maximum lateral extent of flood water would theoretically terminate based upon the 100-year storm elevation referenced in the latest FIRM. The Land Subject to Coastal Storm Flowage extends approximately 1,100 linear ft (335.3 m) from the shoreline, along the route from the proposed landfall. The 100-year flood elevation varies from 13 ft (4 m) National Geodetic Vertical Datum (NGVD) at the landfall location to 11 ft (3.4 m) NGVD just beyond the intersection of Berry Avenue and Broadway.

Portions of the area of the proposed action below elevation 13 ft (4 m) NGVD are also within the "V-zone." The V-zone is an area subject to flooding with wave action during a 100-year storm event. In the vicinity of the proposed landfall, the V-zone extends to approximately 300 ft (91.4 m) north of the Coastal Bank.

- **Land Containing Shellfish** (State and local jurisdiction) is located within Land Under the Ocean and Waters of the United States and may be located in Coastal Beach and Salt Marsh. The applicant's research and discussions with the Yarmouth Shellfish Constable (Caia, 2002) indicate that Lewis Bay contains quahogs (*Mercenaria mercenaria*) and soft shell clams (*Mya arenaria*), with some scallops (*Placopectin magellanicus*) and Eastern oysters (*Crassostrea virginica*). Shellfish resources within Lewis Bay are utilized for commercial and recreational shellfishing.

The proposed submarine transmission cable route in Lewis Bay crosses a designated recreational shellfish area, but would not cross any privately licensed shellfish areas or grants (Town of Yarmouth Natural Resource Commission's Aquaculture Lease Site Maps and Recreational Shellfish Area Maps dated June 1, 1998 and December 2, 1999). [Figure 4.2.2-1](#) presents MassGIS mapping of shellfish suitability areas that includes the locations of these designated commercial and recreational shellfish areas. Additional information on shellfish resources in Lewis Bay is provided in Section 4.2.5.3 (Benthic and Shellfish Resources).

- **Coastal Watershed Areas** (local jurisdiction) are defined in the Yarmouth WPR as wetland and upland landforms that contribute surface and sub-surface water to the estuaries within the town. These areas are mapped and delineated within a "Water Resources Protection Study" prepared for the Town of Yarmouth (see [Figure 4.1.6-1](#)). Conservation Commission jurisdiction is restricted to mapped areas within 300 ft (91.4 m) of a major estuary. Portions of the proposed route are in a mapped Coastal Watershed Area within 300 ft (91.4 m) of Lewis Bay, defined as a major estuary under Section 1.04 of the local regulations.

4.2.2.4 Seagrass Beds

The MassDEP mapping and previous geophysical studies, utilizing side-scan sonar of Horseshoe Shoal, completed in 2002, 2003 and 2005 indicate that there are three potential areas of submerged aquatic vegetation (SAV) occurring within the area of the proposed action. Two are mapped beyond the Massachusetts 3.5 mile (5.6 km) limit and are located on Horseshoe Shoal. The other area occurs within the Massachusetts 3.5 mile (5.6 km) limit, near Egg Island in Lewis Bay. The potential seagrass areas were investigated in order to groundtruth the SAV beds, both in terms of characteristics and extent.

The Horseshoe Shoal investigation conducted on July 25, 2006 was performed to address several areas where previous side-scan sonar observations indicated the potential presence of SAV beds. The major goal of this study was to determine the presence or absence of seagrasses, and to qualitatively assess the composition of SAV in these areas of variable side-scan sonar returns ([Report No. 4.2.2-1](#)). The Lewis Bay investigation was performed July 1, 2003 to determine the extent of mapped SAV bed in the vicinity of the proposed submarine transmission cable route and to modify the proposed cable route accordingly to avoid direct impacts to SAV near Egg Island ([Report No. 4.2.2-2](#)).

The vegetative composition within the Horseshoe Shoal study area was found to consist primarily of attached red (*Grinnellia americana*, *Dasya pedicellat*, and *Gracillaria tikvahiae*), and green (*Codium fragile* and *Ulva lactuca*) macro-algae, not seagrasses. Of the 20 observation points, only one location included patches of eelgrass (*Zostera marina*). Of the algal species identified, only *C. fragile* is not native to New England waters; however, since its introduction it has rapidly expanded its range, and its presence at depths ranging from emergent tidal pools to depths of -39 ft (-12 m) below MLW (Villard-Bohnsack, 2003) ([Report No. 4.2.2-1](#)).

Many of the macro-algae observed are considered seasonal, with growth beginning in early to mid-summer and disappearance by late August (Hillson, 1982; Kingsburry and Sze, 1997; Villard-Bohnsack, 2003). Of the species observed, *G. americana* is potentially the most likely responsible for the variable side-scan sonar readings collected during geophysical studies conducted in 2003 and 2005. *G. americana* is a fast growing red alga, with a two- to four-inch-wide blade capable of growing to 19.7 inches (50 cm) in length within a single summer growth season (Hillson, 1982). For additional details on the methodology and results, see [Report No. 4.2.2-1](#).

Several small patches of eelgrass (*Zostera marina*) were found at location T2B during the July 25, 2006 survey. This is located in the northern end of the western potential SAV bed per the 2003 and 2005 surveys in the Horseshoe Shoal area. The patches ranged in size from 3 to 9 ft (1 to 3 m) in diameter (due to the limited field of view of the camera system, size estimates are approximations) (Report No. 4.2.2-1). No other seagrass was observed during the survey.

The MassDEP Wetlands Conservancy Program has mapped submerged aquatic vegetation (SAV) beds one quarter acre or larger in size along the coast using aerial photography, GPS, and field verification. Mapping was completed in 1995 and 2001. The 2001 data were published in February 2006 and made available on the MassGIS website. The MassGIS mapping is shown on the benthic habitat map (Figure 4.2.2-1). Based upon the MassDEP mapping, one SAV bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. This SAV bed was also confirmed during the geophysical and geotechnical investigations conducted in 2001 and 2003. Based on a December 2002 telephone conversation with Mr. Charles Costello of the MassDEP Wetlands Conservancy Program, the applicant indicates that the mapped SAV bed had not changed much in size between 1995 and 2001. According to the MassGIS website, MassDEP mapping of the eelgrass data are conducted on a 5-year cycle. The next mapping is scheduled for 2006-2007.

The Lewis Bay SAV was identified by free diving and visual observations from a small research vessel. The diver search was conducted using a 100 ft (30.5 m) search line that was marked every 10 ft (3 m) for reference. The area was swept in a 360 degree pattern at 10 ft (3 m) increments out to 100 ft (30 m). It was determined that the SAV was eelgrass (*Zostera marina*). The extent of the mapped eelgrass bed is shown in Report No. 4.2.2-2. As presented in Tables 1 and 2 of Report No. 4.2.2-2, the divers observed that the seagrass tended to occur in small patches ranging in diameter from 3 to 20 ft (1 m to 6.3 m). Based on the field survey results, the submarine transmission cable system would be no closer than 70 ft (21.3 m) to the western edge of the eelgrass bed located near Egg Island.

4.2.3 Terrestrial and Coastal Faunas Other than Birds

The project components that occur on land are restricted to the transmission cable to be installed within and adjacent to roadways, along an existing electric transmission ROW, and a minor amount of work at an existing substation. Therefore, terrestrial fauna are those species likely to inhabit the various vegetative communities adjacent to the roadways, particularly in areas located away from development and busy roadway intersections. However, the area of the proposed action within the paved roadways and roadway shoulders is not expected to provide nesting, breeding, feeding, or overwintering habitat for wildlife species. As a result of "edge effect," the maintained NSTAR Electric ROW is likely to provide habitat for a diverse, but not unique, wildlife community.

4.2.3.1 Mammals

Mammals that could use the terrestrial cable corridor would be typical of southeastern Massachusetts. These mammals would include but not be limited to White-tailed Deer (*Odocoileus virginianus*), Coyote (*Canis latrans*), Red Fox (*Vulpes vulpes*), Virginia Opossum (*Didelphis virginiana*), Woodchuck (*Marmota monax*), Striped Skunk (*Mephitis mephitis*), Common Raccoon (*Procyon lotor*) and various rodents. Many of these species would use the NSTAR ROW and the woodland adjacent to some of the roadway portions of the proposed buried line for hunting, browsing, and nesting habitat.

4.2.3.1.1 Bats

Although the proposed action is to be located several miles offshore, bats are known to fly across Nantucket Sound, and resident and migrant bat populations have been documented on Martha's Vineyard and Nantucket (DeGraaf and Yamasaki, 2001; Buresch, 1999).

Species of bat that currently or historically occur in Massachusetts include big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), Northern long-eared bat (*Myotis septentrionalis*), Indiana bat (*Myotis sodalist*) (last recorded in 1939; Federally and State Endangered), small-footed bat (*Myotis leibii*) (known to occur only in Hampden County; species of conservation concern), Eastern pipistrelle (*Pipistrellus subflavus*), silver-haired bat (*Lasionycteris noctivagans*) (species of conservation concern), red bat (*Lasiurus borealis*) (species of conservation concern), and hoary bat (*Lasiurus cinereus*) (species of conservation concern). The majority of these species occur statewide in Massachusetts, however, no state or federally listed threatened or endangered bat species occur in southeastern Massachusetts. A total of twenty three hibernacula are known to support wintering bats in Massachusetts. Eleven are anthropogenic hibernacula (i.e., mines) and twelve are naturally occurring caves (MDFW, 2005). The majority of hibernacula are located in the western portion of the state in Berkshire County. Known hibernacula are located in the Townships of Charlemont, Cheshire, Chester, Egremont, Lanesborough, New Ashford, New Marlborough, North Adams, Pepperell, Rowe, Sturbridge, and West Stockbridge. There are no known winter hibernacula located in Barnstable, Dukes, or Nantucket Counties. The furthest southeastern known hibernacula in Massachusetts is located in the Township of Sturbridge in Worcester County.

Of the seven species occurring in the region, the silver-haired bat, eastern red bat, and hoary bat (tree-roosting bats) are considered long-distance migrants, whereas the big brown bat, northern myotis, eastern pipistrelle, and little brown myotis do not typically travel long distances between their hibernacula and summer ranges (Whitaker and Hamilton, 1998). Although home ranges have not been described for northern myotis and little brown myotis, eastern pipistrelles and big brown bats are thought to travel no more than 50 miles (80 km) between hibernacula and summer ranges (DeGraaf and Yamasaki, 2001). Bats in southeastern Massachusetts either hibernate or migrate south during the winter, and are generally active between late April and early October, depending upon the temperature and weather conditions. Long-distance migratory bats travel south to their winter ranges (southern United States) between August and early October, and return during April and May. Little is known about the migratory behavior of the tree-roosting bats. However, museum records of migratory bats in North America suggest some tendency to migrate along the Pacific and Atlantic coasts, especially during the fall (Cryan, 2003).

Although bats are terrestrial species and are generally not associated with saline habitats, saltwater crossings have been documented for migratory tree bats. Occasional observations of silver-haired, eastern red bats and hoary bats on ships at sea and offshore islands such as Bermuda confirm that these species are able to travel long distances over water (Cryan, 2003). Additional published records of bats over coastal and marine habitats are limited and generally out-dated, but include the following. Migratory bats (eastern red, silver-haired, and hoary bats) were reported over coastal and marine areas in the fall during late-1800s in the vicinity of Highland Light, a near-shore lighthouse near North Truro, on eastern Cape Cod (Miller, 1897). In 1907, what were believed to be silver-haired bats were observed roughly 5 miles (8 km) offshore, flying just above the water's surface toward the shoreline of Staten Island before sunrise. During October of the same year, bats that were presumed to be migrants that had crossed Long Island Sound were observed roosting under beach cliffs along the north shore of Long Island (Murphy and Nichols, 1913). In 1919, an eastern red bat was observed circling a ship that was out of view of land, an hour after sunrise. The bat was believed to be following a southern migration path over water, and had not merely been blown offshore due to weather conditions (Nichols, 1920). In September 1920, approximately 100 eastern red and silver-haired bats landed on a ship located 20 miles off the coast of

North Carolina (Thomas, 1921). In 1949, roughly 200 bats were seen flying around a ship 65 miles (104 km) offshore (85 miles [136.7 km] southwest of Nantucket Island) (Carter, 1950). There were multiple records of bats circling then coming to roost on ships that were roughly 100 miles (161 km) or more offshore (Mackiewicz et al., 1956; Griffin, 1940; Norton, 1930).

Species such as big brown bats, *myotis* species, and eastern pipistrelle make small scale movements in April and May, and August and September between summer breeding areas and winter hibernacula. Most of these species travel 80 km or less, however, some dispersals are as far as 500 km (England et al., 2001). The long-distance migratory bats over-winter in southern North America. Silver-haired bats winter in mild coastal climates as far north as New York (England et al., 2001). Red-bats winter in Arkansas, Missouri, Kentucky, Tennessee, West Virginia, Virginia, North Carolina, the Gulf States, and northern Mexico (England et al., 2001). Hoary bats winter in coastal areas from South Carolina to central Florida, the Gulf States west to Texas, and south to northern Mexico (England et al., 2001). Their migratory movements are usually associated with the passage of cold fronts. Most migrants arrive at breeding grounds by May or June, and depart for winter habitats in August and September.

Migration or dispersal corridors in the region are not known. There is limited and out-dated information regarding bat undertakings of over-water crossings. Paul Cryan, a research biologist for the USGS Fort Collins Science Center, investigated available information on bat activity over open-ocean and bays along the Atlantic Coast and provided the following summary of information:

The occurrence of migratory bats (eastern red, silver-haired, and hoary bats) over coastal and marine areas in the fall was reported in the late-1800s in the vicinity of a near-shore lighthouse, Highland Light, near North Truro, eastern Cape Cod (Miller, 1897). In 1907, what were believed to be silver-haired bats were observed just above the water's surface before sunrise, roughly 5 miles offshore, flying toward the shoreline of Staten Island. During October the same year, bats were observed roosting under beach cliffs along the north shore of Long Island and were believed to be migrants that had crossed Long Island Sound (Murphy et al., 1913). In 1919, an eastern red bat was observed circling a ship that was out of view of land, an hour after sunrise. It was believed that the bat was following a southern migration path over water and previous weather conditions did not indicate the bat would have been blown offshore (Nichols, 1920). In September 1920, approximately 100 eastern red and silver-haired bats landed on a ship located 20 miles off the coast of North Carolina (Thomas, 1921). In 1949, roughly 200 bats were seen flying around a ship 65 miles (104 km) offshore (85 miles [136.7 km] southwest of Nantucket Island) (Carter, 1950). There were multiple records of bats circling then coming to roost on ships that were roughly 100 miles or more offshore (Mackiewicz et al., 1956; Griffin, 1940; Norton, 1930).

These observations indicate that bats would undertake long distance movements over water. However, these out-dated observations should be interpreted with caution. The observations of groups of hundreds of migrating bats seen offshore nearly one hundred years ago is likely a reflection of historically much more abundant bat populations. Though large flocks of over one hundred individuals of migratory red bats could once be observed, more recent observations have reported no more than 15 individual migrants at a time (England et al., 2001). The populations of many species of bats have suffered notable declines, including species that were once considered common (England et al., 2001).

No surveys specific to bats were conducted in association with the proposed action, and little is known about the frequency with which bats fly over water bodies such as Nantucket Sound. All seven species of bats found in southeastern Massachusetts were confirmed on Martha's Vineyard, and Nantucket is within the theoretical range of four species (little brown myotis, silver-haired bat, eastern red

bat, and hoary bat) (DeGraaf and Yamasaki, 2001; Buresch, 1999). Little information is available of bat use of Nantucket Sound. Bats do inhabit islands in Nantucket Sound, therefore, over-water crossings do occur. An acoustical detection and netting study conducted in spring through fall 1997 and 1998 documented silver-haired bat, red bat, hoary bat, Eastern pipistrelle, big brown bat, little brown bat, and Northern long-eared bat on Martha's Vineyard. Data indicated that *myotis* species may be using Martha's Vineyard as a stopover point during spring dispersal: Higher levels of *myotis* acoustic activity detected in the spring and early summer was believed to be associated with seasonal dispersal activity (Buresch, 1999). These high detection levels did not occur within the fall. This was believed to be a result of a longer, more continual fall migration (Buresch, 1999). Surveys were also conducted at the Camp Edwards portion of MMR on Cape Cod in 1999 and 2000, and documented the presence of four bat species: the big brown bat, eastern red bat, northern myotis, and the eastern pipistrelle (Massachusetts Army National Guard, 2001).

Although all species of bats present in southeastern Massachusetts are theoretically capable of crossing Nantucket Sound and have been documented on Martha's Vineyard, the migratory tree bats (eastern red bat, silver-haired bat, and hoary bat) are the most likely species to travel through the area of the proposed action, as they are stronger fliers and have demonstrated ability to travel over large bodies of water. These species would be expected to be present in the area of the proposed action only during spring and fall migrations. No bat species are expected to forage within the area of the proposed action, and bats would likely pass through the area only during migration and when traveling from the mainland to island habitats.

4.2.3.2 Reptiles and Amphibians

The amphibians and reptiles in the assessment area would be typical for the region including but not limited to the following species; Pickerel Frog (*Rana palustris*); American Bullfrog (*Rana catesbeiana*); Wood Frog (*Rana sylvatica*); Eastern American Toad (*Bufo americanus americanus*); Common Garter Snake (*Thamnophis sirtalis*); Snapping Turtle (*Chelydra serpentina*); Painted Turtle (*Chrysemys picta*); Northern Two-lined Salamander (*Eurycea bislineata*); Eastern Red-backed Salamander (*Plethodon cinereus*); Eastern Newt (*Notophthalmus viridescens*). The majority of the reptile and amphibian species would use the wetlands located adjacent to the proposed buried transmission cable system as breeding, foraging, and nesting habitat. The maintained utility ROW is more than likely to be traveled across by amphibians and reptiles migrating to the wetlands located along the ROW. There are numerous insect populations common to the region that would feed in the herbaceous plants that would be growing in the cleared ROW. These insects provided food for the insectivorous reptile and amphibians.

4.2.3.3 Freshwater Fish

The proposed action has only one crossing where the presence of freshwater fish is a concern. The transmission cable crosses Thornton Brook, designated as a perennial stream on the current USGS topographic map. The proposed transmission corridor crosses Thornton Brook just after it exits Jabinettes Pond. Jabinettes Pond discharges into Thornton Brook, which appears to flow west and crosses beneath Higgins Crowell Road via a culvert. This stream channel was observed to be completely dry during the field reviews in October 2001 and December 2002 and the presence and the potential species of fish that could be impacted could not be assessed.

4.2.3.4 Invertebrates

The invertebrate population in or near the proposed on-land transmission cable system route are typical of southeastern Massachusetts, consisting of, but not limited to, species such as:

- Red-legged Locust (*Melanoplus femur-rubrum*)
- Field Cricket (*Gryllus pennsylvanicus*)
- Meadow Spittlebug (*Philaenus spumarius*)
- Eastern Yellow Jacket (*Vespula maculifrons*)
- Honey Bee (*Apis mellifera*)
- American Bumblebee (*Bombus pennsylvanicus*)
- Wood Ticks (*Dermacentor* spp.)
- Black-legged Ticks (*Ixodes* spp.)
- Daring Jumping Spider (*Phidippus audax*)
- Wolf Spiders (*Pardosa* spp.)
- American House Spider (*Achaearanea tepidariorum*)
- European Earwig (*Forficula auricularia*)
- Convergent Lady Beetle (*Hippodamia convergens*)
- Black Blister Beetle (*Epicauta pennsylvanica*)
- Little Black Ant (*Monomorium minimum*)
- Rose Weevil (*Rhynchites bicolor*)
- Eastern Dobsonfly (*Corydalus cornutus*)
- Tent Caterpillars (*Malacosoma* spp.)
- Gypsy Moth Caterpillar (*Lymantria dispar*)
- Woolly Bear Caterpillar (*Isia isabella*)
- Fall Webworm (*Hyphantria cunea*)
- Monarch Butterfly (*Danaus plexippus*)
- Earthworm (*Lumbricidae* spp.)
- Night crawler (*Lumbricus terrestris*)
- House Mosquito (*Culex pipiens*)

According to the NHESP there are threatened or endangered invertebrate species along the proposed route. These state-listed T&E species are:

- (1) Comet Darner (*Anax longipes*), a species of special concern;
- (2) New England Bluethroat (*Enallagma laterale*), a species of special concern; and
- (3) Water-willow Stem Borer (*Papaipema sulphurata*), a threatened species.

4.2.4 Avifauna

Avian resources that are likely to occur in the area of the proposed action are protected under the Migratory Bird Treaty Act (16 USC §§ 703-712) and in some cases, the Endangered Species Act. Additionally, Federal projects are subject to Section 7 of the ESA (1973, as amended). Each Federal agency is required to ensure that any authorized project is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat (7 USC § 136; 16 USC § 460 et seq. (1973)), as discussed in Section 4.2.9.

Nantucket Sound is recognized as a regionally significant locale for waterbirds (Veit and Peterson, 1993). The Sound is located within the Atlantic flyway, and its position along the flyway is ideal for attracting thousands of waterbirds during migration. The Sound's location, the configuration of the

surrounding landscape, the mixture of contributing waters, and the regional climate combine to attract many species of waterbirds year-round. To evaluate the potential effects of the proposed action, it is necessary to first understand the abundance and distribution of avian resources and their use of the area of the proposed action.

In Nantucket Sound, specific groups of species occur in various habitats at different times of the year. For this description, species are divided into three groups: terrestrial birds, coastal birds, and marine birds. Terrestrial birds are species that spend the majority of their time on land and may cross the area of the proposed action but do not linger or forage there. Coastal birds include shorebirds and wading birds that may cross the area of the proposed action but most likely do not linger or forage there. Marine birds are defined as those species that spend the majority of their time in Nantucket Sound away from shore and may be regular visitors to the Project Area for purposes of feeding or resting. T&E bird species are discussed in Section 4.2.9.

The following sections summarize the distribution, numbers, seasonality, and behavior of the various species groups based on pre-existing information and results of surveys conducted by the applicant and Massachusetts Audubon Society (MAS). From March 2002 through March 2006, aerial, boat, and radar surveys were conducted by the applicant. Additionally, the MAS conducted aerial and boat surveys from August 2002 through September 2004. Survey efforts attempted to estimate avian occurrence and distribution within Nantucket Sound, primarily in relationship to Horseshoe Shoals where the project is proposed. Between the two efforts, survey methods were similar but not identical; therefore, direct comparisons between the two data sets were made with caution. [Table 4.2.4-1](#) shows the studies used during preparation of this description.

A Preliminary Avian Risk Assessment was conducted ([Report No. 4.2.4-1](#)). The initial assessment recognized that available information on bird use of Horseshoe Shoal is limited. The assessment indicated that studies should be directed to investigate bird use of the three shoal areas in Nantucket Sound and to estimate the potential effects of wind turbines on resident and migrant birds. The assessment specifically identified the need to understand waterbird abundance and distribution in Nantucket Sound. Based on this recommendation, terns, seabirds, and diving birds were intensively studied throughout the year from March 2002 through March 2006, including aerial, boat, and radar surveys. Data was collected throughout Nantucket Sound, both inside and outside the area of the proposed action. Focal points of the survey efforts were three possible alternative sites: Horseshoe Shoal, Monomoy-Handkerchief Shoal, and Tuckernuck Shoal.

The applicant and MAS collectively flew 125 systematic aerial surveys to document avian species and distributions in Nantucket Sound (see [Table 4.2.4-2](#) and [Table 4.2.4-3](#)). These surveys included parallel transects aligned north to south throughout the Sound ([Report No. 4.2.4-2](#); Perkins et al., 2004). Surveys were conducted during the daytime throughout different seasons from March 2002 through March 2006. Surveys were flown during the tern breeding and fall staging periods. Surveys also occurred throughout the fall through early spring when large concentrations of wintering sea ducks and waterbirds congregate in Nantucket Sound. The applicant flew 46 aerial surveys from March 2002 through February 2004 and MAS flew 79 aerial surveys from August 2002 through March 2006 ([Report No. 4.2.4-2](#)). The applicant and MAS also conducted boat surveys to complement the aerial surveys and to make observations of avian behavior (e.g., traveling, feeding, resting), and to estimate flight heights when possible. A total of 17 boat surveys were conducted from May 2002- March 2005 during the same study periods as the aerial surveys and covered a similar area but generally did not follow the predetermined transects established for the flights. Observations were recorded on species presence, as well as their numbers, altitude, direction of flight, and other behaviors.

The applicant also conducted radar surveys during the spring and fall migration periods. The spring surveys were conducted from a jack-up lift barge located at the southern end of Horseshoe Shoal and the fall surveys were conducted from a cliff on Cape Pogue, on the northeastern tip of Martha's Vineyard. Horseshoe Shoal is located within the area of the proposed action while the Cape Pogue site is located approximately 10 miles (16.1 km) southwest of the area of the proposed action.

4.2.4.1 Terrestrial Birds

This section describes the landbird species that may cross the area of the proposed action but do not linger or forage there.

4.2.4.1.1 Raptors (hawks, owls, eagles, falcons, etc.)

Except for an occasional osprey (*Pandion haliaetus*) and, perhaps, peregrine falcon (*Falco peregrinus*), these birds are not likely to be present at Horseshoe Shoals except by accident, when they are blown offshore or off course in storms, and on rare occasions during migration. There are no topographic features (such as shorelines or shortest crossings) that funnel such migrants to the area. A total of eight osprey were observed during the boat surveys on August 15 and 22, 2002, and September 12, 2003, ([Report No. 4.2.4-3](#) and [4.2.4-4](#)). All were observed just offshore south of Falmouth, less than 1 mile (1.6 km) from the shore, and none were observed in the Horseshoe Shoal study areas. Osprey were observed foraging at a height of less than 50 ft (15.2 m), which is typical of their foraging behavior although they are known at times to forage from over 100 ft (30.5 m). Osprey likely forage in Lewis Bay, in proximity to the proposed submarine transmission cable route for the proposed action. No peregrine falcons were observed in the study area during any of the 2002 to 2005 surveys of Nantucket Sound.

4.2.4.1.2 Other Landbirds – Migration

Large numbers of migrating landbirds pass over Horseshoe Shoal at a wide range of altitudes during autumn and spring (April through May and September through October, respectively). They are known to travel over a broad front rather than in narrow streams, but numbers flying over Nantucket Sound in both spring and fall are much lower than over the mainland to the northwest (Nisbet and Drury, 1967). Despite this, numbers estimated to migrate through Nantucket Sound are estimated to be in the millions ([Report No. 4.2.4.1](#)).

Geo-Marine, Inc. (GMI) conducted radar surveys for the applicant during four migration seasons to measure passage rates and flight height for both diurnal and nocturnal bird activity ([Table 4.2.4-4](#)). Surveys were conducted in spring and fall 2002 ([Report No. 4.2.4-5](#)), fall 2005 ([Report No. 4.2.4-6](#)), and spring 2006 ([Report No. 4.2.4-7](#)). The spring surveys were conducted from a jack-up lift barge located at the southern end of Horseshoe Shoal and the fall surveys were conducted from a cliff on Cape Pogue, on the northeastern tip of Martha's Vineyard. Horseshoe Shoal is located within the area of the proposed action while the Cape Pogue site is located approximately 10 miles (16.1 km) southwest of the area of the proposed action.

The radar surveys were conducted using two marine radars simultaneously 24 hours a day. Although surveys were targeted for continual operation there were some periods when data was not collected due to equipment malfunctions. An S-band radar was operated to detect targets within a range of 4.6 miles (7.4 km) during the spring and fall 2002, 6.9 miles (11.1 km) during the fall 2005, and 4.6 miles (7.4 km) during the spring 2006. An X-band radar was operated to document the vertical distribution of targets within a range of 1.7 miles (2.8 km) in altitude and 0.9 miles (1.4 km) downrange. The S-band radar operated horizontally and detected the abundance of targets and their flight direction as they passed through the radar's view while the X-band radar detected the targets flight heights as well as the percentage of targets flying below the height of the proposed turbines.

The results of the radar surveys conducted within the area of the proposed action show some consistent trends. The median flight heights observed during the day were lower than at night across all seasons and years. Another trend observed is that a greater percentage of targets were observed flying at altitudes below the proposed maximum turbine height during the day than at night. These trends are typical because the majority of nocturnal migrants are neotropical songbirds whose flight heights over land are typically at higher altitudes than waterbirds that typically migrate during the day.

Due to variation in bird populations and weather conditions some variation in the passage rate, or abundance, of birds was observed between seasons. For example, both night and day time passage rates were relatively consistent during the first three seasons but increased significantly during the spring 2006 survey. This may be the result of an increased survey effort during this time period. The spring 2006 survey included the entire time frame during which many birds in the northeast are known to migrate and several more nights of optimal migration conditions, and migrant abundance, could have been documented that season.

Very few songbirds or other similar passerines were observed during the visual surveys in the study area. None were observed during the aerial surveys, and only three individuals (two swallows and one American Goldfinch) were observed during the boat-based surveys ([Report No. 4.2.4-7](#)). These results were expected, since most songbirds migrate at night and few would be expected to be found in the area of the proposed action during non-migratory, daytime activities. However, the small size of these birds means that they may be easily missed, and boat- or aerial-based visual observations are unreliable indicators of numbers passing through the area.

4.2.4.2 Coastal Birds

This section describes the coastal bird species that may cross the area of the proposed action but most likely do not linger or forage there, other than at the transmission cable landfall area. Piping plover (*Charadrius melodus*) is a federally threatened species, and is discussed in more detail in Section 4.2.9 and [Appendix C](#).

4.2.4.2.1 Shorebirds (sandpipers, plovers, etc)

Shorebirds are most numerous in the area as transients during migration when the large areas of sand and mud near North Monomoy provide important staging areas of internationally recognized importance. Much smaller numbers of shorebirds occur at other sites around Nantucket Sound. Fewer numbers of shorebirds are summer residents in the area. Only a few shorebirds were observed during surveys for the proposed action. It is possible that some shorebirds occasionally fly across the area of the proposed action, from one side of the Sound to another, but no such observations have been recorded, and sightings of shorebirds on beaches do not suggest any concentrated flightlines through the area of the proposed action.

Small numbers of three species/groups of shorebirds were observed during the aerial and boat surveys, including an American oystercatcher (*Haematopus palliatus*) in July, 2003 on the shoreline of Muskeget Island ([Report No. 4.2.4-8](#)). One red knot (*Calidris canutus*) and six unidentified sandpipers (*Calidris* spp.) were observed off Cape Poge during boat-based field surveys and 20 dunlins (*Calidris alpine*) were observed on Muskeget Island during an aerial survey in October 2002 ([Report No. 4.2.4-9](#)).

Migrating shorebirds typically climb rapidly when departing staging areas and are likely to fly over the Horseshoe Shoal area at high altitudes in the spring and fall, although they may fly at lower altitudes while descending to stopover sites such as Monomoy Island (Veit and Petersen, 1993). Identification of targets by radar is not definitive, but many shorebirds are thought to fly from New England directly to

South America, so that flights from Monomoy would pass east of the area of the proposed action (Griffin, 1974).

4.2.4.2.2 Wading Birds (herons, egrets, ibis, etc.)

These birds are numerous during migration and the summer months along the shorelines of bays and estuaries of Nantucket Sound. Small numbers may fly over the area of the proposed action, but are unlikely to linger at Horseshoe Shoal as the water depths are too deep for them to wade. None were observed during surveys conducted by the applicant or by MAS.

4.2.4.3 Marine Birds

This section describes the bird species that spend the majority of their time in Nantucket Sound away from shore and may be regular visitors to the area of the proposed action for purposes of feeding or resting. Roseate terns are a Federally-Endangered species and are discussed in more detail in Section 4.2.9 and [Appendix C](#).

4.2.4.3.1 Loons

Common loons (*Gavia immer*) and red-throated loons (*Gavia stellata*) are known to frequent the coastal waters of Massachusetts, particularly during migration and the winter months. The common loon is most often found in Nantucket Sound during spring and fall migrations with a few individuals remaining throughout the year. The common loon winters along the eastern seaboard after moving from inland lakes. The common loon is reported to be a diurnal migrant; migration routes follow coastlines and also pass overland (Williams, 1973; Viet and Petersen, 1993). The worldwide population has been estimated at 500,000 to 700,000 (Rose and Scott, 1996), the majority of which are found in Canada.

The red-throated loon breeds in tundra and far northern coastal regions. It is found wintering in coastal areas and is a common winter resident from southern Newfoundland to northern Georgia. Some subadults remain in wintering grounds all year and do not accompany adults to breeding grounds. In Massachusetts, spring migration peaks in April (Veit and Petersen, 1993). Fall migration into and through Massachusetts peaks in November (Kerlinger, 1998). There are currently no population estimates for red-throated loons in the Western Hemisphere though Canada is thought to have the second largest population after Russia's estimated 70,000. Russian, European, and Alaskan populations have seen declines during the 1990s, probably as a result of the acidification of northern lakes (Pakarinen and Järvinen, 1984).

Because they are difficult to differentiate, particularly during aerial surveys, observations of both loon species were combined for this discussion. During the applicant's boat and aerial surveys a total of 8,844 loons were observed within the survey area of Nantucket Sound (see [Table 4.2.4-5](#)) with peak numbers observed during the aerial surveys on March 29 and April 5, 2002, ([Report No. 4.2.4-4](#)) and April 23, 2003, ([Report No. 4.2.4-10](#)). Thereafter, numbers observed dropped to nearly zero until November when their numbers increased considerably. In late December 2002 numbers observed dropped off once more and began to increase again in mid-February 2003 ([Report No. 4.2.4-9](#)). These changes reflect the timing of migrations by these species in the eastern United States and use of Nantucket Sound as a staging area during migration (Veit and Petersen, 1993). This trend continued through 2003 when observations of loons dropped off considerably in the summer months and increased again in November while migrating through the area in the fall of 2003 ([Report No. 4.2.4-4](#), [4.2.4-8](#) and [4.2.4-10](#)). It is evident from the surveys that more individuals migrate through the area in the spring than in the fall.

In winter, both species were detected throughout the study area ([Report No. 4.2.4-4](#), [4.2.4-9](#), [4.2.4-10](#) and [4.2.4-11](#)), and occurred singly or in small groups. In spring, flocks included as many as 100 individuals.

The MAS aerial surveys of Nantucket Sound documented very few loons in the Sound during August and September of 2002, 2003, and 2004 (see [Table 4.2.4-6](#)). The 34 surveys conducted in the premigratory staging period included 129 loon observations while six surveys during the 2003 and 2004 breeding periods included 62 loon observations in the Sound (Sadoti et al., 2005a, 2005b). Loon observations in the Sound were higher during the winter months. The 13 aerial surveys in the winter of 2003 to 2004 contained 3,756 loon observations (Perkins et al., 2004c). This represented less than 1 percent of all bird observations in Nantucket Sound during these surveys. Over 2,000 loons were observed on a single aerial survey in early April, indicating that spring migrants were moving through the Sound at this time. These trends of increased abundance in the early spring followed by greatly decreased abundance during summer and early fall were also observed during the applicant's surveys. During 41 boat surveys of Horseshoe Shoal in the Spring and Summer of 2003 and 2004, MAS observed 172 loons on the shoals, 11 of which were traveling above 40 ft (12.2 m) above mean sea level (AMSL). Contrary to aerial abundance findings, the vast majority, 168 loons, were seen during boat surveys in Horseshoe Shoal during the breeding period in 2003 and 2004 (Perkins et al., 2004a and Sadoti et al., 2005a).

4.2.4.3.2 Grebes

Horned grebes (*Podiceps auritus*) and red-necked grebes (*Podiceps grisegena*) occur as winter residents within Nantucket Sound. Both species reliably appear in the Sound by October, but they rarely occur in large numbers. Grebes generally leave their wintering grounds by May. Because they are difficult to differentiate, particularly during aerial surveys, grebe observations were combined for this discussion.

Little was known about grebe use of the Sound prior to surveys of the study area in 2002 through 2005. Grebe observations made during surveys by the applicant and MAS are provided in [Tables 4.2.4-7](#) and [4.2.4-8](#). Grebes were most often observed during the winter and spring months and peaked in March ([Report No. 4.2.4-10](#)) when 57 individuals were observed. They were not typically observed in summer or early fall ([Report No. 4.2.4-10](#)). The largest numbers of grebes were present in the study area during January, March, April, and December. Grebes were widely distributed across the study area in small numbers, but were more numerous in the southern section of the study area on Tuckernuck Shoals ([Report No. 4.2.4-9](#) and [4.2.4-10](#)). Grebes occurred singly or in small flocks on the water. As is typical of grebes, they were rarely observed flying. For example, of the 314 individuals observed during the aerial surveys, only one was seen flying; however, its flight altitude was within rotor height.

During their winter aerial surveys, MAS also observed few grebes (see [Table 4.2.4-8](#)). Winter boat surveys of Horseshoe Shoal in 2003 to 2004 documented a single horned grebe on the shoals (Perkins et al., 2004c). During 40 aerial and 39 boat surveys, MAS did not observe any grebes in Nantucket Sound in the breeding periods of 2003 and 2004 or premigratory periods of 2002, 2003, and 2004 (Sadoti et al., 2005a,b).

4.2.4.3.3 Wilson's Storm-petrel

A summer visitor to the region (May through September), the Wilson's storm-petrel (*Oceanites oceanicus*) is generally abundant offshore (500 to 1,000 individuals per day per locality (Veit and Petersen, 1993). During aerial and boat surveys, the applicant did not find this species to be abundant (see [Table 4.2.4-9](#)). Observations tended to be located in the eastern third of Nantucket Sound ([Report No. 4.2.4-3](#)). Of the storm-petrels observed, all were spotted flying below 10 ft (3 m) AMSL. This species is not easily distinguished from Leach's storm-petrels (*Oceanodroma leucorhoa*), especially

during aerial surveys. However, Leach's storm-petrels are not known to frequent Nantucket Sound but do occur in Buzzard Bay where there is a small nesting colony on Penikese Island (Veit and Petersen, 1993). For the purposes of this document, observed storm-petrels were assumed to be Wilson's storm-petrel.

The MAS aerial surveys (Perkins et al., 2003; 2004b; Sadoti et al., 2005b) observed 62 Wilson's storm-petrels in Nantucket sound during premigratory staging in 2002, 2003, and 2004 (see [Table 4.2.4-10](#)). A single individual was observed in 2002 on Horseshoe Shoal during a boat survey, and this storm-petrel was seen fishing over the shoal at a height of 2 ft (0.6 m) AMSL. During the breeding seasons of 2003 and 2004, 10 storm-petrels were seen during aerial surveys and 33 were seen during boat surveys (Perkins et al., 2004a; Sadoti et al., 2005a). The majority of these individuals, except for two seen fishing, were traveling across the Shoal at less than 15 ft (4.5 m) AMSL. As expected for a species that is a summer visitor, there were no Wilson's storm-petrels observed during the winter surveys.

4.2.4.3.4 Northern Gannet

Northern gannets (*Morus bassanus*) breed in three colonies in the Gulf of St. Lawrence and three colonies on the Atlantic coast of Newfoundland. The breeding population in 1999, obtained from counts of aerial photographs, was at 72,289 breeding pairs. Northern gannets winter all along the Atlantic and Gulf Coast, and large concentrations have been observed off the coast of Massachusetts (Veit and Petersen, 1993).

Northern gannets typically occur in Nantucket Sound from mid-March to early June and from mid-November to mid-January. The highest counts of northern gannets were observed in April and May ([Report No. 4.2.4-4](#), [4.2.4-9](#) and [4.2.4-10](#)). Northern gannets occurred singly and in flocks numbering up to 80 individuals throughout the study area. One large flock of approximately 300 individuals was observed just north of the study area in mid-April 2003 ([Report No. 4.2.4-10](#)). Some individuals were detected on the water, but the majority was observed flying. Of the flying individuals, 28 (1.9 percent) of the 1,415 individuals were seen flying at rotor height. Of the 1,415 total gannet observations during the aerial surveys, 1,081 (76.4 percent) were observed outside the three shoal areas (see [Table 4.2.4-11](#)). Northern gannets tended to be most often detected in the southern and eastern parts of the Sound ([Report No. 4.2.4-4](#), [4.2.4-9](#), [4.2.4-10](#) and [4.2.4-11](#)).

Similar to the observations of the applicant, MAS also observed the majority of northern gannets in the late fall or spring (see [Table 4.2.4-12](#)). In the winter of 2003 to 2004, 629 northern gannets were seen in the Sound during aerial surveys. In two boat surveys, one northern gannet was observed over Horseshoe Shoal (Perkins et al., 2004c). During three seasons of premigratory aerial surveys, 13 northern gannets were observed, all in 2002 surveys (22,883 total birds observed). Throughout the summer of 2003 and 2004, 179 northern gannets were observed during boat surveys of Horseshoe Shoal, none of which were seen flying in the rotor swept zone. A total of 29 northern gannets were observed during 2003 and 2004 summer aerial surveys (2,685 total birds over 2 summers) (Sadoti et al., 2005a).

4.2.4.3.5 Cormorants

Two cormorant species utilize Nantucket Sound, the double-crested cormorant (*Phalacrocorax auritus*) and the great cormorant (*Phalacrocorax carbo*). Great cormorants are primarily present within the area of the proposed action during winter, and double-crested cormorants are more abundant during summer months, although some winter presence is also common.

Double-crested cormorants winter and breed along the coast of Massachusetts (Hatch and Weseloh, 1999). Those that spend part of the winter in Massachusetts arrive in late March at the earliest. Peak autumn migration has been noted in the first half of October (Nisbet and Baird, 1959). Double-crested cormorants have typically been observed beginning migration flights soon after dawn and flying all day,

though some flocks have been seen flying in the late evening with few stopping to roost for the night (Nisbet and Baird, 1959). Cormorants usually fly low over water in loose V-formations and follow the coastline but are known to fly overland to bypass Cape Ann and Cape Cod in Massachusetts. When flying overland, cormorants often fly up to 3,280 ft (1000 m) above ground. Populations are estimated at 350,000 breeding pairs in North America with 96,000 pairs breeding on the Atlantic Coast. Populations have been increasing significantly for about thirty years (Hatch & Weseloh, 1999).

Great cormorants winter along the Atlantic Coast and are seen intermingling with double-crested cormorants off the coast of Massachusetts. The two species are not readily distinguishable and were not differentiated in the field studies and are similarly combined in this account.

A total of 2,511 cormorants were observed within the study area during the aerial surveys (see [Table 4.2.4-13](#)). Most cormorant observations were within 3 miles (4.8 km) of shore. Of the total cormorant observations, 2,506 were observed outside the three shoal areas. Six individuals were observed on Horseshoe Shoal during boat-based observations. Cormorants were observed frequently in small groups or large dense flocks at daytime resting areas on Fernando's Fetch (a transient sandbar northwest of Muskeget Island), on Bishop & Clerks' Lighthouse near the northern edge of the Sound and along the shores of Muskeget Island. Those observed flying were typically low to the water's surface, yet one flock of 40 individuals was observed flying at rotor height. Within the study area, the largest numbers were observed in October 2002; whereas in 2003, they were most abundant in June. Outside the study area, they were frequently observed close to shore and on the sandbars west of Monomoy, especially during post-breeding dispersal for double-crested cormorants in August ([Report No. 4.2.4-9](#)).

MAS observed very few cormorants during winter 2003 to 2004 surveys (see [Table 4.2.4-14](#)) suggesting migrants had left Nantucket Sound for more southern wintering grounds by early December. During boat surveys in the winter of 2003 to 2004, no cormorants were observed in Horseshoe Shoal, while only 7 were observed during aerial surveys. Cormorants were more often seen in the Sound during the breeding and premigratory staging period. Over 2 years of boat surveys during the breeding period, 28 cormorants were observed in Horseshoe Shoal and 16 were observed there during the 3 years of premigratory staging surveys. Aerial surveys of the Sound at these times show more activity than in the winter, though sightings averaged approximately 0.18 cormorants/mile² (0.07 cormorants/km²) (or 265 cormorants in 6 surveys) during the breeding period and <0.01 cormorants/mile² (<0.004 cormorants/km²) (or 1,337 cormorants in 34 surveys) during the staging period (Sadoti et al., 2005b; Perkins et al., 2004b).

4.2.4.3.6 Seaducks

Five species of seaducks migrate in large numbers through Nantucket Sound and adjacent waters in the spring and fall, and many are winter residents. These seaducks are divers that feed principally on benthic mollusks and crustaceans, although some species readily feed on fish. In summer, when most individuals have left the area, small numbers of common eiders (*Somateria mollissima*) nest on Muskeget Island and also on the Elizabeth Islands outside of Nantucket Sound (Veit and Petersen, 1993). A brief discussion of each of the five species of seaducks observed is presented below.

Common Eider

Common eiders are known to both breed and winter along the Massachusetts coastline (Veit and Petersen, 1993). Fall migration brings thousands of eiders to Massachusetts in October and November (Veit and Petersen, 1993). Large rafts of eiders commonly assemble in locations where prey is available in high concentrations, particularly in shallow water (Guillemette et al., 1993). Migrants tend to follow the coastline when moving south (Reed, 1975). In spring, eiders migrate more quickly, sometimes taking shorter, overland routes. The total winter population of common eiders for North America is estimated to

be 600,000–750,000 individuals (Goudie et al., 2000). Bourget et al. (1986) estimated that 181,000 common eiders winter from Maine to Massachusetts.

During aerial surveys conducted by the applicant, a total of 110,555 eiders were observed within the study area (see [Table 4.2.4-15](#)). Eiders accounted for approximately one-quarter of all birds observed in Nantucket Sound during winter surveys. From October to April, eiders were present in substantial numbers, often occurring in large, dense “rafts” numbering thousands of birds. These large rafts often extended beyond the edges of the study transects and therefore were not counted completely. Eider numbers were observed to decrease significantly during the aerial surveys conducted in February when large sections of the study area were frozen over ([Report No. 4.2.4-9](#) and [4.2.4-11](#)). During the summer, small numbers were observed near Muskeget Island, where a few pairs have nested each year since about 1973 to 1975 (Veit and Petersen, 1993).

Approximately 90 to 97 percent of all eiders detected during two winters of aerial surveys were observed outside the shoal areas (see [Table 4.2.4-16](#)). The average number of common eiders counted in Horseshoe Shoal was between 2 and 8 percent of the average number of all eiders counted. For Monomoy-Handkerchief and Tuckernuck Shoals, eider count averages were below 2 percent. Most observations of eider were in the southern part of the study area, between Tuckernuck Shoal and Martha’s Vineyard, and in the northeastern part of the Sound near Monomoy Island ([Report No. 4.2.4-3](#), [4.2.4-4](#), [4.2.4-9](#) and [4.2.4-11](#)). Eiders were observed both on the water and flying; of the 110,555 individuals detected during aerial surveys, none were observed flying at rotor height.

During boat surveys conducted by the applicant, 279 eiders were observed in April 2002, 77 were observed in October 2002, 155 were observed in April 2003, and 1 was observed on August 27, 2003 ([Report No. 4.2.4-3](#), [4.2.4-4](#), [4.2.4-9](#) and [4.2.4-11](#)). Eider counts during boat surveys were considerably lower than those of aerial surveys, which were conducted at roughly the same time.

MAS observed one eider during two years of aerial surveys conducted during the breeding season and 86 eiders during boat surveys, most of which were observed on a single day in April 2004. All of these were traveling in smaller groups at a height of 4 ft (1.2 m) above the water. Of the waterbirds counted during each of 13 aerial surveys conducted during the 2003 to 2004 winter surveys, between 30 and 88 percent were Common Eiders (see [Tables 4.2.4-15](#) and [4.2.4-16](#)). The two highest counts for the season were 53,278 on January 22, 2004, and 40,551 on March 10, 2004. Of all the eider observed in the Sound in winter 2004, 8.3 percent were seen in Horseshoe Shoal and 90.3 percent were outside of the study area (Perkins et al., 2004c).

Long-tailed Duck

Long-tailed ducks (*Clangula hyemalis*) winter on both coasts of North America and remain in the northern areas as long as waters remain open (Robertson and Savard, 2002). The ducks begin northward migrations in late-March or early-April and gather in large flocks in arctic waters until inland breeding grounds have opened (Veit and Petersen, 1993; Robertson and Savard, 2002). Fall migrants move south from molting grounds and numbers tend to peak in late-November and December (Veit and Petersen, 1993). The Atlantic coast wintering population has been difficult to estimate due to this species offshore foraging habits and light colored plumage, which make long-range observation difficult (Robertson and Savard, 2002).

Long-tailed ducks are understood to roost at night in Nantucket Sound and then fly in large flocks over Nantucket and Tuckernuck Islands to forage over the Nantucket Shoals during the day (Davis, 1997). These birds fly in flocks between daytime feeding areas on the shoals southeast of Nantucket and nocturnal roosts in the Sound (Davis, 1997). During a preliminary project survey flight in December

2001, a large roost was located in the southern part of the Sound, north of Tuckernuck. Several attempts were made during the aerial surveys to investigate this phenomenon but were unsuccessful, in part because the birds start moving before sunrise and continue after sunset. Long-tailed ducks were observed flying below 35 ft (10 m) AMSL during all observations made from plane or boat. They are known to fly at higher altitudes over or near land during foraging and roosting flights.

Aerial surveys conducted by the applicant are summarized in [Table 4.2.4-17](#). Seasonal occurrence of long-tailed Ducks in Nantucket Sound was generally from October through April. No Long-tailed Ducks were recorded in summer. The largest numbers were counted during aerial surveys in March 2002 and November 2003, when migrants may use the Sound as a staging area. They were absent from May through September and were first observed in October each year. During the aerial surveys, 52,192 individuals were recorded. Of these, 4,103 (8 percent) were observed in Horseshoe Shoal, 2,685 (5 percent) were observed in Monomoy-Handkerchief Shoal, 2,493 (5 percent) were observed in Tuckernuck Shoal, and 42,911 (82 percent) were observed outside the three shoal areas. These ducks were more numerous in the northeastern corner and southern section of the Sound ([Report No. 4.2.4-3](#), [4.2.4-4](#), [4.2.4-9](#) and [4.2.4-11](#)).

MAS also documented long-tailed ducks only in the winter and spring (see [Table 4.2.4-18](#)). During MAS aerial surveys from December 2003 through April 2004, 33,379 long-tailed ducks were observed, representing about 8.1 percent of all birds counted during this survey period. The largest numbers were seen in December and January, though thousands of ducks were still documented in early April. Long-tailed ducks were found to be more evenly distributed throughout the Sound than common eider or the long-tailed duck observations recorded by the applicant. MAS observations of 1,209 long-tailed ducks during two boat surveys in the winter of 2003 to 2004 constituted about 31 percent of all birds counted (Perkins et al., 2004c).

In order to better understand long-tailed duck flights in and out of the Sound and find nighttime roosting locals, a study was conducted from December 2005 through March 2006 ([Report No. 4.2.4-12](#)). Land-based observations combined with boat surveys and airplane reconnaissance were used to observe duck movements in Nantucket Sound and Horseshoe Shoal. Land-based surveys were conducted from the western end of Nantucket Island at sunrise and sunset in order to record the flight paths and heights of birds leaving and returning to roosting areas. Land surveys were performed in varying weather conditions though at times this meant reduced observation of commuting ducks. Boat-based crews made observations from within the Sound in order to track duck flights and roosting behavior in the area of the proposed action. The study attempted to obtain information on flight paths, flight altitudes, and roosting locales of commuting ducks.

During morning surveys ([Report No. 4.2.4-12](#)), long-tailed ducks were seen flying due south through Tuckernuck Channel, coming from the northeast and turning as they passed Eel Point. The majority of ducks observed (67 percent) followed this flight path. Others flew southeast and southwest as they passed Eel Point. Roosting areas in Nantucket Sound could not be determined for long-tailed ducks, so the origination of these flights is unknown; however ducks were observed moving to the northeastern part of the sound during boat and land surveys. During the evening surveys 99 percent of all ducks were observed moving north or northeast as they passed Eel Point and as they returned to the Sound. During flights between roosting and foraging areas the ducks were observed flying at lower altitudes when flying into a headwind, 66 percent flying less than 25 ft (7.6 m) above the water, 34 percent flying between 25 and 150 ft (7.6 and 45.7 m). Conversely, ducks were seen flying at higher elevations when flying with a tailwind. Under these conditions the majority (84 percent) were seen flying between 25 and 150 ft (7.6 and 45.7 m) AMSL, and 15 percent flying higher than 150 ft (45.7 m). During evening flights it was noted that ducks increased their flight altitude as they passed over land, and then quickly returned to

lower elevations once over water again. This behavior was observed except when ducks were flying into a strong headwind, in which case they flew very low (within 10 ft [3 m]) over land ([Report No. 4.2.4-12](#)).

Scoters

Black scoters (*Melanitta nigra*), white-winged scoters (*Melanitta fusca*) and surf scoters (*Melanitta perspicillata*) are all known to migrate through or winter off the coast of Massachusetts (Veit and Petersen, 1993). All three species of scoters were present in Nantucket Sound in large numbers through the winter, and migrants are known to pass through the area. Together the scoters comprised the largest group of birds observed during the study year, representing 51.6 percent of the total count.

A total of 212,872 scoters were observed by the applicant during the study period (205,802 during aerial surveys and 7,070 during boat surveys). The three species were combined in the reports because the sightings could frequently not be identified to species, especially when conditions for observation were less than ideal or when the scoters were in mixed flocks. Peak numbers were observed from October through April, with the numbers starting to decline in mid-April (see [Table 4.2.4-19](#)). The largest numbers of scoters were observed during the November 2003 aerial surveys when individuals were arriving for the winter and migrating through from their breeding colonies ([Report No. 4.2.4-3](#)). Scoters occurred in small groups and loose flocks numbering up to thousands of individuals, and were widely distributed in the Sound. Of the 205,802 observed during the aerial surveys, 15,222 (7.4 percent) were observed in Horseshoe Shoal, 18,678 (9.1 percent) were observed in Monomoy-Handkerchief Shoal, 30,419 (14.8 percent) were observed in Tuckernuck Shoal, and 141,483 (68.7 percent) were observed outside the three shoal areas. Only 13 scoters were observed during the summer months in all of Nantucket Sound. Flying scoters were generally observed at altitudes less than 15 ft (4.6 m) AMSL, with the exception of flocks of possible migrants at about 65 ft (20 m) AMSL. Large numbers of scoters were observed southwest of Martha's Vineyard in flocks numbering up to 3,000 individuals on March 24, 2003. Of the 212,872 scoters observed during the aerial and boat surveys, four individuals were documented flying within the height of the rotors ([Report No. 4.2.4-10](#)).

MAS also observed a preponderance of scoters during winter surveys (see [Table 4.2.4-20](#)). A total of 94,631 were seen during the study period, 91,244 of which were observed from December 2003 to April 2004. The largest number of scoters was seen during an aerial survey on January 22, 2003, when 25,727 individuals were observed in the Sound. During the winter period, 56.3 percent of scoters observed in the Sound were outside of all three alternative sites. On average, 15.8 percent were seen in Horseshoe Shoal over the course of the 2003 to 2004 winter surveys. During two boat surveys of Horseshoe Shoal in this same winter, 1,750 scoters were observed on the shoals. During MAS surveys, scoters made up 22 percent of all bird observations in the Sound and were the second most abundant group of birds after the common eider in the winter of 2003 to 2004 (Perkins et al., 2004c).

Red-breasted Mergansers

The red-breasted merganser (*Mergus serrator*) is present as a wintering bird along the Massachusetts coast. These mergansers are known to migrate into the area in late October and November and stay until early May. Generally this bird is not known to migrate or winter in mixed flocks with other species. Flights overland from inland breeding grounds may occur at night, though red-breasted mergansers are generally known to migrate along coastlines during the day in small flocks of 5 to 15 (Titman, 1999).

A total of 1,452 red-breasted mergansers were observed within the study area during field investigations by the applicant ([Report No. 4.2.4-3](#), [4.2.4-4](#) and [4.2.4-9](#)). Red-breasted mergansers were observed from October through April and they were not observed from late April through September during both study years ([Table 4.2.4-21](#)). Of the 1,218 observations during the aerial surveys that distinguished between alternative sites, 117 (9 percent) were observed in Horseshoe Shoal, 0 (0 percent)

were observed in Monomoy-Handkerchief Shoal, 0 (0 percent) were observed in Tuckernuck Shoal, and 1,101 (90 percent) were observed outside the three shoal areas. Of the 117 observed within Horseshoe Shoal, 107 were seen on November 24, 2003. They generally occurred close to shore, near Muskeget and Tuckernuck Islands. None were observed flying at rotor height.

MAS observed 56 red-breasted mergansers during the winter 2003 to 2004 surveys (see [Table 4.2.4-22](#)). One merganser was observed in the Sound during an aerial survey in late September 2003 (Perkins et al., 2004b). The largest number of mergansers seen in a single survey by MAS was 32 individuals in December, 2003 (Perkins et al., 2003).

Goldeneyes

The common goldeneye (*Bucephala clangula*) and Barrow's goldeneye (*Bucephala islandica*) are known to be present in Nantucket Sound in the winter or as winter migrants but are generally low in numbers. The applicant observed eight goldeneyes, in similar coastal locations as the red-breasted merganser observations. Of the eight observed, six were observed during the aerial surveys, all of which were observed outside of the three alternative sites. None were observed flying at rotor height. MAS did not observe any goldeneyes during surveys (Perkins et al., 2004a,b,c; Sadoti et al., 2005a,b).

4.2.4.3.7 Gulls

Six species of gulls were observed during the surveys. Gulls are abundant as year-round residents and migrants that travel over large areas of the Sound in search of food, often targeting schools of fish or working fishing boats. Approximately 65,000 nest in Massachusetts (Blodget and Livingston, 1996). A total of 6,229 individuals were observed during the boat and aerial surveys conducted by the applicant with 5,500 being observed during the aerial surveys (see [Table 4.2.4-23](#)). Gulls were observed during all aerial surveys during the study years. Of these, the great black-backed gull (*Larus marinus*) was the most abundant (2,220), followed by the herring gull (*Larus argentatus*) (1,605), Bonaparte's gull (*Larus philadelphia*) (1,444), black-legged kittiwake (*Rissa tridactyla*) (319), laughing gull (*Larus atricilla*) (150), and ring-billed gull (*Larus delawarensis*) (2). In addition, a total of 414 other individual gulls recorded during the surveys were not identified to species.

Gulls were sparsely and relatively evenly spaced throughout Nantucket Sound ([Report No. 4.2.4-4, 4.2.4-8, 4.2.4-9, 4.2.4-10 and 4.2.4-11](#)). Of the 5,500 individuals observed during the aerial surveys, 227 (5.0 percent) were observed in Horseshoe Shoal, 132 (2.4 percent) were observed in Monomoy-Handkerchief Shoal, 552 (10.0 percent) were observed in Tuckernuck Shoal, and 4,539 (82.5 percent) were observed outside the three shoal areas. They were most common in November and December during both study years, primarily due to the presence of Bonaparte's gulls within the study area during that time of year. Many gulls were observed on the water and flying, with a total of 85 of the 5,500 individuals observed during aerial surveys (mostly herring and black-backed gulls) seen in flight at rotor height. Four parasitic jaegers (*Stercorarius parasiticus*) were observed foraging off Monomoy Island on the September 12, 2003, boat surveys.

A total of 8,030 gulls of six species were observed in the Sound during MAS aerial surveys. In these aerial surveys the herring gull (1,610) was most abundant, followed by the greater black-backed gull (1,902), the black-legged kittiwake (578), Bonaparte's gull (61), and the laughing gull (59). A large number (3,820) of unidentified gulls were also seen throughout the aerial surveys. These same gulls were commonly seen during boat surveys of Horseshoe Shoal as well. Greater black-backed gulls (513), herring gulls (193), undifferentiated gulls (77), laughing gulls (7), black-legged kittiwakes (6), and Bonaparte's gulls (6) were all counted on the shoals in all seasons of survey. In addition, a single jaeger (*Stercorarius* spp.) was seen traveling at 4 ft (1.2 m) AMSL over Horseshoe Shoal during the breeding period of 2004 and eight jaegers (*Stercorarius* spp.) were seen traveling in the Sound on aerial surveys

from September 2002 to September 2004 (Sadoti et al., 2005a; Sadoti et al., 2005b; Perkins and Allison, 2003; Perkins et al., 2004b).

4.2.4.3.8 Terns

Common (*Sterna hirundo*), roseate (*Sterna dougallii*), arctic (*Sterna paradisaea*), and least (*Ixobrychus exilis*) terns can all be found nesting along the shoreline of Nantucket Sound. These birds are summer residents, almost 20,000 pairs of the four species nest in Massachusetts, the majority in the southeastern part of the state (Blodget, 2001 as cited in Perkins et al., 2003). Roseate terns are a Federally-Endangered species and are discussed in more detail in Section 4.2.9 and [Appendix C](#); the other three tern species are of Special Concern in Massachusetts. Breeding common and least terns are considered to be locally abundant in Nantucket Sound. However, there are concerns about populations of these two species in other geographic locations, and many terns do migrate through Nantucket Sound from other breeding populations that may be more at risk.

Terns are typically present in the Sound from early April until late September at breeding colonies and staging areas. The extent to which terns use Nantucket Sound is not fully understood.

The applicant and MAS conducted aerial and boat surveys from June 2001 through September 2004 to determine tern distribution and abundance in Nantucket Sound and the area of the proposed action, as well as to document tern behavior within the area of the proposed action. These surveys were timed to capture spring migrant, breeding population and pre-migratory staging use of the Sound. Five species of tern were observed during these surveys with common, roseate and least terns being the most abundant (Perkins et al., 2004a,b; Sadoti et al., 2005a,b; [Report No. 4.2.4-3](#), [4.2.4-8](#), [4.2.4-9](#), [4.2.4-10](#) and [4.2.4-11](#)). Small numbers of black and Forster's terns were also observed, typically in mixed flocks with common and roseate terns ([Report No. 4.2.4-4](#)).

The earliest tern sightings in Nantucket Sound occurred in April. Nineteen common terns were seen in April, 2002, ([Report No. 4.2.4-4](#)) and two common terns were seen on April, 2003, ([Report No. 4.2.4-10](#)). These individuals appeared to be spring migrants, newly returned to the Sound (Perkins et al., 2003a). The largest numbers of terns were observed in mid-May before nest initiation of terns breeding within the Sound and likely included migrants traveling through the Sound on their way to more northern and eastern breeding colonies (Perkins et al., 2004a; Sadoti et al., 2005a).

A total of 8,755 terns were observed within the study area from April to September in 2002 and from April to November in 2003 ([Report No. 4.2.4-3](#), [4.2.4-4](#), [4.2.4-8](#), [4.2.4-9](#), [4.2.4-10](#) and [4.2.4-11](#)). Common terns were the most abundant (5,313), followed by roseate terns (447), and least terns (198), black terns (40), and Forster's terns (2). However, 2,755 individual terns could not be identified to species, because roseate and common terns are similar in appearance and often occur in mixed flocks. A few black terns and Forster's terns were observed during the summer of 2003. Observations outside the study area suggest that terns were more numerous along the shore than in the study area, which is influenced by the proximity of a concentrated prey base that occurs in shallower waters.

During all of the aerial surveys, a total of 2,888 individuals were observed within the study area, of which 277 (9.6 percent) terns were observed in Horseshoe Shoal, 76 (2.6 percent) were observed in Monomoy-Handkerchief Shoal, 164 (5.7 percent) were observed in Tuckernuck Shoal, and 2,371 (82.1 percent) were observed outside the three shoal areas. During the aerial surveys, the number of flying terns recorded in each observation ranged from 1 to 201. Larger aggregations were infrequently encountered at roosting sites such as Fernando's Fetch (a transient exposed sandbar, present northwest of Muskeget Island during the surveys).

MAS (observed a total of 18,257 terns in the Sound from August 2002 to September 2004 (Perkins et al. 2003, 2004a,b,c, Sadoti et al., 2005a, 2005b). Common terns were more abundant (4,779) than roseate terns (832) though the majority of terns observed (12,646) were identified only as common/roseate type.

4.2.4.3.9 Auks (alcids)

A total of 3,530 large alcids were observed in the study area during the study period (see [Table 4.2.4-24](#)). These were much more likely to be razorbills (*Alca torda*) than murres, puffins, or guillemots (Veit and Petersen, 1993), but specific identification was not established for most individuals. Alcids were seen throughout the study area from November to April, with an unusual, unconfirmed individual in June, 2002. Alcids occurred singly or in groups numbering up to 35 individuals and were relatively evenly distributed throughout the study area ([Report No. 4.2.4-4](#), [4.2.4-9](#), [4.2.4-10](#) and [4.2.4-11](#)). Aerial surveys conducted by the applicant documented a total of 3,455 individuals within the study area, of which 426 (12.3 percent) were observed in Horseshoe Shoal, 290 (8.4 percent) were observed in Monomoy-Handkerchief Shoal, 408 (11.8 percent) were observed in Tuckernuck Shoal, and 2,331 (67.5 percent) were observed outside the three shoal areas. Other observations of alcids included a total of 50 dovebies, recorded from January to May and one Atlantic puffin observed in March, generally in association with razorbills. All alcids seen flying were observed below approximately 50 ft (15 m) AMSL. MAS surveys observed 2,576 razorbills and 4 unidentified alcids during aerial surveys from fall 2003 to spring 2004 (Perkins et al., 2004c). Of these, 19 razorbills and one dovebie were observed in Horseshoe Shoal (Perkins et al., 2004c).

4.2.4.4 Additional Waterbirds Observed

The following waterbirds were additional species/species groups that were observed in the study area during the study years but do not necessarily represent abundant species ([Report No. 4.2.4-8](#) and [4.2.4-9](#)).

4.2.4.4.1 Sooty Shearwater

This visitor from the southern hemisphere is seen regularly in Massachusetts coastal waters in the summer, and was recorded in Nantucket Sound on 6 dates during May, June, August, and October. Ten individuals were observed within the study area during the two study years. All were seen flying below approximately 25 ft (7.5 m) AMSL. Only one was observed during the aerial surveys.

4.2.4.4.2 Other Ducks

A total of 14 greater scaup (*Aythya marila*) were observed in the southern section of the study area during an aerial survey in June, 2003. None were flying at rotor height. Also, a total of 109 American black ducks (*Anas rubripes*) were observed on Muskeget Island on four aerial surveys in the fall of 2003.

4.2.4.4.3 Geese and Non-Seaducks

Large numbers of geese and non-seaducks pass close to shore during migration. The few that were observed during field studies included small numbers of Canada geese (*Branta canadensis*) that may have been residents. The Canada geese were observed at Muskeget Island and flying over Tuckernuck Island. In addition, a flock of 25 was observed flying through the study area in December, 2002, and 10 were observed in June, 2003. During boat surveys in September 2002, small numbers of high-flying Snow geese (*Chen caerulescens*) were observed from the bluff at Cape Poge. Of the 35 geese observed during the aerial surveys, none were flying at rotor height. In addition, seven Brandts (*Branta bernicla*) were observed on the eastern part of the study area in February, 2004.

4.2.5 Subtidal Offshore Resources

4.2.5.1 Introduction

A description of existing hard and soft-bottom benthic habitats and species, shellfish, meiofauna and plankton resources in the area of the proposed action is presented in this section. Information presented was derived from a review of the scientific literature, performance of site assessments, review of existing site assessment data, and agency consultation. As part of a characterization of shellfish resources in Nantucket Sound commercial shellfish resource information for the Sound from NMFS and MDMF data, including information on commercial shellfish species such as soft shell clams, surf clams, quahogs, bay scallops, mussels and conch whelk were evaluated. Further information on commercial and recreational shellfishing was obtained during a Survey of Commercial and Recreational Fishing Activities which involved interviewing shellfish and coastal officers. Shellfish resource information for the nearshore area of the proposed action including the landfall locale was obtained through communication with MDMF and Town shellfish constables.

Macrobenthic organisms are those organisms that live on or beneath the seafloor. Macrobenthos includes organisms, such as polychaete and oligochaete worms, clams, snails, crustaceans, seastars, brittle stars, sand dollars, and other large invertebrates. As opposed to these larger benthic invertebrates, small benthic invertebrates, often referred to as meiofauna, are discussed in Section 4.2.5.1. For the purposes of this analysis, meiofauna are considered to be small benthic invertebrate animals ranging in size from 0.02 to 0.002 in (0.5 mm to 0.045) mm. Macrofauna are larger benthic invertebrate organisms (i.e., greater than 0.02 in (0.5 mm) in length). The evaluation of benthic resources has been in accordance with specific requirements that were established for this proposed action as part of the MEPA scoping process and then modified in the USACE EIS Scope of Work. As a result of agency communication with the USEPA (Colarusso, 2002) and the USACE (2002a, 2002b) a sampling design, protocol, and methodology were designed and implemented by the applicant. The benthic database for the project was updated during November 2005 following these same approaches in order to obtain additional benthic community information in areas of the proposed action that were not previously investigated due to a revised proposed action layout.

4.2.5.2 Hard Bottom Benthic Communities

Hard bottom areas with scattered boulders, cobble, and gravel have been confirmed by conducting side-scan sonar surveys of the project areas as well as more focused underwater video surveillance. Areas with this type of substrate are shown in [Figure 4.2.2-1](#), Benthic Habitat Map. The side-scan sonar returns collected during three geophysical surveys were interpreted to represent scattered boulders (1 to 10 ft [0.3 to 3.0 m] in diameter) on the seafloor over approximately 10 percent of the area of the proposed action on Horseshoe Shoal with the remaining 90 percent of the shoal area relatively free of hard bottom substrate or boulders. The strong sonar returns indicative of glacially-deposited erratics are located primarily northwest of the ESP and along the western border of the array, though intermittent cobbles to boulders may be found scattered across the entire area of the proposed action. Along the submarine transmission cable route to the landfall in Yarmouth, the side-scan sonar results indicate rocky seafloor and boulders within an approximate 250 linear foot (76 m) length of the cable corridor south of Point Gammon and the entrance to Hyannis Harbor. This area corresponds to a zone of glacial drift paralleling and just offshore the present south coast of Cape Cod. The drift may be remnants of relict ice contact deposits left by an ice front temporarily stalled at this location during glacial retreat. The remaining seafloor along the submarine transmission cable route is interpreted as primarily unconsolidated sand-sized sediments.

Field sampling programs conducted in the areas of cobble as part of the Submerged Aquatic Vegetation Investigation ([Report No. 4.2.2-1](#)) indicated this type of habitat has macroalgae and attached invertebrates such as sponges. Although not observed or collected as part of the Submerged Aquatic

Vegetation Investigation, other invertebrates that could be expected to occur include barnacles, mollusks and tunicates and various species of mobile invertebrates such as crabs, seastars, gastropods, and fish such as tautog.

4.2.5.3 Soft-Bottom Benthic Communities

From a review of the scientific literature, sand is a dominant bottom substrate in the area of the proposed action with mud and other fine-grained sediments occurring to a lesser extent. SAV, boulders and cobbles are not common. However, these types of substrates were reported to occur occasionally throughout the proposed action locale. Earlier studies of the area present information that focuses on the benthic community that is associated with the sandy substrate when describing and quantifying benthic resources of this area. Bottom sediment mapping for the area of the proposed action is provided in [Figure 4.2.2-1](#), Benthic Habitat Map, and in [Report No. 4.2.5-1](#).

Field studies performed within the area of the proposed action during the summer of 2001 and the spring of 2002 were designed to characterize the benthic community of dominant habitats present including fine-grained sand, coarse-grained sand, presence or absence of sand waves, and differing depths. These field studies were performed during seasonal periods generally reported to have the greatest biological diversity and highest abundance of macroinvertebrates. For the purpose of biomonitoring or community characterization, late spring to early summer benthic sampling in North Atlantic coastal waters is widely supported in the literature (Rudnick et al., 1985; Heck, 1987; Holland et al., 1987; Sardá et al., 1995; Alden et al., 1997; NOAA National Centers for Coastal Ocean Science, 2006). Furthermore, single- or double-season sampling is just as effective as multi-season sampling, especially when conducted during the spring and/or summer (Alden et al., 1997). One reason for this is that benthic abundance and productivity in these waters are typically highest during the spring and early summer (Rudnick et al., 1985; Heck, 1987; Holland et al., 1987; Sardá et al., 1995). While this is most notable in intertidal and estuarine habitats (due to greater seasonal variation in environmental variables), it is also observable in subtidal marine waters (Whitlatch, 1977). In general, increased energy inputs during the spring translate into high abundance and diversity in coastal waters. Recruitment of most marine benthic taxa in the temperate zone crests during the spring (Alden et al., 1997; Chainho et al., 2006). The increase in energy availability that typifies environmental conditions at this time provides sufficient resources for the annual recruitment of a wide range of taxa. In Narragansett Bay, Rudnick et al. (1985) attribute the spring-early summer peak specifically to a combination of warming temperatures and the increased availability of diatomaceous detritus – a major food source for many benthic meio- and macrofaunal taxa – which reaches maximum availability in the spring and is typically exhausted by late summer. Recruitment success during this spring-early summer period is therefore critical to the maintenance of patterns in community structure over time across the region.

With a focus on dominant habitats during the period of peak abundance, this characterization of the soft-bottom benthic community describes existing conditions that are likely to approximate the maximum regarding the soft-bottom benthic community's diversity and abundance for the area of the proposed action.

4.2.5.3.1 Review of Scientific Literature

Benthic fauna data that are available for Nantucket Shoals were obtained and reviewed by Battelle (2001). Based on a review of scientific literature, Nantucket Sound has been generally reported to be a highly productive area for benthic invertebrates. Numbers of benthic organisms typically average in excess of 186 organisms/ft² (2,000 organisms/m²) (Theroux and Wigley, 1998). The average faunal density throughout the entire area of the proposed action studied in 2001 was 388 organisms/ft² (4,180 organisms/m²) and 704 organisms/ft² (7,574 organisms/m²) across three shoals studied in Nantucket Sound in 2002. The average faunal density for four sites sampled in 2005 at new turbine locations was

1007 organisms/ft² (11,589 organisms/m²). It is likely that the abundance averages recorded during these studies are higher due to data collection in spring and summer which are typically periods of peak abundance. Also, the 2005 samples were collected in the fall when the community is dominated by a larger number of smaller organisms (Sanders, 1956). It is also a possibility that the higher numbers of organisms found in the recent studies may be due to differences in gear used. Historically, mesh size used for sieving samples may have been larger than the 500µm-mesh size used in the recent studies that may have resulted in retention of more organisms on the sieve. Benthic faunal diversity (i.e., numbers of species and numbers of individuals per species) in Nantucket Sound has been reported to be lower than diversity in the rest of the Southern New England Shelf (Theroux and Wigley, 1998).

As described in Section 4.1 and [Report No. 4.2.5-1](#) Nantucket Sound has a sandy substrate that is mobile and dynamic as shown by the sand waves and ripple marks. Frequency and magnitude of the sand movements greatly influences the structure and abundance of benthic communities. The organisms that live in or on such sandy sediments are well adapted for settlement or movement in sand and also for recovery from natural burial.

A review of the literature shows that the most abundant taxa (in this document the term taxa is defined as either a distinct species or a group of similar species based on level of taxonomic identification used) in Nantucket Sound benthic fauna include crustaceans and mollusks followed by polychaete worms (Avery et al., 1996). Of the crustaceans, amphipods are noted to be most abundant. The sandy sediments in Nantucket Sound are reported as supporting a diverse assemblage of species of amphipods. The field studies and assessments performed for the proposed action during 2001 and 2002 support these conclusions ([Report No. 4.2.5-1](#) and [4.2.5-2](#)). Samples that were collected from offshore waters during 2002 were, however, dominated by large Nematoda (roundworms) that made up (by number) 45 percent of macroinvertebrate communities that were sampled from Horseshoe Shoal (see [Table 4.2.5-1](#)).

The literature reviewed indicated bivalves to be the most important and diverse of mollusks with gastropods also noted as commonly occurring (Pratt, 1973). MDMF (2001) indicated there is reported to be a heavily populated area of northern quahog (*Mercenaria mercenaria*) in shoals that are east of Horseshoe Shoal. Shellfish suitability areas for quahog in the area of the proposed action are shown in [Figure 4.2.2-1](#), Benthic Habitat Map. It has been reported that bay scallops (*Argopecten irradians*) occur in shallow waters of Nantucket Sound especially near seagrass beds. Shellfish suitability areas for bay scallops in the area of the proposed action are shown in [Figure 4.2.2-1](#), Benthic Habitat Map. It has also been reported that species of large gastropod whelks (*Busycon carica* and *Busycotypus canaliculatum*) are abundant in Nantucket Sound coastal waters (Davis and Sisson, 1988). The 2001 field study program was not specifically designed for capturing large size commercial shellfish. However, the 2002 field study program was modified so that larger organisms occurring deeper in the sediment would be accounted for in the analyses. These mollusk taxa were not identified in field sampling from the area of the proposed action during benthic studies conducted in 2001, 2002, or 2005 ([Report No. 4.2.5-1](#), [4.2.5-2](#), and [4.1.1-1](#)). A shellfish survey was conducted in 2003 in Lewis Bay to locate larger mollusks in the Project's landfall locale ([Report No. 4.2.5-3](#)). Documentation of northern quahogs in near shore areas was associated with Town of Yarmouth shellfish beds.

4.2.5.3.2 Project Field Surveys

The applicant conducted comprehensive benthic field sampling programs, in addition to the literature review of benthic conditions in Nantucket Sound and agency consultations. Five separate field surveys were performed in the area of the proposed action from 2001 through 2005. Ninety benthic samples were collected and analyzed. The field surveys in the area of the proposed action are summarized here.

2001 Benthic Macroinvertebrate Field Sampling Program

During August 2001, an assessment of benthic organisms was performed along the proposed and alternative submarine transmission cable routes connecting Horseshoe Shoal to Lewis Bay and Popponesset Bay, respectively, along with an assessment of benthic organisms associated with the site of the proposed action ([Report No. 4.2.5-2](#)). The survey was conducted in order to assess the composition of the benthic community across the area of the proposed action. One benthic sample was collected by surface grab methods at each of 46 locations, consistent with the proposed action's sediment core sampling program (see [Figure 4.2.5-1](#)). The sampling locations were selected to reflect the range of benthic habitats (Gibson et al., 2000) that occur along the proposed and alternative cable routes that originate from Lewis Bay and Popponesset Bay and from within the site of the proposed action on Horseshoe Shoal. Benthic macroinvertebrates from each sample were separated from sediment and debris, were identified to the lowest practical taxonomic level, and were counted.

The following information is a summary of the detailed results of the 2001 sampling Program found in [Report No. 4.2.5-2](#). Amphipoda was the most abundant and diverse taxonomic class found. Amphipods dominated seven of the 46 grab sites in Nantucket Sound, with a maximum of 95 percent (by number) occurring at one site (BG-G7) that was located approximately 1.5 miles (2.4 km) north of Halfmoon Shoal. Two amphipod taxa reaching greatest abundance ($> 1208/\text{ft}^2$ [$13,000/\text{m}^2$]) include the Ampeliscidae and Ischyroceridae families. When amphipods were found in these high densities the samples had been collected in areas on or in the immediate Horseshoe Shoal locale. These findings are consistent with the data reported in the literature (Sanders, 1958; Avery et al., 1996) that noted very high densities of amphipods in the sandy bottom substrates that were sampled in shallow waters in Nantucket Sound.

Sampling also revealed a wide variety of gastropods in the proposed action locale. Relatively high densities of gastropods were often found including areas along the proposed submarine transmission cable route. The species composition documented during this study was basically consistent with the data that was reported in earlier studies of Nantucket Sound, Georges Bank, and the Southern New England Shelf (Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998). This was particularly true for the samples that were collected at the offshore site locations.

Results of the 2001 Benthic Sampling Program Outside Massachusetts Waters

Data from samples collected during the 2001 benthic sampling program that were collected from Horseshoe Shoal and from the sections of the two alternative interconnecting routes located outside of the 3.5 mile (5.6 km) limit describe the composition of the benthic community outside the 3.5 mile (5.6 km) limit. The data indicate that Amphipoda dominate the benthic community in this locale. Ampeliscidae and Ischyroceridae comprised greater than 68 percent of the macroinvertebrate community by number in this locale in 2001. Other common taxa that were reported from this area included *Crepidula convexa* (convex slippersnail), *Crepidula fornicata* (common Atlantic slippersnail), *Glycera dibranchiata* (bloodworm) and Nematoda and comprised 18 percent of the macroinvertebrate community by number. These six taxonomic groups comprised 86 percent of the organisms by number in the locale in the 2001 study. There were 65 benthic taxa reported as occurring outside the 3.5 mile (5.6 km) limit and in the area of the proposed action at Horseshoe Shoal. Average numbers of taxa per sample in this locale in 2001 were 9.2 taxa/sample. The average number of organisms/ ft^2 (organisms/ m^2) in this locale in 2001 was reported to be 521 (5,611).

Results of the 2001 Benthic Sampling Program Inside Massachusetts Waters

During the 2001 sampling program 46 samples were collected in the area of the proposed action. Of these samples three were collected in Lewis Bay and five were collected along the route, within the 3.5

mile (5.6 km) limit of the area of the proposed action that connects Horseshoe Shoal with Lewis Bay. During this study the benthic community in this locale was dominated by the gastropod species *Crepidula convexa* and *Crepidula fornicata*. Slipper snails were documented in seven of the 46 samples collected in 2001. When found they occurred in very high densities ($>743/\text{ft}^2$ [$8,000/\text{m}^2$]). Patchiness in the slippersnail distribution may be due to nature of the substrate that has been reported to have stones and boulders scattered in the mainly sandy material. Slippersnails disperse via planktonic larvae (Collin, 2001) and can form accumulations of free-standing clusters on the seafloor if the larvae settle and then metamorphose on a stone. Additional larvae can then settle on the pioneer slippersnail and when that slippersnail dies and the attachment to the substrate is released the cluster can then become free-standing (Rayment, 2001). *Crepidula fornicata* is commonly reported attached to stones and shells in soft substrates or in muddy/mixed muddy areas (Rayment, 2001). Additional taxa that were common from samples in this locale included Phoxocephalidae (hood-headed amphipods), *Lumbrineris* sp., Nematoda (roundworms), and Oligochaeta (aquatic worms). These six taxonomic groups made up almost 69 percent of organisms (by number) identified from samples in the locale. There were 50 benthic taxa reported as occurring in the samples collected within the 3.5 mile (5.6 km) limit. The average number of taxa per sample in this locale in 2001 was 11.6 taxa. The average number of organisms/ ft^2 (organisms/ m^2) in this locale in 2001 was reported to be 188 (2,017).

2002 Benthic Macroinvertebrate Field Sampling Program

During late spring of 2002 assessments of the benthic macroinvertebrate community were performed at the site of the proposed action (Horseshoe Shoal), Monomoy-Handkerchief Shoal and Tuckernuck Shoal in Nantucket Sound (see [Figure 4.2.5-1](#)). All of these areas are located outside the 3.5 mile (5.6 km) limit. These three Nantucket Sound study areas were evaluated taking into consideration specific habitat variables including sand wave presence, sediment type, and water depth. These habitat variables are generally accepted as primary factors that influence benthic community abundance and diversity in Nantucket Sound (Theroux and Wigley, 1998; Zajac, 1998; Colarusso, 2002). Published charts and reports (O'Hara and Oldale, 1987; NOAA Fisheries, 2001), results from geophysical surveys conducted in 2001, and surficial marine sediment classification obtained from vibracores, borings, and benthic grab samples collected in 2001 and 2002 were reviewed in order to characterize conditions across the three areas ([Report No. 4.2.5-1](#)).

One benthic sample was collected using a surface grab from each of 33 selected locations ([Report No. 4.2.5-1](#)). The sampling locations were chosen to be representative of the range of sand wave conditions, sediment types, and depths occurring in each of the three evaluated areas in Nantucket Sound. Areas evaluated did not necessarily contain all habitat conditions. Shallow depths were not present at the Monomoy-Handkerchief Shoal Site and sand waves occurred only at the Horseshoe Shoal site. The field sampling program was designed so that statistical comparisons could be made among the physical oceanographic parameters and the benthic organism community composition. Communication with U.S.EPA (Colarusso, 2002) indicated that a minimum of five samples per habitat type would provide sufficient statistical power for the evaluation of differences in benthic resources associated with major habitat types such as sand wave presence, substrate type and depth in each of the three study areas in Nantucket Sound.

The following information is a summary of detailed results of the 2002 Sampling Program found in [Report No. 4.2.5-1](#). Since the 2002 survey was conducted in the spring a comparison could be made to summer surveys conducted in 2001. Information from the Horseshoe Shoal portion of this sampling program is summarized in this section.

For the 2002 sampling program, samples from 12 sampled sites were evaluated and 48 benthic invertebrate taxa from nine different Classes were identified. During the 2002 spring season, data

indicated that Horseshoe Shoal supported a macroinvertebrate community that had an average diversity of 9.9 taxa per sample and an average abundance of 842 organisms/ft² (9,060 organisms/m²). Six dominant taxa represented over 90 percent of the macroinvertebrate community at Horseshoe Shoal in 2002, while in comparison. These six taxa represented over 75 percent of the macroinvertebrate community at Horseshoe Shoal in 2001. The most dominant taxon (by number) was reported to be Nematoda (roundworms) followed by Ampeliscidae (four-eyed amphipods).

The six dominant taxa at Horseshoe Shoal in the spring of 2002 differed when compared to those dominant in late summer of 2001. Nematoda were more dominant in spring of 2002 than in summer of 2001. Two snail species, *Crepidula convexa* and *Crepidula fornicata* ranked in the top six taxa that were collected during the summer 2001 whereas they were not in the spring 2002 top six taxa. Also, three families of crustaceans were ranked in the six dominant taxa during summer 2001 and only two were so ranked in the spring 2002 sampling effort. These variations may be due to life cycles of these organisms that result in varying seasonal abundance patterns or to annual variability of these populations.

Benthic organisms from sediment depths greater than 5 cm were noted. Some of these organisms are not typically found in the deeper sediments and may have become included with deeper sediment organisms due to sediments from the upper 5 cm of the collected sample passing through the sieve. Even though the residual organisms were present, few organisms were noted in the sediment depths that were greater than 5 cm. This analysis reveals that most of the benthic organisms that occur at Horseshoe Shoal live in the top 5 cm of the substrate. This may be due to the presence of shifting sediments in this area that would have greater potential for burying organisms that are sedentary or deeply embedded (Sanders, 1956; Rhoads et al., 1978). Data analyses indicate that during the late summer 2001 sampling period and the spring 2002 sampling period benthic community abundance and diversity was not significantly different in the Horseshoe Shoal area.

2003 Benthic Macroinvertebrate and Shellfish Survey of Lewis Bay

During the summer of 2003, a benthic organism and shellfish sampling program was performed in order to describe shellfish and other benthic organisms that occur in Lewis Bay in the Town of Yarmouth shellfish area to be crossed by the proposed cable route ([Report No. 4.2.5-3](#)). Shellfish and other benthic organisms were sampled at specific locations (see [Figure 4.2.5-2](#)) along the proposed route in Lewis Bay with a clam rake, a ¼-inch mesh box sieve, and a manually operated dredge, when appropriate. All sample locations were mapped. The clam rake, box sieved samples, and dredge were each used at each sampling location so that all components of the benthic community could be adequately evaluated. The proposed cable route would cross approximately 600 ft (183 m) of the recreational shellfish bed in Lewis Bay. The 200 ft (61 m) closest to shore is to be crossed by using HDD with the remaining 400 ft (122 m) to be crossed using a jet plow. Also, for the transition from the seaward terminus of the HDD conduit to the submarine transmission cable system a pre-excavation pit would be required.

The following information is a summary of the detailed results of the 2003 Sampling Program found in [Report No. 4.2.5-3](#). Areas sampled are all located in Massachusetts waters. The benthic macroinvertebrate community in the locale of the Town of Yarmouth's recreational shellfish bed had a variety of organisms including worms, crustaceans, clams and snails. Thirty-one benthic macroinvertebrate taxa from seven taxonomic Classes were recorded in samples evaluated from four sites using the three sampling techniques. The sample site located furthest from shore (BGL1A) had the highest overall macroinvertebrate abundance (organisms/ft² [organisms/m²]), as evaluated by the dredge technique. Abundance of large shellfish, including the northern quahog, as evaluated by the clam rake technique, was similar at all four sites.

Of macroinvertebrates found in Lewis Bay, the Polychaeta were the most diversely represented Class. Thirteen different taxa were present in dredge and sieved samples combined. *Streblospio benedicti* (mud worm) were most abundant with *Prionospio* spp. (mud worm), Family Syllidae, and Capitellid thread worms commonly occurring. The most abundant Class observed using the dredge technique was the Nematoda (round worms) with the Class Oligochaeta also being abundant. The most abundant Class of macroinvertebrates in clam rake samples was Bivalves with the most abundant species being the northern quahog. *Anadara ovalis* (blood ark) was also commonly found. The density of macroinvertebrates collected in this survey averaged 5,406 individuals/ft² (58,168 individuals/m²) compared to an average of 517 individuals/ft² (5,558 individuals/m²) on Horseshoe Shoal in 2001 and 842 individuals/ft² (9,060 individuals/m²) on Horseshoe Shoal in 2002. The density of macroinvertebrates that were collected in the deeper waters of Lewis Bay in 2001 averaged 188 individuals/ft² (2,017 individuals/m²) which is lower than the densities recorded from Horseshoe Shoal at that time. Comparison with previously collected Nantucket Sound data notes a marked absence of the Order Amphipoda in Lewis Bay during this study. A possible reason for the absence of Amphipods in Lewis Bay could be their sensitivity to environmental stresses or disturbances (Pratt, 1973). Many dominant taxa found in Lewis Bay in this study are described as either pollution tolerant, opportunistic in nature, or early colonizers following an environmental disturbance.

2005 Benthic Macroinvertebrate Field Sampling Program at New Turbine Locations

During November 2005 the benthic database for the proposed action was updated to obtain additional benthic community information in areas not investigated previously due to a revised turbine layout. The benthic macroinvertebrate community was assessed at four new locations in a manner that was consistent with methods previously established for the 2001 and 2002 field sampling programs in order to maintain consistency among the surveys ([Report No. 4.1.1-1](#)).

The following information is a summary of the detailed results of the 2005 Sampling Program found in [Report No. 4.1.1-1](#). Results from the analyses of samples from the four new locations indicated a presence of 20 benthic macroinvertebrate taxa ([Report No. 4.1.1-1](#)). The average taxonomic richness for the four sites sampled was 9.5 taxa per sample, with a total taxonomic richness for areas sampled being 20 taxa. Site BG05-04 that is located at a depth of 27 ft (8.2 m) had the highest taxonomic richness with 16 taxa recorded. Site BG05-02 had the lowest taxonomic richness with only 4 taxa recorded at each site. For the four sites sampled the average faunal density was 1,102 individuals/ft² (11,589 individuals/m²) ([Report No. 4.1.1-1](#)). Site BG05-04 on Horseshoe Shoal's western edge had the highest faunal density with 1,942 individuals/ft² (20,898 individuals/m²). Sites BG05-02 and BG05-03, which are located at the center and to the north of Horseshoe Shoal, respectively, had the lowest faunal density with 504 individuals/ft² (5,418 individuals/m²). Average density for the four locations was higher than densities reported during the 2001 sampling program (521 individuals/ft² [5,611 individuals/m²]) and during the 2002 sampling program (842 individuals/ft² [9,060 individuals/m²]). These differences may be the result of community shifts expected from differences between seasons sampled with the 2001 and 2002 being late spring and summer samples while the 2005 samples were collected in the fall when the community is dominated by a larger number of smaller organisms (Sanders, 1956).

In the 2005 sample, Nematoda were more abundant than any other group, comprising 70 percent of the total number of individuals/m² of all the samples. Nematoda were dominant in each sample with over 50 percent in BG05-01, BG05-02, BG05-03 and 47 percent in BG05-04. Oligochaeta was the only other taxon that met criteria for being dominant and was 27 percent dominant in sample BG05-04. The gastropod *Crepidula fornicata* made up 17 percent of the sample. At site BG05-01 Platyhelminthes, *Ophelia* spp. and *Scoloplos* spp. had significant individuals/m² with 3 percent, 4 percent and 2 percent of the sample count, respectively. At sample site BG05-02 Platyhelminthes and *Glycera* spp. were present in significant numbers at 4 percent and 3 percent of the sample count, respectively. At site BG05-03

Platyhelminthes (4 percent) were also present along with *Scoloplos* spp. (5 percent) of the sample count. The only taxa identified on the sieve portion of any of the four samples were three specimens of *Macoma balthica* at site BG05-03.

2005 Macroinvertebrate Survey of Meteorological Tower Colonization

During June 2005 an assessment was made of the macroinvertebrate community colonizing the meteorological tower installed within the proposed offshore area of the proposed action. The tower platform is supported by three steel pilings that are not identical in size to the proposed monopiles, but have the same smooth steel surface. In addition, scour control mats that are proposed for the monopile foundations protected one of the three pilings. The meteorological tower, installed in April 2003, had been in place for more than two years allowing for a macroinvertebrate community to be established. It was hypothesized that the macroinvertebrate community that became established on the support pilings would be similar to a community that may establish itself on the proposed monopiles.

During the survey observations made by divers indicated that similar macroinvertebrate communities were established on the three support pilings, with distinct colonization patterns at different water depths. Vacuum suction techniques were used to collect three samples. Benthic organisms and other attached material were completely removed from 0.14 ft² (0.013 m²) of surface area from one of the support pilings. A sample was collected from each of three localities: one from an area of the piling that was just above the sea floor, one from within a mid-depth range of the piling, and one just below the low water mark located on the piling.

The following information is a summary of the detailed results of the 2005 Survey of Meteorological Tower Colonization found in [Report No. 4.2.5-4](#). The purpose of this survey was to provide a qualitative assessment of the nature and rate of expected patterns of colonization on the proposed WTG monopiles based on the benthic community colonizing the existing meteorological tower support pilings. The survey results indicated that a benthic macroinvertebrate community similar to the surrounding sea floor community had colonized the support pilings. However, taxa were reported that had not been previously noted in the sandy bottom habitat. Twenty-six taxa, including seven species not observed during other baseline surveys at Horseshoe Shoal, were noted during the macroinvertebrate sampling on the tower support pilings (see [Table 4.2.5-2](#)). The seven new species reported included blue mussel (*Mytilus edulis*), sea flea (Photidae spp.), sea slug (*Sacoglossa* spp.), mud worm (*Polydora* spp.), large-eyed feather duster worm (*Potamilla reniformis*), purse sponge (*Scypha ciliata*) and a sea spider (*Tanystylum orbiculare*). These new taxa are likely to be in the area of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders. Average taxonomic richness for the three piling sites that were sampled was 14.3 taxa/sample. Though this sampling effort was limited, it is expected that pilings would support more taxa since they may attract organisms from both the sandy substrate habitat and those that would be attracted to fixed structures. Supporting this conclusion are the results of field observations that noted the most abundant and diverse communities near the base of pilings close to the naturally occurring substrate. The three piling sites sampled had an average faunal density of 106 individuals/ft² (1,145 individuals/m²), lower than values noted from benthic samples evaluated during the 2001 and 2002 surveys (521 individuals/ft² [5,611 individuals/m²] and 842 individuals/ft² [9,060 individuals/m²], respectively).

Conclusions from Benthic Field Investigations

From 2001 to 2005 there were 90 benthic samples collected in Nantucket Sound. Each of the dominant benthic habitats that occur in the site of the proposed action area and in surrounding sites was sampled during a variety of seasons. Overall, benthic community composition documented during the studies was consistent with data noted in previous studies in Nantucket Sound, on Georges Bank, and the Southern New England Shelf (Sanders, 1956; Wigley, 1968; Pratt, 1973, Theroux and Wigley, 1998).

These earlier studies indicated that the Nantucket Sound benthic community had a lower than average invertebrate density when compared with the rest of the Southern New England Shelf. However, biomass and density were found to be relatively high. Certain benthic taxa are more adapted to the shifting sand substrates that are characteristic of shallower waters. Thus, productive shallow water habitats can support greater densities of these adapted organisms but have lower overall densities compared to more stable, often deeper water benthic habitats.

There is natural variability in most benthic communities since the communities are subject to combinations of biological and physical factors that result in a high degree of environmental variability (Sanders, 1958; Zajac, 1998). A high sample-to-sample variability in total invertebrate abundance was also found. This supports conclusions of previous research efforts that indicated the Nantucket Sound benthic community was highly variable from one location to another and from one season to another (Wigley, 1968). The patchy nature of “microhabitats” (specific combination of habitat elements in a place that is occupied by an organism for a specific purpose) in terms of parameters like depth, currents, sediment type, light penetration, temperature, availability of food, disturbance, predation and shelter is believed to be a reason for this variability (Sanders, 1956; DeLeuw et al., 1991; Howes et al., 1997).

Results from benthic samples evaluated reveal a link between sediment type, depth, and macroinvertebrate community diversity. Data also showed there was not a link between the above variables and overall macroinvertebrate abundance. The microhabitat variable evaluated that significantly ($P < 0.10$) affected macroinvertebrate abundance was presence/absence of sand waves. Unstable sand wave environments are mainly inhabited by motile organisms that can avoid shifting sands (e.g., certain amphipod taxa and the tanaid *Leptognathia ceaca*) or by organisms that are capable of burrowing from beneath shifting sands if they get buried (e.g., certain polychaetes, Nematoda, Oligochaeta, and the bivalve *Tellina agilis*). *Tellina agilis* was the only shellfish collected in a sample from a sand wave. This mollusk has been described as an actively burrowing and mobile bivalve (Gosner, 1978).

Although limited numbers of samples were collected from the meteorological tower support pilings, the survey results indicate the benthic community that colonized them was similar in nature to the nearby sea floor community. Several new taxa noted on the pilings had not been recorded during previous sampling efforts from gravelly, sand or mud substrates. It is likely these new taxa colonized through their planktonic larvae or migrated to the pilings from other stationary hard substrate habitats in the proposed action locale such as rocky shoals or boulders.

4.2.5.4 Shellfish Resources

Review of the scientific literature has indicated that few studies related to shellfish resources have occurred in the proposed action locale and submarine route in Nantucket Sound. Information related to commercial shellfish resources in the larger area of Nantucket Sound is available from NMFS and MDMF. In addition, in Massachusetts, local shellfish constables serve to manage shellfishing activities in each town. Certain areas can be designated by shellfish departments to be used for recreational or family harvesting. Other specified areas may be privately licensed shellfish areas. There may also be areas for grants that are managed privately for certain shellfish species.

Shellfish suitability area information for blue mussel, bay scallop, sea scallop, surf clam, soft shell clam, quahog, and also Yarmouth aquaculture lease areas was obtained from the MassGIS database and is shown in [Figure 4.2.2-1](#), Benthic Habitat Map.

4.2.5.4.1 Massachusetts Department of Marine Fisheries Research Trawls

One source of information for shellfish resources is the MDMF bi-annual research trawls that are designed for collecting fishery-independent information on distribution and abundance of invertebrates

and fish in Massachusetts' waters. These trawl surveys have been performed yearly in May and September since 1978, and are based on a stratified random design using depth strata and a 1 square mile nautical grid. Coastal waters are stratified into geographic zones or strata according to depth and area. The pre-determined trawl locations are assigned in proportion to the area of each stratum and are then selected randomly in each stratum. Since timing of the surveys is May and September, this does not allow the surveys to represent abundance and distribution of fish or invertebrates over a whole year. The timing coincides with seasons when adults or juveniles are in the inshore areas. The trawling surveys are also more effective for collection of semi-pelagic and demersal species. Information is available on a Nantucket Sound-wide basis for a 27 year period ([Report No. 4.2.5-5](#)).

The review of MDMF trawl information from 1978 to 2004 (see [Figures 4.2.5-3 through 4.2.5-6](#)) ([Report No. 4.2.5-5](#)) showed that in the fall resource trawls the knobbed whelk and lady crab were included in the top 10 species by catch weight. In the fall resource trawls, spider crabs and lady crabs were ranked in the top 10 species by catch number. In the spring resource trawls, spider crabs were ranked in the top 10 species by catch weight. In the spring resource trawls, spider crabs and Atlantic rock crabs were ranked in the top 10 species by catch number.

4.2.5.4.2 Massachusetts Department of Marine Fisheries and National Marines Fisheries Service Commercial Harvest Data

In addition to the research trawls, the MDMF collects information on commercial harvesting of shellfish, lobster, and other "regulated" fisheries, which is maintained through the Management Information Systems and Fisheries Statistics Project. In order to monitor fishery resources in Massachusetts' waters, coastal waters have been divided into statistical areas with Nantucket Sound identified as Statistical Reporting Area 10. Reporting procedures include commercial fishermen submitting catch reports that address several shellfish species, including the lobster, shellfish and conch pot fisheries. A 15-year period (1990 through 2004) of MDMF catch data for available shellfish species from MDMF Area 10 were obtained from MDMF.

For monitoring commercial fishery landings, NMFS separates U.S. coastal waters into statistical areas. With Nantucket Sound designated as Statistical Area 58/Sub-area 075, which is comparable to MDMF Area 10. Landings information (including certain species of shellfish) from commercial fishermen is reported to NMFS via a mandatory reporting system. These data are called "vessel trip reports (VTR)." The VTR data covering an eleven-year period (1994 to 2004) for available shellfish species in Sub-area 075 were obtained from NMFS. This information was utilized to describe commercial shellfish resources and landings in Nantucket Sound ([Report No. 4.2.5-5](#)).

Shellfish landings in the federally-reportable Area 075 between 1994 and 2004 were represented by several species that included conch (whelk), quahogs, scallops and clams. Conch is a general term for several species of whelk such as the knobbed whelk, channeled whelk and lightning whelk that are found in Southern New England waters. The NMFS VTR data indicate several species of conch make up an important fishery in Nantucket Sound. From 1994 through 2004, conch species made up 80 percent of the total annual shellfish landings (see [Figure 4.2.5-7](#)). From 1994 through 2004, federally-reportable shellfish harvested in Nantucket Sound totaled approximately 1.8 million lbs (816,466 kg) (see [Table 4.2.5-3](#)). Lowest shellfish landings were reported in 1996 (approximately 10,600 lbs [4,808 kg]) and highest shellfish landings were reported in 2001 (approximately 448,000 lbs [203,209 kg]) ([Report No. 4.2.5-5](#)).

The fish pot fishery for conch in Nantucket Sound is monitored by MDMF separately from shellfish that are harvested by other methods. From 1992 through 2004 the state-reportable conch landings from conch pots in the Nantucket Sound area totaled approximately 14.6 million lbs (6,622,449 kg) ([Report](#)

No. 4.2.5-5). Landings information prior to 1992 is not available since catch reports for conch were not required prior to 1992. On an annual basis, state-reported conch landings from pots fished in Nantucket Sound have generally decreased from a high in 1992 (approximately 2 million lbs [907,185 kg]) to a low in 1998 (478,000 lbs [216,817 kg]). Landings have increased since 1998 going from 939,000 lbs (425,923 kg) in 1999 to 1.1 million lbs (498,952 kg) in 2004. During the timeframe from 1998 through 2004 a low of 685,000 lbs (310,711 kg) was reported in 2001. On a seasonal basis, the state-reported conch landings are usually high in June through August (Report No. 4.2.5-5).

State-regulated species of shellfish that are harvested from Nantucket Sound using methods other than fish pots include ocean quahogs, mixed quahog species, sea clams, soft shell clams, bay scallops, sea scallops, mussels and conch. American lobster landings are reported separately. From 1990 through 2004, total landings for the above shellfish species in Nantucket Sound were approximately 27.1 million lbs (12,292,353 kg) (see Table 4.2.5-4). During 1990 and 1992, these state-reported shellfish landings for Nantucket Sound showed an increase from approximately 80,000 lbs (36,287 kg) to approximately 5 million lbs (2,267,962 kg). In 1993, these state-reported shellfish landings decreased and then increased in 1994 to a 10 year high of 7.9 million lbs (3,583,380 kg). In the following years these state-reported shellfish landings in Nantucket Sound decreased in 1999 to 65,000 lbs (29,484 kg), in 2000 to 83,000 lbs (37,648 kg), and in 2003 to 55,000 lbs (24,948 kg) (see Figure 4.2.5-8). Common species harvested over the 15-year period in Nantucket Sound include the sea clam which made up approximately 47 percent of the state shellfish landings during this timeframe. The second most common species were mussels and the third most common species were conchs making up approximately 32 percent and 14 percent, respectively of shellfish reported harvested in Nantucket Sound by state permittees. Quahogs, including ocean quahogs, mixed quahogs, littlenecks and cherrystones, made up approximately 6 percent of the total state-reported shellfish landings. Soft shell clams, bay scallops and sea scallops made up less than 1 percent of the total state shellfish landings during the 15-year timeframe (see Figure 4.2.5-9).

Though northern quahogs (*Mercenaria mercenaria*) have been noted as making up a small percentage of state-reported shellfish landings, they have been reported as an important fishery in Massachusetts (MDMF, 2001) and also to be abundant in the coastal estuaries emptying into Nantucket Sound (MacKenzie, 1997). The MDMF staff (MDMF, 2001) has indicated there is a heavily populated northern quahog area present east of Horseshoe Shoal. A shellfish suitability area for quahogs is shown east of Horseshoe Shoal in Figure 4.2.2-1, Benthic Habitat Map. This locale is called the “quahog grounds” and is described as an area targeted by commercial fishermen (MDMF, 2001).

Bay scallops (*Argopecten irradians*) occur in Nantucket Sound in shallow areas mainly in proximity to seagrass beds. Shellfish suitability areas for scallops along the shoreline in Lewis Bay and along Nantucket Sound shoreline areas in proximity to Lewis Bay are shown in Figure 4.2.2-1, Benthic Habitat Map.

American lobsters (*Homarus americanus*) occur throughout New England. There is a commercial fishery for this species in coastal states from Maine to Delaware. Commercial permits for this species are issued to offshore fishermen (outside of the 3.5 mile [5.6 km] territorial limit) and inshore fishermen (within the 3.5 mile [5.6 km] territorial limit). The MDMF has designated 14 areas in Massachusetts nearshore waters for the reporting of lobster catch. The area of the proposed action is located within MDMF Area 10 that includes Nantucket Sound.

The lobster fishery in Nantucket Sound does not appear to be a major fishery. Massachusetts lobster fishery statistics for 2004 (Dean et al., 2006) reported that the Area 10 (Nantucket Sound) lobster fishery included 0.3 percent (of nearly 9 million lbs [4,082,331 kg]) of the total Massachusetts coastal permit harvest in 2004. Adjacent areas (Areas 9 and 11 through 14) had low yields, each having 5 percent or less

of the total harvest. Areas 2 through 8 that are located along the northern coast above Cape Cod Bay had the highest catches in territorial waters.

From 1990 through 2004 the total state-reportable lobster landings for Area 10 (Nantucket Sound) were estimated to be approximately 457,000 lbs (207,292 kg) (see [Figure 4.2.5-10](#)). The lobster landings increased from 8,000 lbs (3,629 kg) to approximately 50,000 lbs (22,680 kg) during the timeframe of 1990 through 1993. From 1994 to 1999, lobster landings varied from a low of 28,000 lbs (12,701 kg) to a high of approximately 48,000 lbs (21,772 kg) followed by a decline in 2000 to below 20,000 lbs (9,072 kg). Between 2001 and 2004, for Nantucket Sound the lobster landings stayed at approximately 20,000 lbs (9,072 kg) except in 2002 when landings of approximately 42,000 lbs (19,051 kg) were reported. On a seasonal basis, state-regulated lobster landings increased in June, peaked in July, and declined from August through December (see [Figure 4.2.5-11](#)) ([Report No. 4.2.5-5](#)).

4.2.5.4.3 Survey of Commercial and Recreational Fishing Activities

Additional information on commercial and recreational shellfishing was obtained as part of a survey of commercial and recreational fishing activities. Five shellfish and coastal officers were interviewed during this survey ([Report No. 4.2.5-6](#)).

In Edgartown it was reported that shell fishermen reportedly harvest scallops on both sides of Cape Poge, in outer Edgartown Harbor and along the channel area. It was reported that sometimes littlenecks (small quahogs) and surf clams were harvested on Horseshoe Shoal. It was noted that conch fishermen frequent Horseshoe Shoal. The Edgartown shellfish constable commented that Horseshoe Shoal is not a productive area for lobsters, since it is too sandy.

The Barnstable shellfish officer noted that clamming occurs off Squaw Island, Halls Creek and Dead Neck in the Barnstable waters of Nantucket Sound. The Officer commented that the Vineyard and Nantucket are traditional scalloping grounds and Egg Island north of Point Gammon once had a scallop fishery, and noted that draggers harvest quahogs in beds found four to five years ago off Harwich, Brewster and Chatham. The Officer's comments did not include knowledge of scallops in the Horseshoe Shoal locale.

Based on knowledge of those interviewed, no commercial or recreational harvesting of soft shell clams, razor clams, bay scallops or sea scallops was reported on Horseshoe Shoal. It was reported that conch trapping by fixed gear fishermen does occur on Horseshoe Shoal. One municipal official commented that Horseshoe Shoal was too sandy to support a viable lobster fishery. Of the 41 survey participants none reported lobstering on Horseshoe Shoal ([Report No. 4.2.5-6](#)).

4.2.5.4.4 2003 Shellfish and Benthic Macroinvertebrate Survey of Lewis Bay

During the summer of 2003 shellfish and benthic organism sampling program was performed in order to describe shellfish and other benthic organisms that occur in Lewis Bay in the Town of Yarmouth shellfish area to be crossed by the proposed cable route ([Report No. 4.2.5-3](#)). Results of the sampling indicated that the abundance and diversity of shellfish and benthic organisms were similar to previously conducted studies in similar types of areas. Results from this survey were also discussed previously in Section 4.2.5.3.2.

4.2.5.4.5 Municipal Shellfish Resources

Certain towns, including the Town of Yarmouth, have shellfish management programs that involve purchasing seed and adult shellfish for propagation and enhancement of natural shellfish stocks in stretches of waterbodies within the respective town. In cooperation with MDMF, shellfish departments

that participate in such programs have a rotating schedule for opening and closing such areas based on water quality information and availability of shellfish.

In the routing from offshore to the Cape Cod shoreline the proposed submarine transmission cable route crosses the 3.5 mile (5.6 km) state jurisdictional limit and enters Town of Yarmouth waters, then enters Town of Barnstable waters at the outer section of Lewis Bay, and proceeds to the inner section of Lewis Bay back in the Town of Yarmouth and to the proposed landfall site at New Hampshire Avenue in the Town of Yarmouth (see [Figure 4.2.2-1](#), Benthic Habitat Map).

A short section of the submarine transmission cable route passes through jurisdiction of the Town of Barnstable, mostly located in the outer section of Lewis Bay, which has been described as not having substantial recreational or commercial shellfishing harvesting or aquaculture lease areas (Marcotti, 2002). Shellfish expected in this section of Lewis Bay include soft shell clams, quahogs and scallops. Scallop activity takes place near Egg Island and the Town of Barnstable may open some areas offshore for quahog harvesting (Marcotti, 2002). The Town of Barnstable has no privately-licensed shellfish grants or shellfish propagation projects in the outer section of Lewis Bay. The section of Lewis Bay within the Town of Yarmouth has been described as containing quahogs, soft shell clams, scallops, and limited numbers of eastern oysters (*Crassostrea virginica*). Quahogs are very prevalent in Lewis Bay. In this section of Lewis Bay shellfish resources occur in privately licensed shellfish grant areas or areas that are managed through the Town of Yarmouth's shellfish propagation program (Caia, 2002).

Several locations in the Town of Yarmouth have designated recreational shellfish areas open only to Town residents for recreational purposes. One such area is within the direct path of the submarine transmission cable route – extending from Colonial Acres east to the Englewood Breakwater (see [Figure 4.2.2-1](#), Benthic Habitat Map). Another such area is located outside of the submarine transmission cable route in the Mill Creek locale. These areas are enhanced with seed shellfish annually through the Town of Yarmouth's shellfish propagation program (Caia, 2002). The Town of Yarmouth's website indicates that current propagation efforts are directed toward restoration of the bay scallop fishery, maintenance of the quahog fishery, re-establishment of historic soft shell clam beds, and re-establishment of the oyster fishery.

The proposed submarine transmission cable route crosses approximately 600 ft (183 m) of the designated recreational shellfish area in Lewis Bay that is a summer relay area for depuration of contaminated shellfish. The contaminated shellfish come from Mount Hope Bay and Fall River and are usually relayed by mid-June and need to remain in the depuration areas for one year. Recreational harvesting is permitted in these areas every other year to correspond with the schedule and cycle of the relay activities (Caia, 2002).

Privately licensed shellfish areas or grants in Lewis Bay privately farmed or managed for shellfish species are located outside the area where the proposed submarine transmission cable is routed (see [Figure 4.2.2-1](#), Benthic Habitat Map).

Classification information on designated shellfish growing areas provided by the Yarmouth Shellfish Constable (Caia, 2002) and on MassGIS data overlays shows that the submarine transmission cable route in Lewis Bay passes through approved shellfish growing areas. The designation shifts to a conditionally approved growing area as the submarine transmission cable route approaches the Yarmouth landfall. The change in classification occurs approximately 600 ft (183 m) from the landfall location. Approved shellfish areas are described as those that allow shellfish harvest for direct human consumption according to local rules and state regulations. Conditionally approved shellfish areas are described as those that allow shellfish harvest when the area is approved as determined by shellfish availability and water quality characteristics.

4.2.5.5 **Meiofauna and Plankton**

4.2.5.5.1 Meiofauna

Meiofauna are small benthic organisms that range in size from 0.02 to 0.002 inches (0.5 to 0.045 mm). They are found in freshwater and marine environments. The term “meiofauna” refers to the size class transition from micro- to macrofauna. The International Association of Meibenthologists recognizes 20 phyla of organisms that can be meiofaunal representatives. Of these 20 phyla, five are exclusively meiofaunal. The five phyla include *Gnathostomulida* (jaw worms), *Kinorhyncha* (small marine pseudocoelomate invertebrates), *Loricifera* (small sediment dwelling animals), *Gastrotricha* (free-living acoelomate aquatic worms) and *Tardigrada* (small segmented animals similar to arthropods) (IAM, 2006). The 15 other phyla represented, but not exclusively found, within meiofauna include the following: *Porifera*, *Placozoa*, *Cnidaria*, *Ctenophora*, *Platyhelminthes*, *Orthonectida*, *Rhombzoa*, *Cycliophora*, *Acanthocephala*, *Nemertea*, *Nematomorpha*, *Nematoda*, *Rotifera*, *Entoprocta*, *Priapulida*, *Pogonophora*, *Echiura*, *Sipuncula*, *Annelida*, *Arthropoda*, *Onychophora*, *Mollusca*, *Phoronida*, *Bryozoa*, *Brachiopoda*, *Echinodermata*, *Chaetognatha*, *Hemichordata* and *Chordata* (IAM, 2006).

Given the small size of these organisms, they are seldom a part of general environmental surveys performed for environmental assessments of proposed actions and are seldom part of resource management activities. However, they can number in the ten to hundreds of thousands per m² in soft sediments, have reproductive mechanisms that allow them to survive in mobile sand sediments often found in shallow marine environments, and in certain instances, experience large seasonal fluctuations in abundance. For purposes of impact analysis (see discussion in Section 5.3.2.5), previous characterizations of the meiofauna (e.g., Theroux and Wigley, 1998) in the region that includes the area of the proposed action were taken into consideration.

4.2.5.5.2 Plankton

Review of scientific literature suggests there is little existing information that describes plankton communities in Nantucket Sound. Plankton refers to plants (phytoplankton) and animals (zooplankton) that cannot maintain their distribution against movement of water masses and freely drift in the water column. These organisms are generally very small or microscopic, but organisms like jellyfish are sometime considered in the plankton community. Planktonic communities are generally variable in time and place, resulting in a patchy distribution. Zooplankton communities in Nantucket Sound are likely to contain copepods and euphausiids as well as other planktonic crustaceans such as amphipods and isopods. Many species of benthic invertebrates have planktonic egg and larval stages that are also considered within this community. Fish eggs and larvae from spawning of local fish populations would also be found in the Nantucket Sound plankton community, referred to as ichthyoplankton.

Red tide, a traditional but misleading name for a type of Harmful Algal Bloom (HAB), is a phenomenon that occurs when certain species of toxin-producing dinoflagellates become locally abundant. They are of concern because toxins tend to become concentrated in shellfish during HABs and may induce paralytic shellfish poisoning (PSP) in humans. In coastal New England, marine HABs are most often associated with *Alexandrium fundyense* (NOAA-CSCOR, 2006). However, the proposed Nantucket Sound site is unlikely to be the source of this type of HAB because *A. fundyense* cysts may not be retained well by relatively coarse sediments (WHOI, 2006). Dale (1976) reports that cysts from similar dinoflagellate species have settling velocities close to that of silt particles. Thus, they tend to be found in highest concentration in areas of weak currents and silt deposition. They are less likely to be found in shallow, sandy areas subject to strong tidal currents and wave action such as those found throughout the Nantucket Sound site.

4.2.6 Marine Mammals

4.2.6.1 Introduction

This section describes marine mammal species found in the area of the proposed action which are protected under the MMPA. Threatened or endangered marine mammals protected under the federal ESA are presented in Section 4.2.9 and [Appendix C](#). The information contained in this section was obtained from literature review, agency consultations, and site investigations.

All marine mammals are protected under the MMPA (16 U.S.C. §§ 1361 *et seq.*). One duty of the MMPA is to monitor populations of marine mammals with the goal of keeping populations at optimum levels. This responsibility falls to NOAA Fisheries and FWS. If studies show a population falls below its optimum level, the population is designated as “depleted”. In such case a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

The MMPA also established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States.² The MMPA allows the incidental “taking” of marine mammals provided the taking is of small numbers and would result in a negligible impact on marine mammals.³ These “incidental take” authorizations, require that regulations be promulgated and published in the FR outlining the methods and geographical region of taking, the means of limiting adverse impacts on the species or stock and its habitat, and requirements for monitoring and reporting of any proposed activity. Upon consultation with NOAA Fisheries, if it is determined that an IHA is warranted, the applicant would be required to have any necessary MMPA authorizations in place before any MMS-approved activities that may impact marine mammals may take place.

Studies Completed

Review of scientific literature, including stock assessment reports, and consultation with resource management agencies, suggest that few studies of protected whale species have been conducted within Nantucket Sound. A comprehensive literature search targeting protected whale, seal, and sea turtle species in Nantucket Sound and acoustical impacts to marine mammals and sea turtles was conducted to obtain information on protected marine species in Nantucket Sound and potential impacts of the proposed action to these resources. In addition, staff and researchers from the Protected Resources Branch at the NOAA Fisheries Northeast Fisheries Science Center, the Sea Turtle Stranding and Salvage Network, the Provincetown Center for Coastal Studies, and the University of Rhode Island, were contacted by the applicant to obtain additional stock assessment, sighting, stranding, and population studies information.

4.2.6.2 Resource Characterization

Marine mammals that are protected under the MMPA (but not the ESA) and may occur in the waters of Nantucket Sound are described in the following Section 4.2.6.2.1 and 4.2.6.2.2. Threatened or endangered marine mammals protected under the federal ESA are presented in Section 4.2.9 and [Appendix C](#).

² The term “high seas” is defined under the U.N. Convention on the Law of the Sea to mean “...all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State.”

³ Under the MMPA, section 101(a) (5) allows the incidental, but not intentional, “taking” by U.S. citizens engaged in activities other than commercial fishing of small numbers of marine mammals if, after notice and opportunity for public comment, NOAA Fisheries Service determines that appropriate regulations have been met. The Incidental Take Authorization Office of Protected Resources – NOAA Fisheries webpage <http://www.nmfs.noaa.gov/pr/permits/incidental.htm>

4.2.6.2.1 Pinnipeds

A detailed evaluation was performed for two pinniped species that are most likely to occur in the vicinity of the area of the proposed action: the gray seal (*Halichoerus grypus*) and the harbor seal (*Phoca vitulina*) (Report No. 4.2.6-1). The gray seal was previously listed as a species of special concern by the Commonwealth of Massachusetts. The Massachusetts ESA prohibits the “taking” of any rare plant or animal species listed as endangered, threatened, or of special concern by the Massachusetts Division of Fisheries & Wildlife (M.G.L c.131A and regulations 321 CMR 10.00). Both pinniped species are also protected under the MMPA. In addition, the harp seal (*Phoca groenlandica*) and hooded seal (*Cystophora cristata*) are discussed, as they may occur in the vicinity of the site of the proposed action and are protected under the MMPA.

The population status and trends, seasonal distribution, food and feeding behaviors, and known disturbance and mortality factors are described below, and impacts are discussed in Section 5.3.2.6. Detailed discussions of the potential impacts of Project construction/decommissioning and operation/maintenance to gray and harbor seals can be found in the Pinniped Assessment (Report No. 4.2.6-1).

Gray Seal

Gray seals inhabit temperate and sub-arctic waters, and, in the United States are found along the east coast from Maine to Long Island Sound, New York living on remote, exposed islands, shoals and unstable sandbars. They are relatively large, and may be gray, dark brown or even black in colorings with irregular spotting patterns. Gray seals can live as long as 30 to 40 years, with males reaching sexual maturity around six years and females at three years. While breeding, gray seals may live in loose colonies but generally are gregarious with no regular migratory seasons or patterns. Gray seals have an extensive fish diet, and forage at depths up to at least 230 ft (70 m) (Katona et al., 1993).

The Western population of the gray seal (*Halichoerus grypus*) extends from New England to Labrador and is centered in the Sable Island area of Nova Scotia (Waring et al., 2006). Gray seals have known breeding and pupping grounds in Nantucket Sound at Monomoy and Muskeget Islands from late December through mid-February (Waring et al., 2006). While there is no defined migratory behavior for gray seals, there is some adult seal movement north during spring and summer out of Nantucket Sound to the waters of Maine and Canada for pupping, (Waring et al., 2006).

The gray seal is protected under the MMPA but is not considered a strategic stock⁴ (Waring et al., 2006). Available data are insufficient to estimate the size of the entire western North Atlantic gray seal population, but estimates are available for the Sable Island, Maine coast and Muskeget and Monomoy Island populations (NMFS, 2001). The Muskeget and Monomoy population was estimated at 2,010 in the spring of 1994 (Rough, 1995) and rose to 5,611 by the spring of 1999 (Barlas, 1999). Gray seal counts from winter/spring in 2002 at Monomoy, Muskeget, and Tuckernuck Islands in Nantucket Sound (approximately 14.6, 8.5, and 10.5 miles [23.5, 13.7, and 16.9 km] respectively from the proposed action site) showed 1,599, 16, and 1,192 individuals respectively (Wood, unpublished data).

For the period 1999 to 2003, the total estimated human caused mortality and serious injury to gray seals was 274 per year, derived from three components: (1) 141 from 1999 to 2003 observed U.S.

⁴ Under the MMPA, the term “strategic stock” means a marine mammal stock - (A) for which the level of direct human-caused mortality exceeds the potential biological removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA of 1973 within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the ESA of 1973 (16 U.S.C. 1531 et seq.), or is designated as depleted under this Act.

fisheries; (2) 3 from average 1999-2003 stranding mortalities in U.S. waters; and (3) 3 from average 1999 to 2003 observed human caused mortalities by power plant entrainments, oil spills, shooting, boat strikes, and other sources (Waring et al., 2006).

Harbor Seal

Harbor seals (*Phoca vitulina*), or the common seal, are found in the northern Atlantic Ocean and are abundant on the east coast of the U.S. preferring coastal waters and coastal islands, ledges and sandbars (Waring et al., 2006). Harbor seals range in color from bluish gray with small dark spots to tan, brown, black or even reddish in color. Maturity is reached at five to six years for males and three to four years for females, and they have been known to live as long as from 30 to 40 years (Katona et al., 1993). Most of the harbor seal's diet consists of fish and invertebrates found within the Nantucket Sound area, but during late summer months they move offshore to deeper waters presumably for offshore fish migrations.

The harbor seal is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The latest population of harbor seals along the Maine Coast was estimated at 38,014 individuals in 2001 (Waring et al., 2006). Harbor seal counts from winter/spring 1999 to 2000 showed 778, 2,154, and 405 individuals on Muskeget, Monomoy and Tuckernuck Islands, respectively (Waring, unpublished data). Harbor seals pup in New Hampshire, Maine, and Canadian waters in the spring and summer. Many juvenile harbor seals overwinter in Nantucket Sound while adults may be found in Nantucket Sound year round. Tuckernuck and Muskeget Islands are important haul-out sites for harbor seals, and serve as important overwintering habitat.

It is estimated that 1,051 harbor seals are killed or seriously injured each year in relation to human activities, mainly due to fishery practices, boat strikes, power plant entrainment, shooting, and loss of habitat (Waring et al., 2006). The total estimated average fishery-related mortality or serious injury in the Northeast multispecies sink gillnet fishery for the period of 1999 to 2003 was 1,032 harbor seals (Waring et al., 2006). Harbor seal strandings occur in southern New England during the winter period, and have been attributed to vessel strikes, fishing gear entanglement, entrainment in power plant intakes, oils spills, storms, abandonment, and disease (Waring et al., 2006).

Harp Seal

Harp seals (*Phoca groenlandica*) occur throughout much of the north Atlantic and Arctic Oceans. Adult harp seals have a gray coat, and females are typically larger than males. Males may reach maturity between 4 and 5 years, while a female reaches sexual maturity at 6 to 7 years old. They can live to be 30 to 35 years old, feeding off of fish and crustaceans. They tend to be gregarious, living in dense groups during breeding season.

The harp seal has been sighted in winter and spring months at the extreme southernmost reaches of its range from mid-Atlantic waters through New England (Waring et al., 2006). The largest of three stocks of harp seals is the eastern Canadian stock, with breeding herds off the coasts of Newfoundland and Labrador, and in the Gulf of St. Lawrence. The other two stocks occur off the coasts of the former Soviet Union and Greenland.

The harp seal is protected under the MMPA but is not considered a strategic stock (Waring et al., 2006). Abundance of harp seals in Canadian waters is estimated at 5.2 million; however existing data are insufficient to estimate harp seal abundance in U.S. waters (Waring et al., 2006).

The estimated average mortality rate for harp seals by the Northeast sink gillnet fisheries is 26 individuals per year from 1999 through 2003, with the observed number decreasing from 81 in 1999 to 26 and zero in 2001 and 2002 through 2003, respectively (Waring et al., 2006). Annual harp seal strandings

decreased from 67 and 31 in 2002 for Massachusetts and Rhode Island respectively, to 10 and 6 in 2003 (Waring et al., 2006).

Hooded Seal

The hooded seal (*Cystophora cristata*) occurs throughout much of the north Atlantic and Arctic Oceans, in deeper water than other seals are typically found. Hooded seals have a black face and a bluish-grey coat, lighter on the sides and front, with irregular dark patches scattered over the body and the males have a distinguishable inflatable crest on their forehead. Males reach maturity at five to seven years and females reach maturity at three to six years, with life expectancies of 30 to 35 years of age. Hooded seals feed in deeper waters, and their diet consists of fish and larger invertebrates. Hooded seals are highly migratory, and have been occasionally sighted as far south as Puerto Rico. In recent years, they have been sighted with increasing frequency in waters from Maine to Florida, in the winter and spring months, especially from January to May (Waring et al., 2006).

The hooded seal is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The abundance of hooded seals in the Gulf of St. Lawrence in 1999 was estimated at 2,000; however there is no current data to estimate hooded seal numbers in U.S. waters (Waring et al., 2006).

The total annual estimated fishery-related mortality or serious injury to this stock in U.S. waters for the period of 1999 to 2003 is 16 hooded seals (Waring et al., 2006). Incidental bycatch of hooded seals has been observed in the Northeast multispecies sink gillnet fishery (Waring et al., 2001). Commercial harvest of hooded seals is not allowed in the Gulf of St. Lawrence (below 50°N) and in the Davis Strait (Waring et al., 2006). During 2002, 10 hooded seals were found stranded in Massachusetts while 4 were found in 2003 (Waring et al., 2006).

4.2.6.2.2 Cetaceans

The population status and trends, seasonal distribution, food and feeding behaviors, and known disturbance and mortality factors for those cetacean species that can be found in the vicinity of the area of the proposed action are summarized below.

Atlantic White-sided Dolphin

The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) occurs in temperate and polar waters in the North Atlantic, typically around the continental shelf. These animals have black coloring on their dorsal side, with a yellow stripe on their lower dorsal area. Females reach sexual maturity at between 6 and 12 years, and males between 7 and 11 years. Individuals are known to live for up to 22 years (males) and 27 years (females). Their main diet consists of fish such as herring and mackerel and squid (Minasian and Balcomb, 1984; Leatherwood et al., 1982; Ellis, 1982).

In the western North Atlantic, white-sided dolphins are believed to form three stocks, the Gulf of Maine stock, the Gulf of St. Lawrence stock, and the Labrador Sea stock. The Gulf of Maine stock ranges from Hudson Canyon to Georges Bank and in the Gulf of Maine to the Bay of Fundy (Waring et al., 2006). White-sided dolphins of the Gulf of Maine Stock may occur in Nantucket Sound throughout the year but in higher numbers from June until September.

The white-sided dolphin is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The best available estimate for the abundance of the Gulf of Maine stock of white-sided dolphins is 51,640, collected through line transects in 1999, with a minimum population estimate of 37,904 individuals (Waring et al., 2006).

The estimated white-sided dolphin mortality rate for the period of 1999 to 2004 is 38 dolphins per year in the Gulf of Maine, founded mainly on boat collisions, pollution and natural conditions (Waring et al., 2006). Incidental bycatch has been observed in the Northeast sink gillnet fishery, the mid-Atlantic coastal gillnet fishery, the pelagic drift gillnet fishery, the North Atlantic bottom trawl fishery, and the Atlantic squid, mackerel, and butterfish trawl fisheries (Waring et al., 2006). During the period of 1999 to 2003, 217 white-sided dolphins were reported stranded in Massachusetts, while 2 were reported in Rhode Island (Waring et al., 2006).

Striped Dolphin

The striped dolphin (*Stenella coeruleoalba*) is distributed worldwide in temperate, tropical, and subtropical seas. They are distinguishable with their pink underside, and bands that run down their dorsal side. Adults may grow to 8 ft (2.4 m) (females) or 8.5 ft (2.6 m) (males) and weigh 330 lbs (150 kg) (female) or 350 lbs (160 kg) (male). Striped dolphins reach maturity between 7 and 12 years, and may live to between 55 and 60 years. Their main diet is small pelagic fish and squid.

In the western North Atlantic, striped dolphins occur from Nova Scotia south into the Caribbean and the Gulf of Mexico, frequently in continental shelf waters (Waring et al., 2006). The striped dolphin is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The best available estimate for the abundance of the western Atlantic striped dolphin is 94,462, with a population estimate of 52,055 dolphins for the waters of northeast U.S. (Waring et al., 2006).

From 1999 to 2003 there were no reported fisheries-related mortalities of striped dolphins (Waring, et al., 2006). Incidental bycatch has been observed in the pelagic drift gillnet fishery and the North Atlantic bottom trawl fishery (Waring et al., 2006). From 1999 to 2003, 43 striped dolphins were found stranded in U.S. waters from Maine to Florida for unknown reasons.

Common Dolphin

The common dolphin (*Delphinus delphis*) is distributed worldwide in temperate, tropical, and subtropical seas. Their back is dark gray-to-black from the top of the head to the tail. Common dolphins can reach lengths from 7.5 to 8.5 ft (2.3 to 2.6 m) and weigh as much as 297 lbs (135 kg). They travel in small groups and frequently gather into large schools. Sexual maturity is reached at 3 to 4 years of age or when they reach 6 to 7 ft in length (1.8 to 2.1 m). The common dolphin feeds on squid and small schooling fish (Evans, 1994; Heyning and Perrin, 1994; Klinowska, 1991).

In waters off the northeastern United States., common dolphins are associated with Gulf Stream features and are widespread from Cape Hatteras to Georges Bank (Waring et al., 2006). The common dolphin migrates onto Georges Bank, the Scotian Shelf, and the continental shelf off Newfoundland in summer and autumn months.

The common dolphin is protected under the MMPA but is not considered a strategic stock (Waring et al., 2006). The best estimate for the abundance of the common dolphin off the U.S. and Canadian Atlantic coasts is 120,743 with a population estimate of 90,546 in the northern U.S. Atlantic waters (Waring et al., 2006).

The total annual fisheries-related mortality estimate for the period of 1990 to 2003 was 119 common dolphins (Waring et al., 2006). Incidental bycatch was observed in the pelagic drift gillnet fishery, the pelagic pair trawl, the pelagic longline fishery, the mid-Atlantic coastal gillnet fishery, the North Atlantic bottom trawl fishery, the Northeast multi-species sink gillnet fishery, and the Atlantic squid, mackerel, and butterfish trawl fisheries (Waring et al., 2006). During the period of 1999 to 2003, 84

common dolphin strandings were reported in United States waters within Massachusetts and 13 dolphins in Rhode Island waters (Waring et al., 2006).

Harbor Porpoise

The harbor porpoise (*Phocoena phocoena*) is primarily an inshore species. They are small rotund cetaceans, with grey coloring. They reach a maximum length of 6 ft (1.9 m) and do not weigh more than 130 lbs (60 kg). Harbor porpoises reach sexual maturity around three to four years. They can live alone, in pairs, or in larger groups. Their main diet is small spine-less fish (Minasian and Balcomb, 1984; Ellis, 1984; Leatherwood et al., 1982).

During the summer, harbor porpoises are concentrated in the northern Gulf of Maine and the southern Bay of Fundy region. This stock of harbor porpoises, which migrates south into the mid-Atlantic region, is considered one population, separate from three other distinct populations in the Gulf of St. Lawrence, Newfoundland, and Greenland areas (Waring et al., 2006). During fall and spring months, harbor porpoises are widely distributed from New Jersey to Maine. Low densities of harbor porpoises are found in waters off New York and north to Canada in the winter. No specific migratory routes to the Gulf of Maine/Bay of Fundy region have been identified.

The harbor porpoise is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The best estimate for the abundance of the Gulf of Maine/Bay of Fundy population is 89,700 harbor porpoises, with a minimum population estimate of 74,695 (Waring et al., 2006).

The average annual mortality for the period of 1999 to 2003 was estimated at 417, attributable to U.S. fisheries (Waring et al., 2006). Mortality has occurred in the U.S. Northeast sink gillnet fishery, the mid-Atlantic coastal gillnet fishery, and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries. Other human-induced mortality may occur from hunting in some areas of the western North Atlantic. During the period of 1999 to 2003, 569 harbor porpoise strandings were reported from Maine to North Carolina, 184 of which occurred in Massachusetts, and 7 in Rhode Island (Waring et al., 2006).

Long-finned Pilot Whale

The long-finned pilot whale (*Globicephala melas*) occurs along the edge of the U.S. continental shelf in the winter and early spring. A second species of pilot whale, the short-finned pilot whale (*Globicephala macrorhynchus*), also occurs in the western North Atlantic. Difficulty distinguishing the two species in the field prevents separate abundance and mortality estimates. They are generally dark colored, with a distinguishable rounded head. The males are larger than the females reaching 20 ft (6.1 m) while females typically measure 16 ft (4.9 m). Males may reach sexual maturity at about 12 years of age and females reach sexual maturity at about 6 to 7 years of age. Pilot whales typically feed on squid, but have been known to feed on fish (Bernard and Reilly, 1999; Olson and Reilly, 2002).

The long-finned pilot whale primarily occurs north of mid-Atlantic waters. Distribution of this species is widespread, ranging from North Carolina to Africa and north to Iceland, Greenland, and the Barents Sea (Waring et al., 2006). Further stock definition is under development.

The long-finned pilot whale is protected under the MMPA, but is not currently considered a strategic stock (Waring et al., 2006). The best available estimate for the abundance of both pilot whale species in U.S. waters is 31,139 individuals, with an estimate of 15,728 in the northern U.S. Atlantic (Waring et al., 2006).

The total annual fisheries-related mortality estimate for the period of 1999 to 2003, including both species, is 126 pilot whales (Waring et al., 2006). Incidental bycatch has been observed in the pelagic

drift gillnet fishery, the pelagic longline fishery, the pelagic pair trawl fishery, the North Atlantic bottom trawl fishery, the squid, mackerel, and butterfish trawl fisheries, and the Nova Scotia trawl fisheries. Mass strandings are common in pilot whales; during the period of 1999 to 2003, 126 long-finned pilot whales were stranded between Maine and Florida, including two mass strandings in Massachusetts waters of 11 and 57 animals in 2000 and 2002 respectively (Waring et al., 2006). Causes for the strandings have been related to pollution, and toxic exposure through bioaccumulation of polycarbonate biphenyls (PCBs) and pesticides (Waring et al., 2006).

Minke Whale

Minke whales (*Balaenoptera acutorostrata*) occur throughout polar, temperate, and tropical waters. The minke is counter-shaded-black to dark gray on top, white below. They are a small species, males averaging 26 ft (8 m) and females measuring 27 ft (8.2 m). Sexual maturity is reached at 7 or 8 years. Minke whales feed on small schooling fish and some copepods (Minasian and Balcomb, 1984; Ellis, 1982; Leatherwood and Reeves, 1983).

The minke whale is the third most abundant great whale in the U.S. Atlantic Exclusive Economic Zone (EEZ) (CeTAP, 1982). Minke whales off the east coast of the U.S. are part of the Canadian east coast population, one of four minke populations recognized in the North Atlantic. The range of this population extends south from Canada to the Gulf of Mexico, but distribution is primarily concentrated in New England waters, with most sightings occurring during spring and summer months.

The minke whale is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2006). The best available current abundance estimate for minke whales from Georges Bank to the Gulf of St. Lawrence is 2,998 individuals, from surveys conducted in July through August of 1999 (Waring et al., 2006). This species is found in open seas primarily over continental shelf waters, but occasionally enters bays, inlets, and estuaries.

Minke whale incidental catches have been observed in U.S. waters in the mid-Atlantic coastal gillnet fishery, the Gulf of Maine and mid-Atlantic lobster trap/pot fishery, and the Atlantic tuna purse seine fishery. Not all incidental catches have resulted in mortality. The annual mortality estimate from these fisheries for the period of 1999 to 2003 is 3.2 minke whales per year, all from U.S. fishery-related incidents (Waring et al., 2006). Other human-induced mortality occurs from hunting in some areas of the North Atlantic, and from collisions with vessels, although during the period of 1999 to 2003 no collisions were reported (Waring et al., 2006). During October 2003 an 'Unusual Mortality Event' was declared, when an abnormal increase in minke whale mortalities was reported; from September 11 to September 30, nine minke whales were found stranded with no known causes (Waring et al., 2006). Since then the number of minke whale mortalities has returned to previous levels.

Atlantic Spotted Dolphin

Atlantic spotted dolphins (*Stenella frontalis*) are distributed in tropical and warm temperate waters of the western North Atlantic. There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin and the pantropical spotted dolphin (*S. attenuata*) (Waring et al., 2006). They are covered in spots, are typically dark colored with a darker dorsal than ventral side. They average 7 ft (2.1 m) in length, and reach maturity at 6 to 8 years. They are highly social and can be found in large herds numbering in the hundreds or sometimes thousands. Spotted dolphins feed on a variety of fish and squid found near the surface (Minasian and Balcomb, 1984; Leatherwood and Reeves, 1983).

The Atlantic spotted dolphin occurs in two forms, possibly two sub-species; the large, heavily spotted form inhabits the continental shelf and is usually found inside or near the 656 ft (200 m) isobath, and the smaller, less spotted island and offshore form (Waring et al., 2006). The Atlantic spotted dolphin is found

from Southern New England to Venezuela, and is widely distributed on the continental shelf, along the continental shelf edge, and offshore over the deep ocean off the northeast U.S. coast (Waring et al., 2006).

The Atlantic spotted dolphin is protected under the MMPA but is not considered a strategic stock (Waring et al., 2006). The best available estimated population size for the Atlantic spotted dolphins from Maryland to the Bay of Fundy, including both forms, is 3,578 individuals (Waring et al., 2006). Given their distribution range, it is possible that Atlantic spotted dolphins may occur in Nantucket Sound.

There were no reports of fishery-related mortality or serious injury to the Atlantic spotted dolphin during 1999 and 2003 (Waring et al., 2006). Incidental bycatch has recently been observed in the pelagic drift gillnet fishery, the pelagic longline fishery, the pelagic pair trawl fishery, the North Atlantic bottom trawl fishery, the squid, mackerel, and butterfish trawl fisheries, and the Nova Scotia trawl fisheries. During the same period, 17 Atlantic spotted dolphins were stranded between Massachusetts and Florida (Waring et al., 2006).

Risso's Dolphin

Risso's dolphin (*Grampus griseus*) has a worldwide distribution in tropical to warm temperate waters. They are robust with a rounded head, and typically have a light gray coloring. They typically grow to 10 ft (3 m) in length, and males tend to be a little smaller than females. Little is known regarding their life history traits, but maturity is assumed when the animal reaches 8.5 to 9.2 ft (2.6 to 2.8 m) in length. They tend to travel in groups, which may consist of related animals. Their main diet is squid, but they may feed on a variety of fish species (Ellis, 1982; Klinowska, 1991).

Risso's dolphin generally has an oceanic range, and occurs along the Atlantic coast of North America from Florida to eastern Newfoundland. Risso's dolphins are distributed along the continental shelf edge of the U.S. east shore from Cape Hatteras northward to Georges Bank during the spring, summer and autumn (Waring et al., 2006). In winter, their range begins at the Mid-Atlantic bight and extends further into oceanic waters.

Risso's dolphins is protected under the MMPA, but are not considered as strategic stocks (Waring et al., 2006). The best available estimate of Risso's dolphins, from Maryland to the Bay of Fundy, is 15,053 individuals (Waring et al., 2006). Given their distribution range, it is possible that Risso's dolphins may occur in Nantucket Sound.

During the period of 1999 through 2003 the total annual estimated average fishery-related mortality or serious injury was 51 Risso's dolphins (Waring et al., 2006). Incidental bycatch has been observed in the pelagic drift gillnet fishery, and the pelagic longline fishery both in and out of the Northeast Distant water (Waring et al., 2006). From 1999 to 2003, 20 Risso's dolphin strandings were reported, 6 of which were reported in Massachusetts (Waring et al., 2006).

Kogia species

The dwarf sperm whale (*Kogia sima*) and the pygmy sperm whale (*K. breviceps*) are distributed worldwide in temperate to tropical waters. They are very difficult to distinguish at sea, and are often categorized as *Kogia sp.*, as in this report. Sightings of *Kogia sp.* occur in all oceanic waters, including the North Atlantic (Waring et al., 2006). They are stocky animals, reaching average lengths of 10 ft (3 m) and typically have grayish coloring. Males mature at 9 to 10 ft (2.7 to 3 m) while females mature at 8 to 9 ft (2.6 to 2.7 m). They typically form small groups, and are slow swimmers. Their diet consists of mainly squid and octopus, but may also include crab, fish, and shrimp (Katona 1993; Leatherwood and Reeves, 1983).

Both of the *Kogia sp.* are protected under the MMPA. The dwarf sperm whale is not considered a strategic stock, while the pygmy sperm whale is considered a strategic stock in the Western North Atlantic (Waring et al., 2006). The best estimate for *Kogia sp.* from Maryland to the Bay of Fundy is 358 individuals, with a minimum population estimate of 285 (Waring et al., 2006).

During 1999 and 2003 the total annual estimated average fishery-related mortality and serious injury to the dwarf sperm whale and pygmy sperm whale was zero and six, respectively (Waring et al., 2006). Incidental bycatch has been observed in the pelagic longline fishery. From 1999 to 2003 there were no reported strandings of the dwarf sperm whale, while there were 125 strandings reported of pygmy sperm whales from Maine to Puerto Rico, only 1 of which occurred in waters north of North Carolina (Waring et al., 2006).

4.2.7 Fish and Fisheries

In the Nantucket Sound area, managing and/or monitoring of fishery resources is conducted by both Federal and state agencies. The NOAA Fisheries manages recreational and commercial fishing activities in coastal states in the U.S. The New England Fisheries Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC), established by the Magnuson-Stevens Act, manage various fishery resources within the Federal 200 miles (321.9 km) limit in the Nantucket Sound area. The Commonwealth of Massachusetts monitors fishery resources in its coastal waters mainly through the MassDMF.

The following section describes existing fisheries resources that occur within the area of the proposed action. Information included was obtained from agency monitoring programs, consultations, literature review, and site investigations. While shellfish are considered under fisheries because of their linkage with commercial and recreational harvesting of seafood, their life histories, habitat occurrence, and potential impacts are closely aligned with benthic species habitats and are also discussed in Section 4.2.5.

4.2.7.1 Demersal and Pelagic Fish

This section presents a description of species of fishery resources including expected seasonal occurrence in Nantucket Sound and the area of the proposed action. Review of the scientific literature indicates that few studies related to fishery resources have been performed specifically in the proposed action locale in Nantucket Sound and Lewis Bay. Data available from studies conducted by NOAA Fisheries, the MassDMF and others were reviewed and evaluated regarding applicability to the proposed action.

The NOAA Fisheries collects data that are “fishery independent” with a bi-annual bottom research trawl survey program; however, the surveys occur offshore of Nantucket Sound and are therefore not useful in characterizing the fishery resources for the area of the proposed action. In addition, NOAA Fisheries collects information on commercial fishing landings, as defined by discrete statistical reporting zones. The NOAA Fisheries also describes EFH for marine species in the United States as part of their responsibility to manage fish and fish resources of coastal waters. In the Northeast region, NOAA Fisheries works with the and also the MAFMC in defining essential habitat for key species that occur in the coastal New England waters that include Nantucket Sound. Detailed source documents were used to describe life history stages for each species and habitat that is necessary for survival of each life history stage. The source documents also provide information on ecology, basic biology, and species behavior such as spawning, migratory behavior and food preference. This information was used with literature and field data collected by the applicant in preparing an EFH Assessment that is found in [Appendix D](#) of this document.

The MDMF is involved in studying basic biology and ecology of anadromous fish species, tautog, northern shrimp, lobster and recreational fish species including big game species, sharks, bluefin tuna and striped bass in state waters. The MDMF performs bi-annual research trawl surveys for collection of fishery-independent information related to distribution and abundance of fish and invertebrates in Massachusetts' waters (including both state and Federal waters in Nantucket Sound). These trawl surveys have been on-going in May (spring) and September (fall) each year since 1978. Data collected from trawl locations within the proposed WTG array boundaries on Horseshoe Shoal in Nantucket Sound were reviewed ([Report No. 4.2.5-5](#)).

The MDMF research trawl survey dataset was used for providing an understanding of the fishery resource in the area of the proposed action. These data do have limitations since the research trawl program was not designed for statistical testing for similarities/differences in fish abundance and/or distribution between specific sites. Survey timing does not permit the surveys to adequately represent fish distribution and abundance over an entire year. Survey timing coincides with the seasons when juveniles or adults are present in inshore areas. The survey's gear type (otter trawl) and methods are more effective for collecting semi-pelagic and demersal fish species, and thus, analyses evaluating species occurrence may not represent accurate distribution and abundance for pelagic species.

Trawl data from 1978 to 2004 was obtained from MDMF for all of Nantucket Sound. Data fields included species, pounds, catch number and location. Size composition data was not requested. Analyses of catch per unit effort from 1990 through 2002 had been calculated for the site of the proposed action at Horseshoe Shoal ([Report No. 4.2.7-1](#)).

This analysis provides information for a general assessment of species likely to occur in Nantucket Sound and on Horseshoe Shoal in the months of May and September based on the data that were collected over a period of 27 years. Juvenile and adult lifestages are collected using this method.

Between 1978 and 2004, 122 species were noted in the bi-annual resource trawl data set for Nantucket Sound. Over the 27-year period surveys conducted in the spring collected 74 species and surveys conducted in the fall collected 105 species. Fall catch numbers were higher than spring catch numbers (see [Tables 4.2.7-1](#) and [4.2.7-2](#)). Fall catch weight was lower than spring catch weight which may be due to large presence of juveniles expected to be passing through Nantucket Sound during the fall (see [Tables 4.2.7-3](#) and [4.2.7-4](#)).

The top 10 species from the MDMF trawls in the fall over the 27-year period were described. The top 10 species by weight over this timeframe, approximately 74,055 lbs (33,591 kg), represents approximately 88 percent of total catch weight. The top 10 species by number over this timeframe, 2,168,572 individuals, represents 98.6 percent of total numbers of individuals collected. During the fall there were six species that were included in the top 10 species for both catch weight and number. These species were scup, northern searobin, lady crab, longfin squid, butterfish, and little skate. The knobbed whelk, winter skate, summer flounder and smooth dogfish ranked in the top 10 species for weight but not number. The spider crab, striped anchovy, bay anchovy and black sea bass ranked in the top 10 species for catch number but not weight (see [Figure 4.2.5-3](#) and [4.2.5-4](#)).

The top 10 species from the MDMF trawls in the spring over the 27-year period were described. The top 10 species by weight over this timeframe, approximately 130,291 lbs (59,099 kg), represents approximately 92 percent of total catch weight. The top 10 species by number over this timeframe, 317,090 individuals, represents 91 percent of total numbers of individuals collected. The winter skate, tautog, and smooth dogfish ranked in the top 10 species for weight but not number. The butterfish, Atlantic herring and Atlantic rock crab ranked in the top 10 species for catch number but not weight (see [Figure 4.2.5-5](#) and [4.2.5-6](#)).

Results showed that six species within the top 10 species by weight were collected for both the fall and spring surveys. These species were scup, winter skate, little skate, longfin squid, northern searobin and smooth dogfish. Knobbed whelk, summer flounder, lady crab, and butterfish were in the top 10 species by weight for fall only. Tautog, spider crab, winter flounder and windowpane were in the top 10 species by weight for spring only. Results showed that six species within the top 10 species by catch numbers were collected for both the fall and spring surveys. These species were scup, butterfish, little skate, longfin squid, northern searobin and spider crab. Striped anchovy, bay anchovy, black sea bass and lady crab were in the top 10 species by number for fall only. Winter flounder, windowpane, Atlantic herring and Atlantic rock crab were in the top 10 species by number for spring only.

Nantucket Sound supports a diverse fish community. Off the east coast of Cape Cod during summer months there is a temperature gradient that forms. This temperature gradient sets a boundary so that cold-water fish occur to the north and warmer water fish occur to the south (Freeman and Walford, 1974). This temperature gradient fluctuates north and south over an area of 20 to 40 miles (32 to 64 km) of the Cape Cod shoreline. Due to the presence of the temperature gradient along Cape Cod and geographic location, Nantucket Sound serves as a migratory pathway for some warm-water species as they move into Cape Cod Bay and Massachusetts Bay. The Nantucket Sound area is also a northern border for some summer migrant species including black sea bass, northern fluke and scup.

Some fish species that have been observed in Nantucket Sound exhibit migratory behavior and are known to move in and out of areas when there are changes in water temperature. In winter and early spring, some fish species are known to concentrate on shoal areas in Nantucket Sound for spawning and/or feeding and some move from the shoal areas to deeper water or channel areas. The winter flounder is a species that is known to move from shoal areas to deeper water and channel areas in summer months when shallower water in the shoal areas has warmer water temperatures. In fall when the water temperatures start to cool, winter flounder are known to move back to shoal areas. Thus, in spring when water temperatures are cool winter flounder are likely to be more common than in September when water temperatures remain warmer.

4.2.7.2 Commercial and Recreational Fish and Shellfish

Review of the scientific literature indicates that few studies related to commercial fishery resources have been performed specifically in the proposed action locale in Nantucket Sound. Data on commercial fishing are, however, available from monitoring conducted by NOAA Fisheries and MDMF. Information from these monitoring programs is useful for characterizing commercial fishery resources in the Nantucket Sound locale. This section presents an evaluation of commercial fisheries and recreational fisheries data for Nantucket Sound from available databases from NOAA Fisheries and MDMF.

In addition to the resource management agency data, a survey of commercial and recreational fishing activities was performed to obtain additional information about fishing activities in Nantucket Sound. This information was collected in order to identify when, where, and for what species fishermen fish in Nantucket Sound.

Lastly, [Report No. 4.2.7-2](#) provides life history descriptions for the following additional groups of species that were not addressed in the EFH Assessment (see Section 4.2.8) that may occur in Nantucket Sound: Atlantic States Marine Fisheries Commission (ASMFC) managed species (22 species), other commercially or recreationally important species, and forage species. The other commercially or recreationally important species were derived from reviews of MDMF Nantucket Sound commercial catch data, NOAA commercial VTR data covering Nantucket Sound, NOAA charter and party VTR data covering Nantucket Sound, and results from recreational intercept surveys and interviews ([Report No.](#)

4.2.7-2). Summary information of the prey species of fish described as EFH species, ASMFC managed species, additional commercial and recreational fish species is detailed along with life history descriptions for these species ([Report No. 4.2.7-2](#)).

4.2.7.2.1 Commercial Fisheries

Nantucket Sound supports a commercial fishery for diverse species of fish and invertebrates such as squid, lobster and conch. The Federal and State agencies monitor certain commercial fishing activities in Nantucket Sound. The NOAA Fisheries monitors federally-permitted commercial fishing activities in all U.S. coastal states. The Commonwealth of Massachusetts monitors state-permitted commercial fishing activity for certain fisheries and gear types in its coastal waters. The NOAA Fisheries also collects price information for fisheries that are federally-permitted on a county-wide basis through a dealer database. Information from these programs has been used for characterization of commercial fisheries in the Nantucket Sound locale.

Federal (NOAA Fisheries) and MDMF agencies that are responsible for collecting commercial fishing data in Massachusetts collect independent and overlapping data. Mechanisms for collecting the data vary. The NOAA Fisheries uses trip-based reports where species and gear types are surveyed, but only for Federal permit holders. The MDMF uses an annual report system and gear-based reports. Although MDMF issues permits to all commercial fishermen and seafood dealers in Massachusetts, the catch and effort data are collected only for certain fisheries (striped bass, lobster, fish wier, gillnet, fish-pot (conch, scup and sea bass) and shellfish. The data should be evaluated and considered separately and can be used for a sense of types of commercial fishing activity taking place in Nantucket Sound and proportion of different fisheries landings.

NMFS Commercial Fisheries Data

Commercial fisheries data have been collected over a long period of time by NOAA Fisheries. In order to summarize commercial landings in the United States, NOAA Fisheries has divided the U.S. coastline into statistical sampling areas. Waters that are around Cape Cod and the Islands have been designated as NOAA Fisheries Statistical Area 538 and Nantucket Sound is designated as Sub-area 075. Landings are recorded by the statistical area and/or sub area. Prior to 1994, in the northeast, landings information was collected by a system of voluntary reporting. The NOAA Fisheries port agents collected fish landing and price information where the initial sale of the catch took place through dealer reports or “weigh out receipts.” A mandatory reporting system replaced the voluntary “weigh out” reporting method in June 1994. The mandatory reporting system is currently in practice and includes fishermen submitting logbooks of VTR detailing their catch. From 1994 through 2004, approximately 9.6 million lbs (4,354,487 kg) of commercial landings that are subject to federal VTR reporting were harvested from Area 075, Nantucket Sound (see [Figure 4.2.7-1](#)). The commercial landings data include fish species and invertebrates such as squid, lobster, shrimp, and crabs. Total federally-reported landings appear to have increased from 1994 through 2000. Between 2001 and 2004 landings have fluctuated. Note that this trend may be the result of fishermen adjusting to details of mandatory reporting requirements that were initiated for the VTR in 1994. [Report No. 4.2.5.5](#) presents the detailed analyses of commercial fisheries data presented in this section.

The top twenty species of fish and invertebrates that were landed in Nantucket Sound (Area 075) by commercial fishermen, as reported from NOAA Fisheries VTRs from 1994 to 2004, include *Loligo* squid, Atlantic mackerel, channeled whelk, summer flounder, black sea bass, scup, unidentified squid species, unidentified whelk species, unidentified clam species, menhaden, knobbed whelk, *Ilex* squid, winter flounder, sea scallop, butterfish, ocean quahog, king whiting, tautog, hard clam, and bluefish (see [Figure 4.2.7-2](#)). Between 1994 and 2004, a total of approximately 3.6 million lbs (1,632,932 kg) of squid were

harvested from Nantucket Sound (Area 075). The squid landings accounted for approximately 49 percent of federally-reportable fish and squid landings during the eleven year period.

Types of gear that commercial fishermen use in Nantucket Sound for harvesting these commercial species include otter trawls, dredges, fish weirs, seines, a variety of traps/pots, and hand lines. Federal VTR data report that greatest landings during the time period of 1994 to 2004 were from otter trawls for bottom fish. These landings were approximately 4.9 million lbs (2,222,603 kg) or approximately 52 percent of total federally-reportable commercial landings (see [Table 4.2.7-5](#)). Fish weirs, fish pot/traps, and hand lines also produced significant catches. The gill net fishery, fish weir fishery, and fish pot fishery for scup and sea bass are monitored independently by MDMF.

MDMF Commercial Fisheries Data

The MDMF studies and monitors marine resources that fall under its jurisdiction. This includes monitoring of commercial harvest of marine fish, lobster, and other shellfish. There are several programs involved in managing marine resources and harvesting these resources. The Fisheries Dependent Investigation Project involves monitoring catch and by-catch composition of some of the state's fisheries. The Management Information Systems and Fisheries Statistics Project maintains a commercial database for shellfish, lobster and other fisheries that are "regulated." For monitoring fishery resources in Massachusetts' waters, coastal water areas are divided into statistical areas. Nantucket Sound is assigned a designation as Area 10, which is equivalent to NMFS Sub-area 075. Catch reports are required to be submitted by commercial fishermen for fisheries that include striped bass, the fish weir fishery, the gill net fishery, shellfish, lobster, and the fish pot fishery (sea bass, scup and conch). [Report No. 4.2.5-5](#) presents detailed information regarding these data.

Annual landings from fish weirs from 1990 through 2004 are shown on [Figure 4.2.7-3](#). Annual landings from the gill net fishery from 1992 through 2002 are shown on [Figure 4.2.7-4](#). Annual landings from the fish pot fishery for sea bass, 1990 through 2004, and for scup (1994 through 2004) are shown on [Figure 4.2.7-5](#).

Total landings in Nantucket Sound from the fish weir fishery from 1990 to 2004 are estimated to be 13.7 million lbs (6,214,215 kg). The highest landings from fish weirs were reported in 1990 (1.4 million lbs (635,029 kg) with the lowest reported in 2003 (184 thousand lbs [83,461 kg]). Species commonly reported from fish weirs include Atlantic mackerel, squid and scup. Numbers of fishermen that report use of fish weirs on state catch reports ranged from 3 to 5 from 1992 through 2004. The fifteen-year total state-reported landings for these species in Area 10 are as follows: Atlantic mackerel (5.8 million lbs [2,630,836 kg]; mean = 385,688 lbs/yr [174,945 kg/yr]), squid (4.7 million lbs [2,131,884 kg]; mean = 315,121 lbs/yr [142,936 kg/yr]), and scup (1.6 million lbs [725,748 kg]; mean = 105,571 lbs/yr [47,886 kg/yr]). Over the 15-year period (see [Figure 4.2.7-6](#), squid showed a downward trend in total landings from fish weirs. Atlantic mackerel landings fluctuated over the years peaking to an annual high of 876,160 lbs (397,419 kg) in 1997 and then declining between 7 to 530 thousand lbs (3.2 to 240 thousand kg) from 1998 through 2004. Scup landings peaked in 1992 (334 thousand lbs [151,500 kg]), declined to low landings in 1996 through 1998, and had a slight upward trend from 1999 through 2004.

The state-permitted gill net fishery does not make up a large component of state-reported landings in Nantucket Sound. For the time period of 1990 to 2004 gill net landings were reported during five years including 1992, 1993, 1995, 1999 and 2002. One commercial gill net license was issued for the area in 1992, 1995, and 1999. Three fishermen reported using gillnets in the area in 1993. There were no fishermen reporting use of gill nets in the remaining years. Given the low gill net fishing effort, the total landings from the gill net fishery in Nantucket Sound from these five years totaled approximately 195,000 lbs (88,451 kg) (see [Figure 4.2.7-4](#)). In 1992, only Atlantic mackerel were collected in the gill nets. The

diversity of species increased slightly in the other years and species collected include cod, haddock, hake, summer flounder, winter flounder, witch flounder, yellowtail flounder, monkfish, pollock, tautog, cusk, various skates, and dogfish. In 2002, diversity decreased to three species. Monkfish, dogfish, and Atlantic mackerel were the most common species to be reported collected from fish gill nets. On an annual basis, total landings from gill nets were greatest in 1995 (165,000 lbs [74,843 kg]) due to the large landings of dogfish (approximately 158,000 lbs [71,668 kg]).

Both scup and sea bass are important fisheries in Nantucket Sound. Many commercial fishermen have licenses for the harvesting of these species using fish pots. Numbers of fishermen using fish pots for sea bass in Nantucket Sound varied over the years with a high of 38 in 1991 and a low of 18 in 1998. Total sea bass landings using fish pots from 1990 through 2004 were approximately 2.8 million lbs (1,270,059 kg). From 1990 through 1992, sea bass landings dropped substantially (from 336,000 lbs to 36,000 lbs [152,407 kg to 16,329 kg]). From 1992 through 1998, however, total landings have steadily increased to a high of 419,000 lbs (190,055 kg) in 1999 (see [Figure 4.2.7-5](#)). Between 2000 and 2004 landings have fluctuated. Seasonally, sea bass landings are highest in May and June and average more than 72,000 lbs (32,659 kg) per year in May and more than 49,000 lbs (22,226 kg) per year in June over the 15-year period (see [Figure 4.2.7-7](#)).

Reporting of catch for harvesting of scup from fish pots has only been required since 1994. As for sea bass, many commercial fishermen are licensed to harvest scup from fish pots. For 1994 there were 49 fishermen fishing pots for scup in MDMF Area 10. This number decreased to 28 by 2004. This number has declined during the years to a low of 21 fishermen fishing pots for scup in Nantucket Sound. The total scup landings that came from fish pots during the timeframe of 1994 to 2004 were approximately 1.3 million lbs (589,670 kg). Landings declined from 1994 through 2001 from approximately 277,000 lbs (125,645 kg) in 1994 to 7,700 lbs (3,493 kg) in 2001 (see [Figure 4.2.7-5](#)). Scup landings fluctuated from 2002 through 2004. On a seasonal basis, scup landings are highest in June, averaging approximately 53,000 lbs (24,040 kg) per year from 1994 through 2004.

The striped bass fishery is another important fishery in Nantucket Sound. This species is harvested commercially and recreationally in the region. The striped bass commercial fishery is a hook and line fishery only with the season going from mid July until the quota is filled (MDMF, 2005). The MDMF monitors striped bass that are landed and sold to market in addition to those caught and released, or kept by fishermen. On a seasonal basis, striped bass landings sold to market were greatest in the month of July with a mean of 25,324 lbs (11,487 kg) per year landed from 1990 to 2004 (see [Figure 4.2.7-8](#)). By September, amounts of striped bass that were landed and sold to market were lower with a mean of 814 lbs (369 kg) per year from 1990 through 2004. The total striped bass landings (based on those sold to market) for Nantucket Sound from 1990 through 2004 were estimated to be approximately 574,000 lbs (260,362 kg). Total annual landings from 1990 through 1994 did not exceed 15,000 lbs (6,804 kg). During 1995 through 1998, the annual landings of striped bass increased to a high of 80,000 lbs (36,287 kg) in 1998. Annual landings then decreased to below 50,000 lbs (22,680 kg) in 1999 and 2001. From 2002 through 2004 annual landings of striped bass fluctuated up and down (see [Figure 4.2.7-9](#)).

Survey of Commercial and Recreational Fishing Activities – 2005

Information was gathered by survey from recreational and commercial fishermen, shellfish officers, harbor masters, bait and tackle shop employees and a commercial fish dealer. Commercial fishermen and a fish dealer were contacted by mail and were asked for voluntary participation in the survey. Some of these individuals were interviewed in person with most being interviewed by phone in late summer and early fall of 2005. Information on categories and numbers of interviewees, selection methodologies, survey methodologies, and summary information on the respondents is presented in detail in the *Survey of Commercial and Recreational Fishing Activities* ([Report No. 4.2.5-6](#)). Information from the survey is

summarized in [Table 4.2.7-6](#). In the overall survey group there were 18 commercial and fixed gear fishermen who averaged 32 years of fishing commercially ([Report No. 4.2.5-6](#)).

The 18 surveyed commercial fishermen reported that their boats fished in Nantucket Sound for the following species, which are presented in order of diminishing frequency: scup, squid and fluke (summer flounder), sea bass, conch, tautog, stripers, and bluefish.

Commercial mobile gear fishermen reported that squid is an important fishery in Nantucket Sound in the spring. Trawlers harvest this species. Twelve of 13 trawlers in the sample survey of 21 boats (57 percent) fish for squid in April and May. Ten boats were active in June. Areas heavily fished included nearshore Falmouth to Hyannis to Horseshoe Shoal and Half Moon/Cross Rip Shoals. Out of 12 commercial trawlers targeting squid that were surveyed, approximately 27 percent reported fishing in the Horseshoe Shoal area and 73 percent reported fishing outside the Horseshoe Shoal area.

Of 21 boats owned or managed by surveyed commercial fishermen, 11 (52 percent) trawled for fluke with mobile gear some time during the season in Nantucket Sound. Active areas for fluke targeted by trawlers included Horseshoe Shoal and Half Moon/Cross Rip Shoals. Medium activity was reported for these areas from April through September. In fall, activity for fluke, especially hook and line fishermen, was reported in Eastern Sound. Of 11 surveyed commercial trawlers targeting fluke, approximately 24 percent reported fishing in the Horseshoe Shoal area and 76 percent reported fishing outside the Horseshoe Shoal area.

In Nantucket Sound, scup fishing with mobile gear was reported to have two active periods. The first was in April through June reported in the nearshore Falmouth to Hyannis, Horseshoe Shoal and Half Moon/Cross Rip Shoals areas. The second was in the fall reported in Tuckernuck Shoals followed by Horseshoe Shoal and Big Flat. Eight of 21 boats (38 percent) under management of surveyed respondents were noted as trawling for scup using mobile gear some time during the season in Nantucket Sound. Of the eight surveyed commercial trawlers that were targeting scup, approximately 28 percent reported fishing in the Horseshoe Shoal area and 72 percent reported fishing outside the Horseshoe Shoal area.

For sea bass the most active fishing was reported to occur in May to June in the Horseshoe Shoal and Half Moon/Cross Rip Shoals areas. In July and August activity diminished but then increased in these areas during September through November. Of the 21 boats owned or managed by the surveyed commercial fishermen, 4 (19 percent) trawl for sea bass some time during the year in Nantucket Sound. Of these 4 surveyed commercial trawlers that target sea bass, approximately 41 percent reported fishing in and 59 percent reported fishing outside the Horseshoe Shoal locale.

Conch fishing was reported to have medium activity levels in summer across much of Nantucket Sound. Areas where medium activity occurred included Horseshoe Shoal, Half Moon/Cross Rip Shoals, Tuckernuck Shoals, and Eastern Sound. Of the 21 boats in the survey sample, two trawlers reported harvesting conch in the Nantucket Sound area. Of the 2 surveyed commercial trawlers that targeted conch, approximately 19 percent reported fishing in and 81 percent reported fishing outside the Horseshoe Shoal locale.

Hook and line commercial fishermen reported fishing activity information. Three of 21 boats (14 percent) under management of surveyed respondents commercially fish with hook and line in the Nantucket Sound area some time during the season. Fish species that are targeted include bluefish, fluke, scup, sea bass, striped bass, and tautog. Bluefish were caught by one such fisherman from May to July in various areas of Nantucket Sound including Horseshoe Shoal. Approximately 17 percent of his fishing reported was in the Horseshoe Shoal locale and approximately 83 percent occurred outside the Horseshoe Shoal locale. Two such fishermen caught striped bass. One reported fishing just in July in the Eastern

Sound area and the other also targeted bluefish and tautog concurrently. Out of the two commercial hook and line boats surveyed, approximately 12.5 percent of reported fishing for striped bass took place in the Horseshoe Shoal locale and approximately 87.5 percent took place outside the Horseshoe Shoal locale. Two of 21 boats owned/managed by surveyed commercial fishermen reported fishing for tautog in Nantucket Sound using hook and line. These fishermen fished commercially for tautog in April to May and in September to October. Of these boats approximately 30 percent of reported fishing occurred in the Horseshoe Shoal locale and approximately 70 percent occurred outside the Horseshoe Shoal locale. Of three commercial hook and line boats surveyed that targeted scup and fluke, approximately 22 percent of scup fishing and 14 percent of fluke fishing was reported to take place in the Horseshoe Shoal locale. The rest of the fishing effort was reported taking place outside the Horseshoe Shoal locale. For commercial sea bass fishing using hook and line Eastern Sound was noted as the most active area during the season. Of three commercial hook and line boats surveyed, approximately 20 percent noted fishing for sea bass in the Horseshoe Shoal locale with 80 percent reporting such fishing occurred outside the Horseshoe Shoal locale. Details on the findings of this survey are presented in the *Survey of Commercial and Recreational Fishing Activities* ([Report No. 4.2.5-6](#)).

Commercial fixed gear fishermen reported that most active areas for scup were in the areas that include nearshore Falmouth to Hyannis and Horseshoe Shoal in April and May. Central and eastern Sound areas had medium activity levels in the remainder of the season. Activity levels for sea bass by trap and pot fisherman were the same as those described for scup. Three of 21 boats owned/managed by commercial fishermen surveyed target scup and sea bass with the use of pots and traps. Of the surveyed boats approximately 27 percent of fishing was noted to occur in the Horseshoe Shoal locale and approximately 73 percent of fishing was noted to occur outside the Horseshoe Shoal locale. Conch was reported as caught in pots and traps at varying depths in Nantucket Sound. Information about boats targeting conch indicated that Horseshoe Shoal has most activity during the spring through June and in December. In summer, Big Flat and Eastern Sound were reported to have the most conch fishing. Two of 21 boats owned/managed by commercial fishermen surveyed fish for conch with the use of pots and traps. Of these two boats approximately 27 percent of fishing was noted to take place in the Horseshoe Shoal locale and approximately 73 percent of fishing was noted to occur outside the Horseshoe Shoal locale. For tautog, the fixed gear boat was reported as most active in April and May in the Horseshoe Shoal and nearshore Falmouth to Hyannis areas. Central and eastern Sound areas had medium activity levels in the remainder of the season. The one boat that targets tautog with pots/traps noted that approximately 31 percent of the tautog fishing took place in the Horseshoe Shoal locale with approximately 69 percent taking place outside the Horseshoe Shoal locale. Bluefish are commercially caught by one fixed gear gill netter in Nantucket Sound. It was reported that only bluefish were fished for on Horseshoe Shoal from May through July employing this method (see [Table 4.2.7-6](#)). Details on the findings of this survey are presented in the *Survey of Commercial and Recreational Fishing Activities* ([Report No. 4.2.5-6](#)).

Commercial Fisheries Summary

The results from the Federal commercial VTR database and the commercial interviews indicate the commercial gear type most commonly used in the Nantucket Sound locale is the mobile trawl gear. The Federal VTR data indicate that between 1994 and 2004 otter trawls made up 52 percent of total federally-reportable commercial landings in the Nantucket Sound locale. Of the 21 commercial fishing boats in the survey sample 13 (62 percent) were noted to haul mobile trawl gear in 2005 in the Nantucket Sound locale. Information from the commercial fishing survey and also from state regulators indicates that most trawlers in the region hold Federal permits. For economic reasons they would also tend to fish outside the Nantucket locale. Thus, the Federal VTR data would have given information on most commercial trawling activity in the Nantucket Sound locale. There may be some trawlers with only state permits, however these may represent only a few fishermen (MDMF, 2006).

The Federal VTR data indicate that approximately 5 percent of federally-reportable fishing using otter trawls takes place in the Horseshoe Shoal locale and approximately 95 percent takes place outside the Horseshoe Shoal locale. The commercial fishermen using mobile trawl gear that were surveyed indicated higher usage of Horseshoe Shoal. Of the five mobile gear fisheries that were noted as targeted by commercial trawlers surveyed (fluke, sea bass, scup, squid and conch) an average of approximately 27 percent of trawling efforts for these fisheries was noted to take place within the Horseshoe Shoal locale. Survey responses may have some bias since comparable numbers of fishermen working in other areas of Nantucket Sound may not have responded to the survey request. Also the sample size of fishermen surveyed was small compared to the sample size of VTR data.

Pots/traps were noted to make up approximately 22 percent of federally-reportable commercial landings between 1994 and 2004 in the Nantucket Sound locale and approximately 56 percent of state-reportable commercial landings between 1990 and 2004 (excluding lobster and shellfish). Four of 18 surveyed commercial fishermen reported use of pots/traps in the Nantucket Sound locale during 2005. The Federal VTR data indicate approximately 7.5 percent of federally-reportable pot/trap fishing takes place in the Horseshoe Shoal locale. Approximately 92.5 percent of pot/trap fishing takes place outside the Horseshoe Shoal locale. The commercial fishermen that use pots/traps that were surveyed reported higher usage of Horseshoe Shoal. Of four pot/trap fisheries that were reported by the commercial fishermen surveyed an average of approximately 28 percent of this fishery activity was reported taking place in the Horseshoe Shoal locale. As was previously noted usage of the Horseshoe Shoal locale noted from the surveyed commercial fishermen may be over-representative of fishing in the Horseshoe Shoal locale compared to fishing in the rest of the Nantucket Sound area.

The Federal VTR data and state catch reports noted that fish weirs were used by some fishermen in nearshore portions of the Nantucket Sound area, outside the area of the proposed action.

Top commercial species that were reported to be targeted by the commercial fishermen surveyed in the Nantucket Sound locale include scup, squid, fluke (summer flounder), sea bass, conch, tautog, striped bass, and bluefish. These species were similar to the top commercial species in Nantucket Sound that were reported through the state and Federal reporting systems.

Analysis of State and Federal commercial catch data show that there are many commercial fishermen fishing in Nantucket Sound that hold state permits only and thus do not report through the Federal VTR reporting system. This is true for the gill net fishery, fish weir fishery, fish pot fishery, shellfish, and striped bass fishery.

Certain fisheries are not tracked by state or Federal databases. However, the commercial fishery data that are collected by State and Federal agencies give an indication of the types of commercial fishing activity that takes place in Nantucket Sound and proportions of landings of different fisheries.

4.2.7.2.2 Recreational Fisheries

Nantucket Sound and waters surrounding the islands of Nantucket and Martha's Vineyard are located near several major vacation destinations (i.e., Cape Cod, Nantucket, and Martha's Vineyard). These areas support numerous recreational fishing activities. Review of the scientific literature indicates that few studies related to recreational fishery resources have been performed specifically in the proposed action locale in Nantucket Sound. Data are, however, available from monitoring conducted by NOAA Fisheries with additional funding provided by MDMF. The NOAA uses two methods to monitor recreational fishing activity, a Marine Recreational Fisheries Statistics Survey (MRFSS) and VTR data. Although MDMF does not perform its own recreational fishing activity surveys, it does assist with funding the

NOAA Fisheries MRFSS surveys in Massachusetts' counties. In addition, the applicant undertook two data collection efforts; an intercept survey was performed from August 2002 through November 2002, and a survey of commercial and recreational fishing activities was performed in 2005. Information from these monitoring and project specific programs is useful for characterizing recreational fishery resources in the Nantucket Sound locale.

NOAA Marine Recreational Fisheries Statistics Survey

The MRFSS methods include face-to-face or telephone interviews held with recreational anglers in several ports. Data collected as part of these surveys is not reported using a statistical sampling grid of the coastal waters. For face-to-face interviews the county where the survey was held is recorded. For telephone interviews the county where the anglers indicated they visited to participate in the recreational fishing activities is recorded. Typical questions asked include location of fishing activity, length of time fished, type of gear used, and description of species that were caught. For the characterization of recreational fishing in Nantucket Sound, data were collected from Barnstable, Dukes and Nantucket counties (those that surround Nantucket Sound). These data cover a timeframe from 1990 to 2004, a fifteen year period. [Report No. 4.2.5-6](#) presents detailed information on these data.

The number of surveys conducted in Dukes, Barnstable, and Nantucket Counties over this 15-year period was 40,130 (see [Table 4.2.7-7](#)). Information presented gives estimates of the proportion of individuals that participate in recreational fishing activities in these counties for any given year. Since NOAA Fisheries is not able to target every angler each year the actual recreational effort would be greater than this. It must be taken into account that for individuals interviewed in the three counties, only a portion would have been involved in recreational fishing activities in Nantucket Sound. The surveys are likely to include anglers involved in fishing activities that are offshore, in waters further out on Cape Cod, further offshore south of Martha's Vineyard and Nantucket, and even in sections of Buzzards Bay.

Recreational fishing data are summarized in two-month intervals that are described as "waves" (NOAA Fisheries, 2001). NOAA Fisheries defines the "waves" as shown below:

- Wave 1: Jan-Feb;
- Wave 2: Mar-Apr;
- Wave 3: May-June;
- Wave 4: July-Aug;
- Wave 5: Sep-Oct; and
- Wave 6: Nov-Dec.

Recreational fishing may take place in Nantucket Sound during the entire year; however, the NOAA Fisheries does not report any information for the New England region during Wave 1 timeframe. As a result, numbers of surveys reported only cover the period from March through December. NOAA has indicated that sampling efforts during the period of January and February since 1980 were generally limited to the Atlantic coast of Florida, the Gulf coast states and the Pacific coast. Only about five percent of the annual recreational catch on the Atlantic and Gulf coasts had been taken during Wave 1 timeframe. Costs for sampling during these months were high due to low fishing activity, especially in the North and Mid-Atlantic subregion areas. As a result, the MRFSS was not performed in any region during Jan/Feb of 1981. Data collection for Jan/Feb did resume along the Gulf and Pacific coasts and along the Atlantic Coast of Florida. With the exceptions of Georgia 1985 to 1989, South Carolina 1988, North Carolina 1988 to 1992, the MRFSS has not been conducted in Jan/Feb timeframe along the Atlantic Coast north of Florida since 1980 (NOAA Fisheries, 2004).

Nantucket Sound has the highest recreational fishing pressure in warmer months (i.e., June through September) when tourists vacation in this region. The mean number of hours fished by wave from 1990 to 2004 as reported by surveyed anglers is presented in [Figure 4.2.7-10](#)). The mean number of hours of recreational fishing was greatest during Wave 4 (July-August). The mean number of recreational fishing hours was also high in Wave 3 (May-June) and Wave 5 (September-October). Few hours were spent fishing in March and April (Wave 2). Average numbers of hours fished by recreational anglers from all surveys did not vary greatly between years (see [Figure 4.2.7-11](#)).

A majority (99.7 percent) of surveyed recreational anglers reported hook and line as the gear type used for recreational fishing activities, and most recreational anglers reported they fished from a private/rental boat as the type/mode of recreational fishing (see [Figure 4.2.7-12](#)). From 1990 through 2004, 45 percent of anglers surveyed reported fishing from private/rental boats (see [Figure 4.2.7-12](#)). Shore fishing was common, with approximately 40 percent of anglers surveyed reporting this mode of recreational fishing. Fishing from shore can include from structures such as docks and piers or structures that are built over the water; rock walls that are built out into the water or parallel to shore for restraining currents or protection of a harbor; breakwater devices; bridges; causeways; beaches; or banks.

Numbers of anglers reporting use of party/charter boats were lower than those reporting use of private/rental boats or shore fishing. Only 15 percent of anglers surveyed reported fishing from party/charter boats. Party boats (often referred to as a head boat) are boats where fishing space/privileges are provided for by fees. A licensed captain and crew operate this type of vessel. A licensed captain and crew also operate charter boats, but anglers are part of a group that “charters” the boat, captain and crew for a specific time and price.

Common species caught by the recreational anglers surveyed included scup, bluefish, Atlantic mackerel, striped bass, summer flounder, Atlantic cod, winter flounder, and black sea bass. There appears to be an increase in the numbers of individual fish that anglers reported catching over the timeframe of 1990 through 2004. It is important to take into consideration the fact that if anglers are surveyed several times over numerous years, they may become familiar with survey questions and may tend to provide more detailed catch information. Survey interviewers observed an average of 11.5 percent of catch information reported by anglers who fished from shore, fished from party/charter boats, or fished from private/rental boats from 1990 through 2004. Highest numbers of fish were reported by anglers who used the private/rental boats (see [Figure 4.2.7-13](#)). Anglers who fished from party/charter boats also reported catching large numbers of fish. Anglers who fished from shore reported the lowest numbers of fish. Detailed information on these data is presented in [Report No. 4.2.5-6](#).

NOAA Fisheries Recreational VTR Data - Charter and Party Boats

The recreational VTR data were obtained from NOAA Fisheries for Nantucket Sound (Area 075) for the timeframe of 1994 to 2004. These data include information on recreational landings for federally permitted charter or party boats that are subject to VTR reporting. Federal charter/party permits are issued by NOAA Fisheries to Federal vessels for fisheries that include the following: black sea bass, bluefish, squid/mackerel/butterfish, scup, summer flounder, and New England multi-species. Federal vessel permits that are for bluefish were not implemented till 2000 for charter/party fisheries (NOAA Fisheries, 2005 – personal communication). [Report No. 4.2.5-6](#) presents detailed information on these data.

Recreational landings data included information on fish species, certain shellfish species and squid. Over the time period of 1992 to 2004 there appears to be a trend of increasing counts of federally-reported recreational landings (see [Figure 4.2.7-14](#)). Recreational charter and party boat landings were reported for federally-permitted vessels from 1994 through 2004 from the months of April to October. Peak landings

were reported during the month of June over the eleven year period. Top 10 species harvested that were reported on NOAA Fisheries recreational VTRs from 1994 to 2004 included the following species: scup, black sea bass, *Loligo* squid, summer flounder, tautog, bluefish, sea robin, channeled whelk, unidentified squid and striped bass (see [Figure 4.2.7-15](#)). These species made up approximately 99.99 percent of the total federally-reportable recreational species harvested during the eleven-year period. During the 1994 to 2004 timeframe, top recreational species landed in Nantucket Sound by federally-permitted charter and party boats included scup, black sea bass, and *Loligo* squid. These species accounted for approximately 83 percent, 10 percent and 3 percent, respectively, of total federally-reportable recreational charter and party boat landings in Area 075 during the eleven year period.

Gear types that were used for harvesting recreational species were reported to include hand line/rod and reel, fish pots, and otter trawls. According to Federal recreational VTR data, during the timeframe of 1994 to 2004 greatest landings were from hand line/rod and reel. Rod and reel landings accounted for approximately 99.5 percent of total federally-reportable recreational charter and party boat landings during the eleven year period.

Information reported on VTRs by federally-permitted recreational charter and party boats in Area 075 indicates where most fishing occurs. Many of the vessels fish close to shore along the Monomoy Island area and adjacent to Martha's Vineyard. The portion of fishing reported to occur within the area of the proposed action on Horseshoe Shoal only accounted for approximately 2.8 percent of total federally-reportable charter and party boat trips over the eleven year period. [Report No. 4.2.5-6](#) presents detailed information on these data.

Recreational Intercept Survey

An intercept survey was performed from August 2002 through November 2002 for better estimation of fishing by party/head boats and charter boats in Nantucket Sound. These types of boats are common platforms for recreational fishing activities, especially for those without access to personal boats. Party/head boats are those that accept individually paying passengers on a first come, first served basis and then take such individuals fishing for a ½ day or full day. A charter boat is one that is reserved in advance by a small number of anglers who pay a set fee.

One purpose of the survey was to collect information on existing recreational fishing efforts by party/head boats and charter boats in Nantucket Sound for evaluation of potential impacts of the proposed action on these types of recreational fishing activity. Further, the survey was to collect information on those species targeted by recreational anglers in Nantucket Sound. The survey was designed to be answered by captains or crew of party/head boats and charter boats. Charter boat and registered party boat captains expected to fish in the area were identified, contacted by phone, and questioned. A map that indicated the locations of the WTGs and other areas in Nantucket Sound was sent to captains so they might identify specific fishing locations in the Sound. [Report No. 4.2.7-3](#) presents detailed information on these data.

A telephone survey was conducted with registered charter/party boat captains in the region ([Report No. 4.2.7-3](#)). The survey was performed during the months of September through November 2002. The purpose of this survey was to better estimate the charter and party boat industry within Nantucket Sound.

Thirty charter and party boat captains were contacted and then questioned. Of the 30 respondents most (27) were charter boat operators and just three were party boat operators. When charter and party boat operators were asked to estimate the number of days fished during a year, both reported, in general, that they fished an average of 150 days per year. Some operators indicated that several trips were made each day, thus numbers of days fished may not correspond with total numbers of trips. Charter and party

boat captains surveyed reported totals of 430 full-day trips and 1,752 half-day trips. Vessel size determines the number of anglers that can fish from charter or party boats. Charter vessels usually can take five to six anglers whereas party boats were usually noted as taking 20 to 30 anglers each trip.

Operators of both the charter and party boats indicated that the most sought after species for both types of fishing excursions include scup, striped bass, and various tunas. Other common species that anglers on these vessels may catch include bluefish, bonito, cod, sea bass, and various sharks. It was reported that most species are caught during trips taken from May through September, months when more people participate in fishing activities on charter and party boats.

Charter and party boat captains were asked about the specific areas where they take anglers for fishing. Most charter and party boat captains reported that for short (half-day) trips they did not take their anglers to the site of the proposed action. Areas reported by captains as being frequently fished included the following: Elizabeth Islands, Squibnocket, Vineyard Sound, South Beach, Nauset, Stage Harbor, Buzzards Bay, Old Man, shoreline areas near Dennis/Harwich, Canyons, regions south of Martha's Vineyard, Muskeget Channel, Nantucket Shoals, and Great Point. Other areas fished on half-day trips, but fished less frequently than the above noted areas include areas around Tuckernuck Island and around Monomoy Island.

Survey results showed that charter and party boat captains reported they fish shoal areas around Horseshoe Shoal, Tuckernuck Island and Monomoy Island on the full day trips. Approximately 56 percent of the 430 full-day trips that were reported in the most recent 12 months were to shoal areas around Monomoy Island, 21 percent were to the Horseshoe Shoal area, and 9 percent were to shoal areas around Tuckernuck Island. The remaining full-day trips were reported to be to regions southeast of Nantucket, to areas east of Monomoy Island, and south of Martha's Vineyard. [Report No. 4.2.7-3](#) presents detailed information on the recreational intercept survey.

Survey of Commercial and Recreational Fishing Activities – 2005

Information was gathered by survey from recreational and commercial fishermen, shellfish officers, harbor masters, bait and tackle shop employees and a commercial fish dealer. Recreational fishermen were approached in person and interviewed at several types of boat access locations. Harbor masters, shellfish and coastal officers, and bait and tackle shops were identified using town web sites or through a review of MDMF's January Massachusetts Saltwater Recreational Fishing Guide. Twenty-three individuals were surveyed in late summer and early fall of 2005. Some of these individuals were interviewed in person with most being interviewed by phone. Information on categories and numbers of interviewees, selection methodologies, survey methodologies, and summary information on the respondents is presented in detail in the *Survey of Commercial and Recreational Fishing Activities* ([Report No. 4.2.5-6](#)).

Information obtained from interviews with eight individuals who described themselves as recreational fishermen gave some information on areas that are fished and species of fish sought. Twenty five percent (two out of eight fishermen interviewed) reported that they fish some portion of time on Horseshoe Shoal. Other individuals reported that they only fish areas that are closer to shore (25 percent), they fish near Monomoy (25 percent), they only fish off the Elizabeth Islands and in Vineyard Sound (12.5 percent), and they fish in Nantucket Sound and offshore areas but not on Horseshoe Shoal (12.5 percent). Species mainly fished for were reported to include bluefish and striped bass. Other species reported as targeted include fluke and bonito (see [Table 4.2.7-8](#)).

Harbor masters and shellfish wardens who were interviewed reported there were more recreational fishermen than commercial fishermen in their areas of jurisdiction. Edgartown and Yarmouth did,

however, report a 50/50 split. Fishing areas preferred for most of the users were in proximity to home port areas. Species reported to be targeted included the following: bluefish, striped bass, scup, mackerel, bottom fish such as fluke, squid and lobster, conch (technically a shellfish), and summer and fall transient species that include false albacore, bonito, shark, and tuna (see [Table 4.2.7-8](#)). Details on the findings of this survey are presented in the *Survey of Commercial and Recreational Fishing Activities* ([Report No. 4.2.5-6](#)).

Recreational Fisheries Summary

The MRFSS survey indicated that approximately 45 percent of the recreational fishermen surveyed from the counties that surround the Nantucket Sound locale fish from rental or private boats. Approximately 40 percent of the recreational fishermen surveyed from these counties fish from shore and approximately 15 percent of those surveyed indicated they fish from charter/party boats. Hand line/rod and reel was noted to be the primary gear type used by recreational fishermen in the Nantucket Sound locale according to results from Federal VTR charter/party data, MRFSS survey, and recreational interview surveys. Recreational fishing activity in the Nantucket Sound locale was highest in summer months (June-August) followed by secondary peaks in May-June and September-October. Striped bass and bluefish were the recreational species mainly targeted in the Nantucket Sound locale. The MRFSS surveys noted Atlantic mackerel, scup, and summer flounder as most common species reported caught by recreational fishermen fishing from private/rental boats. The Federal VTR data from charter/party boats and MRFSS survey results indicate the following as top species reported caught from charter/party boats: Atlantic cod, black sea bass, bluefish, scup, striped bass, summer flounder, and tautog. Other targeted species noted by bait and tackle shop employees surveyed on Cape Cod included bonito and false albacore.

Horseshoe Shoal was not noted as a frequently targeted recreational fishing destination by charter/party boats that are subject to Federal VTR reporting. Most federally-permitted charter/party vessels are reported to fish in areas close to shore, in the vicinity of Monomoy Island and in proximity to Martha's Vineyard. Approximately 2.8 percent of total federally-reportable charter/party trips from 1994-2004 were to the area of the proposed action on Horseshoe Shoal. Of eight recreational fishermen surveyed, two indicated they fished some of the time in the Horseshoe Shoal locale. Bluefish and striped bass were the major targeted species on Horseshoe Shoal. Bonito, false albacore, fluke, and scup were also noted as targeted species on Horseshoe Shoal by a local bait and tackle shop.

4.2.8 Essential Fish Habitat (EFH)

4.2.8.1 Introduction

A requirement of the 1996 amendments to the Magnuson-Stevens Act is that an EFH consultation and assessment be conducted for activities that may adversely affect important habitats of federally managed marine and anadromous fish species. The following is a summary of the EFH assessment (the full EFH assessment is provided in [Appendix D](#)). The definition of EFH is “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). In the definition the term “waters” refers to the physical, chemical, and biological properties of aquatic areas that are currently being used or have historically been used by fish and certain designated invertebrates. In the definition the term “substrate” refers to sediment, hard bottom, or other underwater structures and their biological communities. In the definition the term “necessary” indicates the habitat is required to sustain the fishery and support the fish species’ contribution to a healthy ecosystem. Nantucket Sound has been designated as EFH for twenty fish and invertebrate species that are introduced in the EFH Assessment description below. In addition, the EFH process involves the designation of HAPC for those habitat areas determined to be of particular importance to the survival and growth of a particular species. An EFH Assessment was conducted for these species as they relate to proposed action activities.

Habitat in the proposed action locale has been designated EFH for 17 federally managed fish and three federally managed invertebrates. The Magnuson-Stevens Act requires assessment of the potential impacts to the 17 federally managed fish and three federally managed invertebrates. These species include the following: Atlantic cod (*Gadus morhua*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*), winter flounder (*Pseudopleuronectes americanus*), windowpane (*Scophthalmus aquosus*), summer flounder (*Paralichthys dentatus*), yellowtail flounder (*Limanda ferruginea*), Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), blue shark (*Prionace glauca*), shortfin mako shark (*Isurus oxyrinchus*), bluefin tuna (*Thunnus thynnus*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), cobia (*Rachycentron canadum*), little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*), long-finned squid (*Loligo pealei*), short-finned squid (*Illex illecebrosus*), and the surf clam (*Spisula solidissima*). A summary of specific life stage EFH designations for these species is provided in [Table 4.2.8-1](#). One EFH HAPC has been identified in the proposed action locale. Eelgrass beds, when located within summer flounder EFH, have been designated as an HAPC by MAFMC. The complete EFH Assessment is provided in [Appendix D](#) of this document. Descriptions of potential direct and indirect impacts of the proposed action to these species and their associated habitat are discussed in Section 5.3.2.8 and are further detailed in the EFH Assessment.

4.2.8.2 Life History Characteristics of Species with EFH Designation

In addition to the life history characteristics of the species with designated EFH in the proposed action area, information is also provided on the occurrence of these species based on several available databases. Although the species presented in Section 4.2.8.1 are reported by NOAA Fisheries to have designated EFH in the four 10 x 10 minute grid squares that encompass the proposed action area, NOAA Fisheries and MassDMF databases were analyzed to determine the occurrence and relative reported landings of these species in Nantucket Sound. While it is understood that the EFH designations are partially based on abundance data from NOAA's Estuarine Living Marine Resources (ELMR) program and other sources and that EFH can be designated based on the habitat that support species and lifestages and not the actual presence of certain species, however, to tie EFH designations to actual occurrence and relative abundance as documented in landings and other available resource data, results from these databases were reviewed. These are summarized in Section 4.2.8.3 below and the [Appendix A](#) of the EFH Assessment. [Report No. 4.2.7-2](#) provides more extensive and detailed information on the forage characteristics of the EFH species. Life history characteristics for each EFH species are presented below.

4.2.8.2.1 Demersal Species

Atlantic cod (*Gadus morhua*)

Adults. EFH for adult Atlantic cod is designated as those bottom habitats with substrates of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay. Nantucket Shoals exists as a migration point for adults in the Mid-Atlantic Bight during summer and fall as southern water temperatures exceed 68 °F (20 °C) (Heyerdahl and Livingstone, 1982). MDMF trawl surveys (Fahay et al., 1999) in Massachusetts found adults occur more frequently in spring than in fall, but are rare for both seasons in Nantucket Sound. Consequently, the ELMR database indicates that adult cod are common in the Sound during the colder months, from October to April. In the spring, adult cod occur abundantly around Cape Ann, the tip of Cape Cod, and the western part of Cape Cod Bay. Few were found during fall, and those were restricted to the Cape Ann and Cape Cod tip areas. Adult cod are typically found on or near bottom along rocky slopes and ledges, preferring depths between 131 and 427 ft (40 to 130 m), but are sometimes found at mid-water depths (Fahay et al., 1999). NMFS has designated all of Nantucket Sound as EFH for this life stage.

Forage Species. Juvenile cod are bottom-dwelling and feed mainly upon small crustaceans such as shrimp and amphipods (Marine Fisheries, 2005). However, although studies have shown that the most frequently consumed food items by adult cod are invertebrates (Fahay et al., 1999), they will in fact eat almost anything small enough to fit into their mouths, including clams, cockles, mussels, and other mollusks, as well as crabs, lobsters, and sea urchins (Marine Fisheries, 2005). Adults also pursue schooling fish, eating substantial numbers of herring, shad (*Alosa spp.*), mackerel, and silver hake (*Merluccius bilinearis*) (Marine Fisheries, 2005).

Scup (*Stenotomus chrysops*)

Juveniles. For juvenile scup, EFH is designated as the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries and bays where juvenile scup were identified as being common, abundant or highly abundant in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones between Massachusetts and Virginia, in association with various sands, mud, mussel, and eelgrass bed type substrates. Juveniles are common and highly abundant in Nantucket Sound from May to October as indicated in the ELMR database. As inshore water temperatures decline to less than 46 to 48 °F (8 to 9 °C) in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight, returning inshore with rising temperatures in the spring (Steimle et al., 1999b). Juveniles will often use biogenic depressions, sand wave troughs, and possibly mollusk shell fields for shelter in winter (Steimle et al., 1999b).

Adults. EFH for adult scup is designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult scup were identified as being common, abundant or highly abundant in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Adults are highly abundant in Nantucket Sound from May to September and common in October as indicated in the ELMR database. The distribution and abundance of adult scup off New England is temperature dependent (Mayo, 1982; Gabriel, 1992). As inshore water temperatures decline to less than 46 to 48 °F (8 to 9 °C) in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight (Steimle et al., 1999b). Thus, wintering adults (November through April) are primarily offshore, south of New York to North Carolina relative to the location of the 45 °F (7 °C) bottom isotherm, their lower preferred limit (Neville and Talbot, 1964). With rising temperatures in the spring, scup return inshore (Steimle et al., 1999b).

Forage species. Scup are benthic feeders, adult scup forage upon a variety of prey including zooplankton, small crabs, amphipods, cnidarians, squid, polychaetes, clams, mussels, snails, sand dollars, insect larvae, and vegetative detritus (Ross, 1991; Steimle et al., 1999b; Marine Fisheries, 2005). Smaller scup eat a larger proportion of cnidarians, polychaetes, amphipods, and mysid shrimp, whereas larger scup consume more squids and fishes (Collette and Klein-MacPhee, 2002).

Black sea bass (*Centropristis striata*)

Larvae. For larval black sea bass, EFH is designated as the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all the estuaries where larval black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Larval black sea bass are not yet compiled in the ELMR database. Based on New England Fisheries Science Center (NEFSC) Marine Resources Monitoring Assessment and Prediction Program (MARMAP) ichthyoplankton surveys (Steimle et al., 1999a), larvae are generally found at water temperatures of 52 to 79 °F (11 to 26 °C) (55 to 70 °F [13 to 21 °C] preferred range). They were also collected at depths less than 328 ft (100 m), but several collections during May-July and October occurred over deeper (>656 ft [200 m]) waters. The habitats for transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries

between New York and Virginia. When larvae become demersal, they are generally found on structured inshore habitat.

Juveniles. The demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for juvenile black sea bass. EFH in inshore waters includes all estuaries where juvenile black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Juveniles are common in Nantucket Sound from May to October as indicated in the ELMR database. Most juvenile settlement does not occur in estuaries, but in coastal areas (Steimle et al., 1999a). Recently settled juveniles then find their way into estuarine nurseries, where they will co-exist with other fish species in and around oyster beds (Steimle et al., 1999a). Older juveniles return to estuaries in late spring and early summer, and may follow the migration routes of adults into coastal waters (Steimle et al., 1999a). However, all juveniles seem to winter offshore, from New Jersey southward. Juvenile black sea bass are associated with rough and hardbottom substrate, shellfish and eelgrass beds, and man-made structures in sandy/shelly areas, as well as offshore clam beds and shell patches during the wintering. Some individuals may spend the warmer months along the coast in accumulations of surf clam and ocean quahog shells (Able et al., 1995).

Adults. EFH for adult black sea bass is also designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated in the ELMR database. They are heavily associated with man-made structures, rough and hardbottom substrate along the sides of navigational channels (Steimle et al., 1999a), shellfish and eelgrass beds, and sandy/shelly areas. Studies (Mercer, 1989) have found adult black sea bass to prefer depths of 66 to 197 ft (20 to 60 m).

Forage species. Juveniles feed upon a variety of benthic organisms such as shrimp, isopods and amphipods with mysid shrimp constituting more than half their food intake (Ross, 1991). Adults commonly feed upon rock crabs (*Cancer spp.*) and hermit crabs (*Pagurus spp.*) as well as other crustaceans (Ross, 1991) including juvenile American lobster (*Homarus americanus*) (Steimle et al., 1999a), mollusks and squid (Ross, 1991). Adults also occasionally graze upon attached organisms such as barnacles and colonial tunicates (Ross, 1991) as well as razor clams (*Siliqua patula*) (Marine Fisheries, 2005). Fishes including herring and anchovies (*Anchoa spp.*) are also a major component of the adult diet as well as other species such as, scup, sand lance and windowpane (Collette and Klein-MacPhee, 2002).

4.2.8.2.2 Demersal Groundfish Species

Winter flounder (*Pseudopleuronectes americanus*)

Eggs. EFH for winter flounder eggs consists of bottom habitat with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. However, sand appears to be the most common associated substrate (Pereira et al., 1999). Winter flounder eggs are not yet compiled in the ELMR database.

Larvae. EFH for larval winter flounder is designated as pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder larvae are not yet compiled in the ELMR database.

“Young-of-the-Year” Juveniles. Winter flounder less than one year old (Young-of-the-Year, or YOY) are treated separately for this species because their habitat requirements are different from that of larger

juveniles (>1 yr.) (Pereira et al., 1999). EFH includes bottom habitat with a substrate of mud or sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Many studies reviewed in Pereira et al. (1999) confirm young winter flounder are plentiful along the east coast, especially in Massachusetts. In southern New England, newly metamorphosed YOY juveniles take up residence in shallow water where they may grow to larger juvenile sizes within the first year (Bigelow and Schroeder, 1953). Sandy coves appear to be the preferred habitat in the very shallow waters of estuaries and bays where they were spawned (Hildebrand and Schroeder, 1928). However, recent comparisons of habitat-specific patterns of abundance and distribution of YOY winter flounder in many Mid-Atlantic estuaries support the conclusion that habitat utilization by YOY winter flounder is not consistent across habitat types and is highly variable among systems and from year to year (Pereira et al., 1999; Goldberg et al., in prep).

Age 1+ Juveniles. Winter flounder juveniles older than 1 year have EFH in bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Juveniles are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Older juveniles inhabiting estuaries gradually move seaward as they grow larger (Mulkana, 1966).

Adults. EFH for adult winter flounder consists of bottom habitat, including estuaries, with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Adults are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Traditionally, New England and the New York Metropolitan area have contained the most abundant populations (NUSC, 1989). MDMF (2001b) survey trawls on Horseshoe Shoal have found winter flounder are relatively common during spring and rare during fall within the proposed action area.

Spawning Adults. For spawning winter flounder, EFH consists of bottom habitat, including estuaries, with a substrate of sand, mud, muddy sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder adults undertake small-scale migrations into estuaries, embayments, and saltwater ponds from winter through spring to spawn. Winter flounder are most often observed spawning during the months of February to June with the peak spawning occurring during February and March south of Cape Cod (Goldberg et al., in prep). Typically, eggs are deposited over a sandy substrate at depths of 6.6 to 262.5 ft (2 to 80 m) (Bigelow and Schroeder, 1953), although most spawning takes place at depths less than 16.4 ft (5 m). Major egg production occurs in New England waters before temperatures go below 37.9 °F (3.3 °C) (Bigelow and Schroeder, 1953). After spawning, adults may remain in the spawning areas before moving to deeper waters when water temperatures reach 59 °F (15 °C) (McCracken, 1963).

Forage species. Winter flounder have been described as omnivorous or opportunistic feeders, consuming a wide variety of prey; polychaetes and crustaceans (mostly amphipods) generally make up the bulk of the diet (Pereira et al., 1999). Juveniles feed heavily upon copepods, nemerteans, ostracods, amphipods, and polychaetes (Ross, 1991; Buckley, 1989). Adults feed primarily upon polychaetes, anthozoans (e.g., anemones) and amphipods (Bowman et al., 2000) however they also feed upon a great variety of other organisms including shrimp, small crabs, mollusks, squids, fish eggs, fish fry, vegetation, (Bowman et al., 2000; Ross, 1991) and rarely they will also eat fishes such as sand lance (Collette and Klein-MacPhee, 2002).

Summer flounder or Fluke (*Paralichthys dentatus*)

Eggs. EFH for summer flounder eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. Summer flounder eggs are not yet compiled in the ELMR

database. Generally, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles (14.5 km) offshore of New Jersey and New York. Able et al. (1990) found the highest frequencies of occurrence and greatest abundances of eggs in the northwest Atlantic occur in October and November. However, due to limited sampling in areas of southern New England in the month of December, this lifestage could be under represented.

Larvae. The pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for summer flounder larvae. EFH in inshore waters includes all the estuaries where larval summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Larvae are not yet compiled in the ELMR database. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February.

Juveniles. EFH for juvenile summer flounder consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where juvenile summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Juveniles are rare in Nantucket Sound from May to October as indicated by the ELMR database. In estuaries north of Chesapeake Bay, some juveniles remain in their estuarine habitat for 10 to 12 months before migrating offshore their second fall and winter (Packer et al., 1999). Generally, juvenile summer flounder use several different estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in a salinity range of 10 to 30 ppt.

Adults. Like juveniles, EFH for adult summer flounder also consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated by the ELMR database. The preferred substrate is sand, which is used to conceal themselves from predators and thus avoid predation. Summer flounder in Massachusetts migrate inshore in early May and occur along the entire shoal area south of Cape Cod and Buzzards Bay, Vineyard Sound, Nantucket Sound, and the coastal waters around Martha’s Vineyard (Howe et al., 1997). MDMF considers the shoal waters of Cape Cod Bay and the region east and south of Cape Cod, including all estuaries, bays, and harbors thereof, as critically important habitat (Packer et al., 1999). All of these designated areas are outside of the proposed action area and alternative sites in Nantucket Sound.

Studies by Burke (1991) and Burke et al. (1991) have made it clear that the summer flounder’s distribution is due to substrate preference and is not affected by salinity. Summer flounder occupy a variety of habitats over sand, mud, and vegetated substrate including marsh creeks (Able and Fahay, 1998). Generally, adult summer flounder inhabit shallow coastal and estuarine waters during spring and summer, then move offshore during late summer and fall to the OCS to depths of 558 ft (170 m). Some evidence suggests that older adults may remain offshore all year (Festa, 1977).

HAPC for summer flounder is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH.

Forage species. Juveniles and smaller adults feed mostly upon mysid shrimp and other crustaceans (Ross, 1991; Collette and Klein-MacPhee, 2002), adults eat a variety of fishes, including small winter flounder, menhaden, sand lances, red hakes, silver hakes, anchovies, silversides, bluefish, weakfish, and

mummichogs, as well as invertebrates such as blue crabs, squid, sand shrimp (*Crangon septemspinosa*), and mollusks (Ross, 1991; Collette and Klein-MacPhee, 2002). Weakfish, winter flounder and sand lance have been found to constitute the greatest volume of food eaten by summer flounder, although sand shrimp are also a major food for both juveniles and adults (Ross, 1991; Collette and Klein-MacPhee, 2002).

Windowpane (*Scophthalmus aquosus*)

Adults. For adult windowpane, EFH exists in bottom habitats with a substrate of sand, fine-grained sand, or mud around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to the Virginia-North Carolina border. Adults are common and abundant in Nantucket Sound throughout the year as indicated by the ELMR database. Adults occur primarily on sand substrates off southern New England (Chang et al., 1999). MDMF (2001b) survey trawls on Horseshoe Shoal have found windowpane are relatively common during spring and rare during fall within the proposed action area.

Spawning Adults. Spawning windowpane have designated EFH in bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Aggregations of adults south of Cape Cod in spring suggest spawning activities may occur in the proposed action area (Chang et al., 1999). The seabed sediment composition of Nantucket Sound primarily consists of sand. Since the preference for spawning adults is fine-grained sand or mud, spawning activities may occur in the proposed action area. However, NMFS has not designated EFH in the proposed action area for eggs.

Forage species. The three major components of the windowpane diet are mysid shrimp, fishes and decapods (Bowman et al., 2000). Other prey items include chaetognaths, squids, mollusks, ascidians (sea squirts), polychaetes, cumaceans, isopods, amphipods, sand shrimp, and euphausiids (Bowman et al., 2000; Collette and Klein-MacPhee, 2002; Ross, 1991). Windowpane over 7.9 inches (20 cm) also feed on the afore mentioned items but in addition prey on juvenile fishes such as anchovies, silver hake, tomcod, killifishes (i.e., mummichog and striped killifish), pipefish, longhorn sculpin, striped bass, sand lance, pollock, herring, and flatfishes (Bowman et al., 2000; Collette and Klein-MacPhee, 2002; Ross, 1991) as well as their own species (Chang et al., 1999).

Yellowtail flounder (*Limanda ferruginea*)

Juveniles. EFH for juvenile yellowtail flounder is not present in Nantucket Sound but is within other areas of the designated EFH squares overlapping with Nantucket Sound. NMFS has not appointed specific regions of EFH in Nantucket Sound for this life stage (NEFMC, 1998).

4.2.8.2.3 Coastal Pelagic Species

Atlantic butterfish (*Peprilus triacanthus*)

Eggs. EFH for butterfish eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all estuaries where Atlantic butterfish eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Massachusetts Bay, Cape Cod Bay, Waquoit Bay, and Buzzards Bay (Cross et al., 1999).

Larvae. EFH for Atlantic butterfish larvae consists of those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH for inshore waters includes the “mixing” (0.5 to 25.0 ppt)

and “seawater” (>25 ppt) portions of all the estuaries where Atlantic butterfish larvae were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Buzzards Bay and Waquoit Bay (Cross et al., 1999).

Juveniles. EFH for juvenile butterfish is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where juvenile Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are abundant in Nantucket Sound from June to October, and common in November as indicated by the ELMR database.

Adults. EFH for adult butterfish also consists of the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where adult Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are abundant in Nantucket Sound from June to October, and common in May and November as indicated by the ELMR database. Several studies in Cross et al. (1999) reveal adults will inhabit high salinity and mixed salinity zones of most estuaries from the Gulf of Maine to Florida. MDMF (2001b) survey trawls on Horseshoe Shoal have found butterfish are rare during spring and more common during fall within the proposed action area.

Forage Species. In general butterfish predominantly prey upon urochordates (tunicates), but also are known to feed upon cnidarians (i.e., jellyfish, hydroids, anemones) and a wide variety of planktonic organisms (Bowman et al., 2000). Some other common prey items include mollusks (primarily squids), crustaceans (copepods, amphipods, and decapods), polychaetes, and small fishes (Cross et al., 1999). In addition, a ctenophore (comb jelly) (*Mnemiopsis leidyi*) has been shown to be an important component of the diet of butterfish juveniles in Narragansett Bay, R.I. (Collette and Klein-MacPhee, 2002).

Atlantic mackerel (*Scomber scombrus*)

Eggs. EFH for Atlantic mackerel eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where Atlantic mackerel eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), eggs in Nantucket Sound occur only randomly.

Larvae. EFH for Atlantic mackerel larvae is also designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where larval Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic mackerel larvae are not yet compiled in the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), larvae in Nantucket Sound occur only randomly.

Juveniles. EFH for juvenile Atlantic mackerel is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where juvenile Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are common in Nantucket Sound from

August to November as indicated by the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), juveniles in Nantucket Sound occur only randomly.

Adults. For adult Atlantic mackerel, EFH is also designated as those pelagic waters found over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where adult Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are common in Nantucket Sound in March, April, and from October to December as indicated by the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), adults in Nantucket Sound occur only randomly.

Forage species. These fish are opportunistic feeders that swallow prey whole. Food is acquired either through filter feeding or pursuit of individuals (Studholme et al., 1999). Juveniles will eat mostly small crustaceans such as copepods, amphipods, mysid shrimp (*Mysis spp.*), and decapod larvae (Studholme et al., 1999). Adults feed on the same foods as juveniles but their diet will additionally include larger prey items such as squid, silver hake, sand lance (*Ammodytes spp.*), and small herring (Collette and Klein-MacPhee, 2002) as well as young mackerel (Ross, 1991).

4.2.8.2.4 Coastal Migratory Pelagic Species

The general NMFS EFH designation (NOAA Fisheries Service, 2006) for all the Coastal Migratory Pelagic Species listed below, except the bluefin tuna, includes the sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward (including *Sargassum*), coastal inlets, and tidal estuaries. In addition, all coastal inlets in the South and Mid-Atlantic Bight are state-designated nursery habitats of particular importance to these species as well. However, the following species do not have a management plan in the North Atlantic, and are currently managed within the jurisdiction of the South Atlantic Fisheries Management Council. All are considered rare in Nantucket Sound, as their preference lies in warmer waters south of Chesapeake Bay. Therefore, no specific EFH designations exist within the proposed action area. More specific habitat characteristics taken from literature review and desktop analyses are described below.

Bluefin tuna (*Thunnus thynnus*)

EFH is not present for the designated lifestages of bluefin tuna in the proposed action area within Nantucket Sound but is located further offshore within the designated EFH blocks that overlap with Nantucket Sound

King mackerel (*Scomberomorus cavalla*)

Eggs. Studies in Godcharles and Murphy (1986) reveal that king mackerel spawn in the coastal waters of the northern Gulf of Mexico, and off the southern Atlantic coast. There does not appear to be a well-defined area for spawning, but warm waters are preferred. There is no documentation found of king mackerel eggs occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

Larvae. King mackerel larvae have been collected near the surface on the Atlantic coast from May through October in surface water temperatures of 78.8 to 87.8 °F (26 to 31 °C) and in a salinity range of 26 to 37 ppt (Godcharles and Murphy, 1986). Larval distribution indicates that spawning occurs in the western Atlantic off the Carolinas, Cape Canaveral and Miami, Florida. There does not appear to be a well-defined area for spawning. There is no documentation found of king mackerel larvae occurring at

any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

Juveniles. There is no documentation found of juvenile king mackerel occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, a small amount of landings have been reported from state-reportable fish weirs in Nantucket Sound according to the DMF commercial database.

Adults. King mackerel adults range from the Gulf of Maine to Rio de Janeiro, Brazil. However, they are most commonly found from the Chesapeake Bay southward (Chesapeake Bay Program, 2006). Migratory patterns are driven heavily by water temperature, preferring those greater than 68 °F (20 °C). There is no documentation found of adults occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, a small amount of landings have been reported from state-reportable fish weirs in Nantucket Sound according to the DMF commercial database.

Forage species. King mackerel are primarily pelagic carnivores, principally piscivorous but also showing a preference for invertebrates (Godcharles and Murphy, 1986). They feed primarily on fishes and in smaller quantities on squid (Collette and Klein-MacPhee, 2002). Menhaden are also an important prey species as well as other mackerel (Bowman et al., 2000).

Spanish mackerel (*Scomberomorus maculatus*)

All life stages of Spanish mackerel are primarily seen in waters above 63.9 °F (17.7 °C) and within a salinity range of 32 to 36 ppt (Godcharles and Murphy, 1986). There is no documentation found of Spanish mackerel lifestages occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

Cobia (*Rachycentron canadum*)

There is no documentation found of cobia eggs, larvae, or juveniles occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. Cobia adults range from Cape Cod to Argentina. They undergo extensive migrations from overwintering grounds near the Florida Keys to more northerly spawning/feeding grounds in spring and summer months (Richards, 1967). Cobia can be found in high salinity bays, estuaries, and seagrass habitat in a variety of locations over mud, gravel, or sand bottoms, coral reefs, and man-made sloughs. They often congregate along reefs and around buoys, pilings, wrecks, anchored boats, and other stationary or floating objects. There is no documentation found of adult cobia occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

4.2.8.2.5 Sharks

The following shark species would most likely be rare around the proposed action area due to their preference for deeper waters outside of Nantucket Sound. Personal communications with the NMFS office in Gloucester, Massachusetts indicated that shark species EFH is located more offshore on the OCS, outside of Nantucket Sound.

Blue shark (*Prionace glauca*)

Adults. Blue shark adults inhabit the pelagic, surface waters of tropical, subtropical, and temperate oceans worldwide. They are commonly found in the Cape Cod area during the summer months (New England Sharks, 2006), moving out to deeper water in late fall and winter (DFO, 2006). Blue sharks are

not expected to occur within the proposed action area and were not documented in any of the agency databases for Nantucket Sound (see Appendix A of [EFH Assessment](#)).

Forage species. A large proportion of the diet of the adult blue sharks in western Atlantic waters is made up of squid and octopods (Bowman et al., 2000). Fishes also constitute an important part of the blue sharks diet, with bluefish and red and silver hakes the most important, and mackerel, menhaden, Atlantic herring, and blueback herring also being common forage items (Ross, 1991).

Shortfin mako shark (*Isurus oxyrinchus*)

Late Juveniles/Subadults. EFH exists for juvenile shortfin mako sharks in the offshore waters between Cape Cod and Onslow Bay, NC, between the 82 and 6,652 foot (25 and 2000 m) isobaths; and extending west between 38°N and 41.5°N to the EEZ boundary. It is most commonly seen in offshore waters from Cape Cod to Cape Hatteras (Passarelli et al., 2006). Shortfin mako sharks are not expected to occur within the proposed action area.

Forage species. The mako feeds heavily upon a variety of fish species; one of the most important of these is the bluefish although mako will also eat small bodied schooling species such as mackerel and herring and larger fishes such as swordfish, bonito and tuna (Ross, 1991). Other fish species found in shortfin mako stomachs include blue shark, eel, menhaden, and butterfish (Bowman et al., 2000). In addition, squid are also commonly eaten but generally only in offshore areas (Collette and Klein-MacPhee, 2002).

4.2.8.2.6 Skates

Little skate (*Leucoraja erinacea*)

Juveniles. EFH for juvenile little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH (NOAA, 2006).

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid et al., 1999) captured juvenile little skate year-round and showed that in the winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m (656 ft) depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, but were also heavily concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid et al., 1999) show nearly identical abundances and distributions of juveniles around Nantucket and in Nantucket Sound, in Cape Cod Bay, along the Massachusetts coast and Broad Sound, and north of Cape Ann, with higher concentrations west and south of Martha's Vineyard. Along the inshore edge of its range, little skate moves onshore and offshore seasonally. They generally move into shallow water during the spring and into deeper water in the winter and may leave some estuaries for deeper water during warmer months.

Adults. EFH for adult little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys (Reid et al., 1999) captured adult little skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In

winter, they were caught from Georges Bank to North Carolina, with very few in the Gulf of Maine. In spring they were also found from Georges Bank to North Carolina and, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as in Cape Cod and Massachusetts Bays. They had a limited distribution in the summer, being found mostly in southern New England, Georges Bank, Cape Cod Bay, in the Gulf of Maine near Penobscot Bay, and near Browns Bank and the Northeast Channel. The distributions of adult little skate from both the spring and fall Massachusetts inshore trawl surveys (Reid et al., 1999) were similar to that of the juveniles, but with fewer numbers collected in all areas (including west and south of Martha's Vineyard).

Forage species. In general, little skate feed on benthic fishes and invertebrates (i.e., associated with the bottom) (Collette and Klein-MacPhee, 2002). Little skate from the Woods Hole region were found to contain mostly crabs, followed by sand shrimp (*Crangon septemspinosa*) and squid (Packer et al., 2003a), although overall the most important prey items for the species are decapod crustaceans (crabs) and amphipods followed by polychaetes (Bowman et al., 2000). Razor clams are also frequently taken (Ross, 1991). Fish prey include sand lance, alewives, herring, cunners, silversides, tomcod, and silver hake (Packer et al., 2003a), as well as sculpins and yellowtail flounder (Collette and Klein-MacPhee, 2002).

Winter skate (*Leucoraja ocellata*)

Juveniles. EFH for juvenile winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid et al., 1999) captured juvenile winter skate year-round. In winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m (656 ft) depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, and were concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Comparatively few were present in summer, with concentrations on Georges Bank and around Cape Cod. Winter skate abundances in the fall were not as high as in the spring. In the fall they were collected from Georges Bank to the Delmarva Peninsula and were again concentrated along Long Island, southern New England, around Cape Cod, and on Georges Bank. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid et al., 1999) show similar abundances and distributions of juveniles. The highest concentrations were found on the Atlantic side of Cape Cod and south and west of Martha's Vineyard (especially in spring) and south and northeast of Nantucket (also in spring). Large numbers were also found near Monomoy Point in the fall. Other notable occurrences of winter skate were around Plum Island, Ipswich Bay, north of Cape Ann, near Nahant Bay (especially in the fall), in Cape Cod Bay, and in Nantucket Sound.

Adults. EFH for adult winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys (Reid et al., 1999) captured adult winter skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In winter, adult winter skate were scattered from Georges Bank to North Carolina; very few occurred in the Gulf of Maine. In the spring, they were also found from Georges Bank to North Carolina but, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as around Cape Cod and Massachusetts Bays. Few occurred in summer, being found mostly on

Georges Bank, Nantucket Shoals, and near Cape Cod. In the fall, they were mostly confined to Georges Bank, near Nantucket shoals, and near Cape Cod, with very few found south of those areas. Adult little skate were collected in much fewer numbers than juveniles during the spring and fall Massachusetts inshore trawl surveys. The greatest numbers were found on the Atlantic side of Cape Cod and, in spring, south of Nantucket.

Forage species. In general, winter skate prey on fishes and invertebrates that are associated with the bottom. Prey include hydrozoans, gastropods, bivalves, squids, polychaetes, cumaceans, isopods, amphipods, mysids, euphausiids, pandalid shrimps, crangon shrimps, hermit crabs, cancer crabs, portunid crabs, rock crabs, razor clams, echinoderms, and fishes (Bowman et al., 2000; Ross, 1991). Out of the above prey mentioned, amphipods and polychaetes are the most common forage but fishes, decapod crustaceans, isopods, bivalves, and hydroids are also important (Packer et al., 2003b). Studies show that smaller individuals consume relatively more amphipods and cumaceans and larger specimens consume relatively more decapods, polychaetes and fishes (Collette and Klein-MacPhee, 2002). In general, fishes make up the majority of the diet of individuals larger than 20 cm (Bowman et al., 2000). Fish prey include skates, herring, alewife, blueback herring, menhaden, silver hake, red hake, tomcod, cod, smelts, sculpins, sand lance, cunner, butterfish, and summer and yellowtail flounders (Collette and Klein-MacPhee, 2002).

4.2.8.2.7 Invertebrates

Long-finned squid (*Loligo pealei*)

Juveniles, or "Pre-recruits." EFH for long-finned squid pre-recruits consists of those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Older juveniles (sub-adults) are thought to overwinter in deeper waters along the edge of the continental shelf (Black et al., 1987). They were also collected in greater abundance during the fall than in spring, with concentrations in Buzzards Bay, around Martha's Vineyard and Nantucket, throughout Cape Cod Bay, in Massachusetts Bay, and north and south of Cape Ann. The spring concentrations occurred in Buzzards Bay and around Martha's Vineyard and Nantucket Islands (Cargnelli et al., 1999b).

Adults, or "Recruits." Adult long-finned squid also have EFH designated as the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Adults will migrate offshore during late fall and overwinter in warmer waters along the edge of the continental shelf, returning inshore during the spring and early summer (MAFMC, 1996b). Off Massachusetts, larger individuals migrate inshore in April-May to begin spawning, while smaller individuals move inshore during the summer (Lange, 1982). MDMF (2001b) survey trawls on Horseshoe Shoal have found long-finned squid are abundant year round within the proposed action area.

Forage species. In general the diet of the long-finned squid changes with size; small immature individuals feed on planktonic organisms and polychaete worms, whereas larger individuals feed on small fish and crustaceans such as euphausiids (krill), small crabs and shrimp. (Cargnelli et al., 1999b). In addition, studies (Cargnelli et al., 1999b) stated that cannibalism is observed in individuals larger than 5 cm. Fish species preyed on by long-finned squid include silver hake, mackerel, herring, menhaden, sand lance, bay anchovy, menhaden, weakfish, and silversides (Cargnelli et al., 1999b).

Short-finned squid (*Illex illecebrosus*)

Juveniles, or "Pre-recruits." EFH for juvenile short-finned squid is designated as those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in Cargnelli et al. (1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli et al., 1999a), very few juveniles

were taken during the spring north of Nantucket, while only few were taken in the fall west of Nantucket and east of Cape Cod. Short-finned squid exist mainly in deeper waters, and are not particularly common within the proposed action area.

Adults, or "Recruits." For adult short-finned squid, EFH also exists in the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in (Cargnelli et al., 1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli et al., 1999a), as with the juvenile population, very few adults were taken during the spring in the coastal waters of Massachusetts, while more were taken in the fall west of Nantucket and east of Cape Cod. The distribution was found to correlate well with the species' inshore-offshore migrations (Cargnelli et al., 1999a). In general, there are more adults present in the spring than juveniles due to size-related differences in the timing of migration (i.e., larger individuals migrate inshore earlier in the spring) (Cargnelli et al., 1999a). Short-finned squid exist mainly in deeper waters and are not particularly common within the proposed action area.

Forage species. Northern shortfin squid feed primarily on fish, squid and crustaceans. Fish prey include the early life history stages of Atlantic cod, sand lance, mackerel, Atlantic herring, sculpin, and mummichogs as well as longfin inshore squid, cannibalism is also significant among this species (Hendrickson and Holmes, 2004). Studies in (Hendrickson and Holmes, 2004) also state that when the shortfin squid are inshore in the summer and fall they primarily consume fish and squid.

Surf clam (*Spisula solidissima*)

Juveniles and Adults. Because of the wide variability in age at maturity, juvenile and adult surf clams are discussed together (Cargnelli et al., 1999c). EFH for both life stages exists within the substrate to a depth of 1 m (3.3 ft) below the water/sediment interface, from the Gulf of Maine and eastern Georges Bank throughout the Atlantic EEZ. Studies reviewed in Cargnelli et al. (1999c) have shown the greatest concentration of surf clams are usually found in well-sorted, medium-grained sand, and are most common at depths of 26.2 to 216.5 ft (8 to 66 m) in the turbulent areas beyond the breaker zone.

Forage species. In general, Atlantic surf clams are planktivorous siphon feeders (Cargnelli et al., 1999c). Studies in (Cargnelli et al., 1999c) noted the presence of many genera and species of diatoms (a unicellular organism) in the guts of Atlantic surf clams although ciliates (unicellular free-living protists) were also found to be a common component of their diet (Cargnelli et al., 1999c).

4.2.8.3 Landings Data for EFH Species

Both NOAA Fisheries and MassDMF monitor certain commercial and recreational fishing activities within Nantucket Sound. NOAA Fisheries monitors federally-permitted commercial and recreational fishing activities in all coastal states throughout the United States. The Commonwealth of Massachusetts monitors state-permitted commercial fishing activities in its coastal waters for certain fisheries and gear types. In addition, a valuable source of resource data available for Nantucket Sound is the MassDMF independent fisheries monitoring program. For more details on these datasets, please see [Report No. 4.2.7-1](#). Using these agency database sources, the following were reviewed to determine the occurrence and relative reported landings of species with designated EFH in Nantucket Sound:

- Commercial catch data monitored by NOAA Fisheries and reported on NOAA VTRs by federally-permitted vessels fishing in Nantucket Sound
- Commercial catch data monitored by MassDMF and reported by state-permitted vessels fishing in Nantucket Sound

- Recreational fishery information obtained from the NOAA Fisheries MRFSS for three counties surrounding Nantucket Sound (Dukes, Nantucket, and Barnstable)
- Recreational catch data reported by federally-permitted charter or party boats fishing in Nantucket Sound
- MassDMF bi-annual resource trawls for Nantucket Sound (information gathered is for state resource assessment and management purposes and is independent of commercial fisheries activities)

A summary table listing which databases reported the presence of the EFH designated species is provided in [Table 4.2.8-2](#). The detailed reported landings and catch data for these species according to the NOAA and MassDMF databases are summarized below.

Atlantic cod

This species was documented by the NOAA VTR commercial landings database, NOAA Fisheries MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), cod was reported in six of the years with a total of 2,865 lb (1,299.5 kg) harvested from Nantucket Sound.
- The numbers of Atlantic cod observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 278 from party/charter boats and 38 from private/rental boats.
- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in Nantucket Sound only five of the years. Cod was reported in three of five of the years with a total of 3,346 lb (1,517.7 kg) harvested from the Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic cod was reported in one year in the fall with a total of 6 individuals caught and in every year in the spring with a total of 4,768 individuals caught.

Scup

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), scup was reported every year with a total of 564,380 lb (564,380 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), scup was reported every year with a total of 508,129 individuals harvested from Nantucket Sound.
- The numbers of scup observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 192 from shore, 2,472 from party/charter boats and 566 from private/rental boats.

- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), scup was reported every year with a total of 1,583,567 lb (718,293.9 kg) harvested from Nantucket Sound. Scup was also reported in the eleven years of fish pots landings (1994-2004) with a total of 1,307,897 lb (593,250 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, scup was reported in every year in the fall with a total of 1,559,537 individuals caught and in every year in the spring with a total of 27,616 individuals caught.

Black sea bass

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), black sea bass was reported every year with a total of 736,861 lb (334,235.5 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), black sea bass was reported every year with a total of 58,871 individuals harvested from Nantucket Sound.
- The numbers of black sea bass observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 10 from shore, 186 from party/charter boats and 102 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs and fish pots (1990-2004), black sea bass was reported in four of the years with a total of 63,929 lb (28,997.7 kg) harvested from Nantucket Sound and in every year with a total of 2,837,308 lb (1,286,981.3 kg) harvested from Nantucket Sound, respectfully.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, black sea bass was reported in every year in the fall with a total of 64,950 individuals caught and in 25 of the years in the spring with a total of 891 individuals caught.

Winter flounder

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), winter flounder was reported every year with a total of 77,961 lb (35,362.5 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), winter flounder was reported in eight of the years with a total of 169 individuals harvested from Nantucket Sound. An additional 5 lb of unspecified flounder was harvested in 1995.

- The numbers of winter flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 87 from shore, 38 from party/charter boats and 415 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), winter flounder was reported in four of the years with a total of 2,093 lb (949.4 kg) harvested from Nantucket Sound. An additional 376 lb (170.5 kg) of unclassified flounder was harvested from the Sound using fish weirs. Gill nets were fished in only five out of eleven years (1994-2004) according to MassDMF commercial data landings. Winter flounder was reported in three of the five years with a total of 2,549 lb (1156.2 kg) harvested and an additional 43 lb (19.5 kg) of unclassified flounder harvested from gill nets in Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic cod was reported in 26 of the years in the fall with a total of 1,094 individuals caught and in every year in the spring with a total of 13,451 individuals caught.

Summer flounder

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), summer flounder was reported every year with a total of 912,017 lb (413,683.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), summer flounder was reported every year with a total of 6,036 individuals harvested from Nantucket Sound.
- The numbers of summer flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 63 from shore, 60 from party/charter boats and 664 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), summer flounder was reported in every year with a total of 54,311 lb (24,635 kg) harvested from Nantucket Sound. Gill nets were fished in only five out of eleven years (1994-2004) according to MassDMF commercial data landings. Summer flounder was reported in three of the five years with a total of only 112 lb (50.8 kg) harvested from gill nets in Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, summer flounder was reported in every year in the fall and spring with a total of 1,509 individuals and 846 individuals caught, respectively.

Windowpane

This species was documented by the NOAA VTR commercial landings database, NOAA MRFSS database, DMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), windowpane was reported in seven of the years with a total of 2,981 lb (1,352.2 kg) harvested from Nantucket Sound.
- The numbers of windowpane observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 31 from shore and 3 from private/rental boats.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, windowpane was reported in every year in the fall and spring with a total of 655 individuals and 18,768 individuals caught, respectively.

Yellowtail flounder

This species was documented by the NOAA VTR commercial landings database, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), yellowtail flounder was reported in four of the years with a total of 2,981 lb (1,352.2 kg) harvested from Nantucket Sound.
- The numbers of yellowtail flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from shore and 2 from private/rental boats.
- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in only five of the years. Yellowtail flounder was reported in three of the five years with a total of 3,862 lb (1,751.8 kg) harvested from gill nets in the Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, yellowtail flounder was reported in nine of the years with a total of only 14 individuals caught. Yellowtail flounder was not reported in any of DMF fall resource trawl data in Nantucket Sound over the 27 year period.

Atlantic butterfish

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Atlantic butterfish was reported in nine of the years with a total of 70,034 lb (31,766.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Atlantic butterfish was reported in two of the years with a total of 2 individuals harvested from Nantucket Sound.

- The numbers of Atlantic butterfish observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 9 from shore.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Atlantic butterfish were reported in every year with a total of 191,814 lb (87,005.4 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic butterfish was reported in every year in the fall with a total of 217,038 individuals caught and in 24 of the years in the spring with a total of 6,579 individuals caught.

Atlantic mackerel

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Atlantic mackerel was reported in eight of the years with a total of 1,269,104 lb (575,655.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Atlantic mackerel was reported in two of the years with a total of 2 individuals harvested from Nantucket Sound.
- The numbers of Atlantic mackerel observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 453 from shore, 25 from party/charter boats and 1 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Atlantic mackerel were reported in every year with a total of 5,785,313 lb (2,624,173.8 kg) harvested from Nantucket Sound. Gill nets were fished in only five out of eleven years (1994-2004) according to DMF commercial data landings. Atlantic mackerel was reported in three of the five years with a total of 6,305 lb (2,859.9 kg) harvested from Nantucket Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, Atlantic mackerel was reported in 10 of the years in the spring with a total of 68 individuals caught. Atlantic mackerel was not reported in any of DMF fall resource trawl data in Nantucket Sound over the 27 year period.

King mackerel

This species was documented by the MassDMF commercial database only.

- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), king mackerel was reported in twelve of the years with a total of 4,910 lb (2,227.1 kg) harvested from Nantucket Sound. King mackerel was not reported in MassDMF commercial data landings for any other fishery or gear type in Nantucket Sound.

Spanish mackerel

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, and the MassDMF commercial database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Spanish mackerel was reported in one of the years with a total of only 4 lb (1.8 k kilograms) harvested in Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Spanish mackerel was reported in one of the years with a total of only 1 individual harvested in Nantucket Sound.
- The numbers of Spanish mackerel observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 5 from shore and 1 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Spanish mackerel was reported in fourteen of the years with a total of 67,687 lb (30,702.3 kg) harvested from Nantucket Sound.

Cobia

This species was not reported in any of the five databases.

Blue shark

This species was not reported in any of the five databases. The MRFSS survey reported shark, but it was not classified to the species level.

Shortfin mako shark

This species was documented by the NOAA MRFSS database only.

- The numbers of shortfin mako shark observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from party/charter boats and 1 from private/rental boats.

Bluefin tuna

This species was documented by the NOAA VTR commercial landings database and the NOAA MRFSS database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), bluefin tuna was reported in only one of the years with a total of 375 lb (170 kg) harvested from Nantucket Sound.
- The numbers of bluefin tuna observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 16 from private/rental boats.

Little skate

The NOAA VTR commercial and recreational charter landings databases and the MassDMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the MassDMF resource trawl spring and fall survey database reported landings specifically for little skate.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), unspecified skate species was reported in ten of the years with a total of 12,792 lb (5,802.3 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), unspecified skate species was reported in ten of the years with a total of 174 individuals harvested from Nantucket Sound.
- The numbers of little skates observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 4 from private/rental boats. In addition, one unspecified skate was observed from private/rental boats.
- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in only five of the years. Unclassified skates were reported in one of the five years with a total of 371 lb (168.3 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, little skate was reported in every year in the fall and spring with a total of 6,534 individuals and 6,794 individuals caught, respectively.

Winter skate

The NOAA VTR commercial and recreational charter landings databases and the MassDMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the MassDMF resource trawl spring and fall survey database reported landings specifically for winter skate.

- For NOAA commercial VTR data and recreational charter VTR data landings, see above.
- The numbers of winter skate observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from private/rental boats.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, winter skate was reported in every year in the fall and spring with a total of 4,205 individuals and 5,481 individuals caught, respectively.

Long-finned squid

This species was documented by the NOAA VTR commercial and recreational charter landings databases, MassDMF commercial database (not specific to species), and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), long-finned squid was reported in every year with a total of 3,583,134 lb (1,625,282.2 kg) harvested from Nantucket Sound. An additional 169,825 lb (77,031.3 kg) of unspecified squid was harvested from Nantucket Sound.

- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), long-finned squid was reported in seven of the years with a total of 19,680 individuals harvested from Nantucket Sound. An additional 1,031 lb (467.7 kg) of unspecified squid was harvested from Nantucket Sound.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), unclassified squid were reported in every year with a total of 4,726,815 lb (2,144,047.2 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, long-finned squid was reported in every year in the fall and spring with a total of 228,817 individuals and 54,408 individuals caught, respectively.

Short-finned squid

This species was documented by the NOAA VTR commercial and recreational charter landings databases, MassDMF commercial database (not specific to species), and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), short-finned squid was reported in six of the years with a total of 79,152 lb (35,902.7 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), short-finned squid was reported in one of the years with a total of 500 individuals harvested from Nantucket Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, short-finned squid was reported in one of the years with a total of 1 caught in the spring. Short-finned squid was not reported in any of MassDMF fall resource trawl data in Nantucket Sound over the 27 year period.

Surf clam

This species was documented by the NOAA VTR commercial landings database (not specific to species), MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), an unspecified clam species was reported in two of the years with a total of 137,936 lb (62,566.7 kg) harvested from Nantucket Sound.
- During the fifteen years of MassDMF commercial data landings for fish pots (1990-2004), surf clam was reported in six of the years with a total of 12,816,980 lb (5,813,684.3 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, surf clam was reported in thirteen of the years in the fall with a total of 61 individuals caught and in eight of the years in the spring with a total of 17 individuals caught.

4.2.9 Threatened and Endangered (T&E) Species

4.2.9.1 Introduction

This section provides an overview of the species in the area of the proposed action that are protected under the ESA. More detailed information on the presence of federally listed species in the area of the proposed action and potential impacts to these species from the proposed action is included in [Appendix C](#). The MMS, as the lead federal NEPA agency for the proposed action, is mandated by Section 7 of the ESA to consult with the Department of Commerce (via NOAA Fisheries Service) and the Secretary of the Interior (via U.S. Fish & Wildlife Service [USFWS]) to determine if any species protected under the ESA may be affected by the proposed action. To date, consultations with these agencies have been informal. MMS intends to submit a Biological Assessment to these agencies around the time of publication of this DEIS to initiate formal consultation. If these agencies determine that any listed species or their habitat have the potential to be affected by the proposed action, this consultation includes the evaluation of potential impacts from the proposed action on listed species and designated critical habitat. Accordingly, the MMS has initiated such consultations with NOAA Fisheries Service and USFWS. The outcome of these consultations and reviews by these agencies would most likely result in the Service's preparation of separate Biological Opinions, which assesses whether the action is likely to "...jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species" (50 CFR Part 402). Where possible, requirements and recommendations would be provided within these Biological Opinions as to how the potential for impacts from the proposed action can be minimized or eliminated. Further, an Incidental Take Statement (ITS) may be given, allowing the unintentional "taking" of listed species based on certain conditions.

4.2.9.2 Studies Completed

Review of scientific literature, including stock assessment reports, and consultation with resource management agencies, suggest that few studies of ESA protected marine mammal and turtle species have been conducted within Nantucket Sound. A comprehensive literature search targeting protected whale, seal, and reptile species in Nantucket Sound and acoustical impacts to marine mammals and reptiles was conducted to obtain information on protected marine species in Nantucket Sound and potential impacts of the proposed action to these resources. In addition, researchers from the Protected Resources Branch at the NMFS Northeast Fisheries Science Center, the Sea Turtle Stranding and Salvage Network, the Provincetown Center for Coastal Studies, and the University of Rhode Island, were contacted by the applicant to obtain additional stock assessment, sighting, stranding, and population studies information.

4.2.9.3 Resource Characterization

According to the most recent FWS letters, there are no federally-listed or proposed threatened or endangered species located within the proposed onshore transmission cable system route to the Barnstable Switching Station, with the exception of the occasional transient bald eagle (*Haliaeetus leucocephalus*) ([Appendix E](#)). However, since the date the FWS letters were sent, the bald eagle has been de-listed, and is therefore not discussed in this document. There are two listed birds, the roseate tern (*Sterna dougallii*) and the piping plover (*Charadrius melodus*) that have the potential to occur in the area of the proposed action, as well as the candidate species, the red knot (*Calidris canutus rufa*). The NOAA Fisheries consultation has led to the identification of 3 whales and 4 sea turtles as having the potential to occur in the area of the proposed action. The whale species include the humpback whale (*Megaptera novaeangliae*), the fin whale (*Balaenoptera physalus*), and the North Atlantic right whale (*Eubalaena glacialis*). The sea turtle species include the loggerhead sea turtle (*Caretta caretta*), the Kemp's ridley sea turtle (*Lepidochelys kempi*), the leatherback sea turtle (*Dermochelys coriacea*), and the green sea turtle (*Chelonia mydas*). The proposed transmission cable landfall for the proposed action is located approximately 0.8 miles (1.3 km) from the nearest known nesting sites of piping plover on Great Island

and 1.5 miles (2.4 km) from nesting sites at Kalmus Beach/Dunbar Point, Hyannis and the north-western corner of Great Island. The proposed actions's buried cables (at their closest point to nesting sites) would pass within approximately 820 ft (250 m) of Kalmus Beach/Dunbar Point and approximately 1,210 ft (369 m) of Great Island. Support vessels associated with the proposed action's cable installation would pass within approximately 670 ft (204 m) of Kalmus Beach/Dunbar Point and 1,060 ft (323 m) of Great Island ([Report No. 4.2.9-1](#)). In addition to the species noted above, another species of concern is the New England Cottontail (*Sylvilagus transitionalis*)

A brief overview of the life history characteristics for these species is provided below, and a summary overview of the potential impacts is provided in Section 5.3.2.9. For a detailed presentation of the characteristics of the T&E species that have been identified as potentially occurring in the area of the proposed action and potential impacts associated with the project (see [Appendix C](#)). Detailed presentation of information on the red knot is provided below, and in Section 5.3.2.9, but not in [Appendix C](#), since this is a candidate species and is not yet afforded protection under the ESA.

New England Cottontail

The New England cottontail (*Sylvilagus transitionalis*) is a species of rabbit that is a candidate for protection under the ESA (Capitol Reports, 2006). Decline of New England cottontail populations are believed to be due to reduction of favorable habitats and displacement by the adaptable populations of the introduced Eastern cottontail (*Sylvilagus floridanus*) (MDFWELE, 2007; NatureServe, 2007). Historically, New England cottontails were present in all 14 counties of Massachusetts and prior to 1930 were the only cottontails appearing among 59 reports except for seven that were from Nantucket where Eastern cottontails were introduced in the late 1800's (MDFWELE, 2007). New England cottontails appear to prefer areas that are brushy, areas with woodlands and an open understory, areas with shrub-dominated wetlands and areas that are mountainous (MDFWELE, 2007). Home ranges of this species have been noted to be between 0.5 to 8.3 acres (0.002 to 0.034 km²) depending on the habitat and geographical area (MDFWELE, 2007). New England cottontails are active at dawn and dusk or at night, and feed on tender grasses and herbs in spring/summer, and bark, twigs and buds of young trees and shrubs in winter (MDFWELE, 2007). This species' breeding period is from March to July, occasionally extending to September and there are two or three litters per year (MDFWELE, 2007). Small populations of New England cottontails were observed in Barnstable County during a 2000 - 2003 survey (MDFW, 2003).

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) occur throughout the world. Humpback whales are opportunistic feeders, and prey on a variety of pelagic crustaceans and small fish (Nemoto, 1970; Kreiger and Wing, 1984). There are three primary feeding aggregations in the Western Atlantic: the U.S. east coast (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and Western Greenland (Waring et al., 2006). Humpback whales are a migratory species, feeding in the northern latitudes during the summer months and migrating to the West Indies during winter months to mate and calve (Waring et al., 2006). Humpback whales regularly visit the area of southern New England, where they are present in greatest abundance between June and September (Payne and Heinemann, 1990; Sadove and Cardinale, 1993). Located offshore from Nantucket Sound are primary feeding grounds for humpback whales, mainly supplying whales from the Gulf of Maine feeding aggregation. Few humpback whales are sighted within Nantucket Sound since they favor locations further north for feeding grounds, as prey species are not plentiful within the Sound (Kenney and Winn, 1986). Humpback whales were first listed as an endangered species in the U.S. in 1970.

Between 1999 and 2003, the total human-caused mortality and serious injury to the Gulf of Maine humpback whale population was estimated at 3.8 per year, based on three causes: (1) incidental fishery

interactions; (2) vessel collisions; and (3) direct takes (this occurred during winter breeding periods in the south) (Waring et al., 2006). The most common source of mortality for humpback whales in the western North Atlantic is entanglement in commercial fishing gear, particularly off Newfoundland (O'Hara et al., 1986; Lien et al., 1989 a, b; Hofman, 1990; Volgenau and Kraus, 1990; NMFS, 1991). The second major anthropogenic source of mortality for humpback whales in the New England is collisions with vessels. In NMFS records from 1999 to 2003, 15 humpback whales were recorded as been struck by a vessel, 6 of which resulted in mortalities.

Fin Whale

Fin whales (*Balaenoptera physalus*) are large whales found in the temperate waters of the western North Atlantic. Fin whales feed on a wide variety of small schooling fish and crustaceans, primarily capelin (Piatt et al., 1989). Fin whales range along the continental shelf between Cape Hatteras and southeastern Canada (Hain et al., 1992). Stocks of fin whales from the Gulf of Maine, Nova Scotia and Labrador are believed to be of one or a few closely related populations (Waring et al., 2006). Fin whales occur in Massachusetts waters from mid March to the end of November, in important feeding grounds of New England waters, specifically the areas around Jeffrey's Ledge, Stellwagen Bank, and Cape Cod Bay with few sightings within Nantucket Sound (NOAA Fisheries Service, 2005). Fin whales were listed as endangered throughout their range in 1970.

While there is little published information about natural and anthropogenic causes of mortality in fin whales, it can be assumed that the hazards that affect humpback whales would also affect fin whales. According to NMFS records from 1999 to 2003 there was an average of 1.4 fin whale deaths due to human-related causes, of which 0.4 deaths resulted from fishing entanglement and 1.0 resulted from vessel strikes (Waring et al., 2006).

North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) is the rarest of the larger whales. The primary food of right whales in the western North Atlantic is calanoid copepods, *Calanus finmarchicus*, and juvenile euphausiids (Nemoto, 1970; Murison and Gaskin, 1989). Right whales are migratory animals, with seasonal movements including "high use" of areas from spring to fall within Cape Cod Bay, Massachusetts Bay, Georges Bank and the Gulf of Maine (Waring et al., 2006). The Great South Channel and Cape Cod Bay have been designated as critical habitat for the North Atlantic right whale, and considered to be essential for the recovery of the population (Report No. 4.2.9-2). North Atlantic right whales may occasionally occur in Nantucket Sound; however, as the waters are too shallow and not productive enough for the whale's prey, their occurrence would be considered "rare and transient". The North Atlantic right whale has been listed as endangered under the ESA since 1973.

Collisions with vessels have resulted in 16 of 75 confirmed deaths in the stock between 1970 and 1999, and are the leading source of human-related mortality in the North Atlantic right whale (NWFS, 2005). Researchers believe that North Atlantic right whales are more susceptible to strikes due to the characteristics of slow swimming, feeding at the surface, and preferring nearshore waters. Entanglement in fishing gear is the second leading cause of mortality in North Atlantic right whales; over half of the photographed population has some scarring from fishing gear entanglements (Waring et al., 2006). The total known human-caused mortality is unknown, but is suggested at minimum to be 2.6 right whales per year from 1999 to 2003 (Waring et al., 2006).

Loggerhead Turtle

The loggerhead sea turtle (*Caretta caretta*) is a turtle that seasonably inhabits the inshore coastal waters of the North Atlantic. Adult loggerheads are primarily bottom feeders, foraging in coastal waters

for benthic mollusks and crustaceans (Bjorndal, 1985). The range of the loggerhead sea turtle extends from Newfoundland to Argentina. Loggerhead turtles are abundant in the northeast from May 1 through November 15 when water temperatures are favorable (NOAA, 2005). During the spring and summer months, loggerhead turtles are commonly found in the waters off New York, with a small number of individuals, mostly comprised of juveniles, reaching as far north as New England (NOAA, 2005). There have been no direct surveys of leatherback turtles along the North Atlantic Coast, the best estimates can be obtained through incidental observation of sea turtles made by the MAS from 2002 through 2004 during boat tern surveys. During this survey in the waters of Nantucket Sound, 115 individuals were recorded, identified as leatherback, non-leatherback and unidentifiable, of which only 14 were located within the proposed action area and 10 identified as non-leatherback or unidentifiable (MAS, 2005). The loggerhead sea turtle was listed as threatened under the ESA throughout its range in 1978, and its status has not changed.

While the causes of loggerhead sea turtle strandings, whether human-caused or natural, are not well understood, between four and seven strandings per year have been recorded in the waters Massachusetts and Rhode Island from 1990 to 2000, and 11 loggerhead strandings were recorded on the shorelines of Nantucket and Martha's Vineyard from 1980 through 1997 (NMFS, 2002 unpublished data). Strandings occur most frequently in the fall and winter, presumably caused by cold stunning due to prolonged exposure to lower water temperatures (Morreale et al., 1992; Matassa et al., 1994). Human-caused mortality of loggerhead turtles includes incidental take, fishing gear and marine debris entanglement and ingestion, and loss of nesting habitat (NOAA, 2005).

Kemp's Ridley Turtle

The Kemp's ridley sea turtle (*Lepidochelys kempii*) is distributed through coastal areas of the Gulf of Mexico and northwestern Atlantic Ocean. Juveniles, representing the greatest proportion of Kemp's ridley sea turtles in the North Atlantic forage in shallow coastal waters, usually in waters less than 3 ft (1 m) deep (Ogren, 1989), but tend to move into deeper water as they grow. Young Kemp's ridley sea turtles consume several species of crabs, and crustaceans represent more than 80 percent of their diet (Burke et al., 1994). Adult Kemp's ridley sea turtles are found mainly in the Gulf of Mexico, while juveniles use northeast and mid-Atlantic coastal waters during the summer months as primary developmental habitat. Kemp's ridley turtles feed in the shallow nearshore waters of Vineyard Sound and Buzzards Bay in summer months, and may be present in the vicinity of Nantucket Sound through the fall (Burke et al., 1989; Morreale and Standora, 1989; Keniath et al., 1987; Musick and Limpus, 1997). The Kemp's ridley sea turtle was listed as endangered under the ESA in 1970.

For the period of 1990 to 2000, between nine and 216 Kemp's ridley sea turtle strandings were reported in Massachusetts waters, and one Kemp's ridley sea turtle stranding was reported in Rhode Island waters (Sea Turtle Stranding and Salvage Network, unpublished data). Each year between November and January when ocean water temperatures are falling, small numbers of Kemp's ridley sea turtles become stranded and die on beaches of the north and east shores of Long Island and Cape Cod Bay, due to cold stunning (NOAA, 1991; Morreale and Standora, 1992). Other human-caused mortality of Kemp's ridley sea turtles include incidental take, fishing gear and marine debris entanglement and ingestion, chemical pollution, and loss of nesting habitat (NOAA, 2005).

Leatherback Turtle

Leatherback sea turtles (*Dermochelys coriacea*) are found in temperate and tropical waters. They are common turtle along the eastern United States and the most common north of 42° N latitude. They are pelagic feeders preying on zooplankton; they can dive to considerable depths of at least 1000 m (Eckert et al., 1989). The seasonable distribution of leatherback sea turtles in the North Atlantic waters range from Cape Sable, Nova Scotia south to Puerto Rico and the US Virgin Islands. Leatherback sea turtles can be

expected to be present in Nantucket Sound when water temperatures are favorable, from early summer through late fall. Leatherback sea turtles are more commonly reported in Massachusetts waters than other sea turtle species, and densities are likely associated with inshore concentrations of jellyfish. The leatherback sea turtle was listed as endangered throughout its range in 1970 under the ESA.

Incidental observation of sea turtles made by the MAS from 2002 to 2004 during tern surveys recorded 115 individuals in the waters of Nantucket Sound, of which only 14 were located within the proposed action area and 12 were identified as leatherback sea turtles or unidentifiable (MAS, 2005). Leatherbacks sea turtles are highly vulnerable to entanglement in fishing gear; 6,363 individual turtles were caught by U.S. Atlantic tuna and swordfish longlines from 1992 to 1999; 88 of those turtles died (NMFS-SEFSC, 2001). Human-caused mortality of leatherback sea turtles includes incidental take, fishing gear and marine debris entanglement and ingestion, and loss of habitat nesting (NOAA, 2005).

Green Turtle

The green sea turtle (*Chelonia mydas*) range in the continental U.S. extends from Massachusetts to Texas, the occurrence of this species north of Virginia during any month of the year is considered unusual (NOAA Fisheries, 2002; Thompson, 1988). Adult green sea turtles forage on shallow-growing algae and seagrasses (Crite, 2000). The green sea turtle was originally protected under the ESA in 1978.

Documented accounts of green sea turtles in New England are most commonly instances of reported strandings; between 1999 and 2001, nine strandings of green sea turtles were reported within Massachusetts and Rhode Island (STSSN, 2005). Strandings occur most frequently in the fall and winter, presumably caused by cold stunning due to prolonged exposure to low water temperatures below 50°F (10°C) (Morreale et al., 1992; Matassa et al., 1994). Human-caused mortality of green sea turtles include incidental bycatch by various fishing practices, fishing gear and marine debris entanglement and ingestion, oil spills, PCBs, and the loss of nesting habitat (Thompson, 1988; NMFS & USFWS, 1991; NOAA, 2005).

Roseate Tern

Federally endangered roseate terns (*Sterna dougallii*) breed at limited colony locations within Buzzards Bay including Bird, Ram, and Penikese Islands; and South Monomoy and Minimoy Island in Nantucket Sound. Roseate terns return to breeding grounds in the Northeast and Atlantic Canada from late-April to mid-May. Roseate terns depart the region for their wintering grounds by September. Cape Cod, Massachusetts supports the largest pre-migratory staging habitat for roseate terns in North America and any individual from the northeastern population could occur in the area of Nantucket Sound during migration.

The majority of tern observations in Nantucket Sound during the applicant and MAS's surveys from 2002 to 2006 occurred outside of HSS. Terns were generally concentrated around the mainland and island coasts of the Sound, particularly Monomoy Island during the late-August and early-September staging period. Terns were observed traveling through the area of the proposed action, and few were observed actively foraging. During this period HSS likely had the lowest level of activity out of any similar habitat surveyed in the Sound.

Piping Plover

Federally threatened piping plover (*Charadrius melodus*) breed along the mainland and island shores of Nantucket Sound. Piping plover spring arrival in the region peaks in late April to early May. In the fall in Massachusetts, the birds depart breeding sites by late-August. During migration periods, any individual from the Atlantic Canada or New England populations could occur in the area. Migration

corridors along the coast are not well known. South Beach, Chatham and locations on Nantucket and Martha's Vineyard may provide stop-over habitat.

No piping plover were observed during either the applicant or MAS's aerial and boat surveys conducted over areas of Nantucket Sound. However, these surveys were conducted only during the day, and therefore do not account for the potential of plover crossings of the Sound at night during migration.

Beach habitat at the cable landing location is not optimal for piping plover, and the nearest known nesting beach is 1.5 miles (2.4 km) from the landfall. For the offshore portion of the proposed action area, piping plover occurrence, while not well known, is most likely less than that associated with their use of coastal beaches and shoreline areas, rather than open water areas like Horseshoe Shoal. Few crossings of Nantucket Sound are expected during the breeding season as plovers are mainly sedentary and make small scale movements between nesting and foraging locations along the beach. Regular daily movements would not result in crossings of Nantucket Sound. The exception would be occasional crossings of Nantucket Sound as individuals access alternate nesting or foraging areas. Other unusual crossings could be conducted by failed nesters or unpaired individuals traveling between the mainland and Nantucket or Martha's Vineyard in search of habitat or a mate.

Red Knot

The red knot (*Calidris canutus rufa*) is a medium-sized shorebird that is noted for having one of the longest migrations of any bird, and is capable of sustained flight for thousands of km (Piersma, 1987). There are six subspecies, three of which occur regularly in North America; only the *C.c.rufa* population is described as "highly imperiled" in the US Shorebird Conservation Plan, and all subspecies nesting in North America are of "high concern" (USFWS, 2004; Brown et al., 2001). A decline in the number of red knot at stopover sites in the western Atlantic has been documented since the 1970's, with sharp drops observed from 1999 to 2004 (Baker et al., 2004; Morrison et al., 1994). This decline has been attributed to reduction in stopover food resources and habitat loss, in conjunction with global climate change and general human disturbances. Based on the threats to the Delaware Bay ecosystem attributed to over harvesting of horseshoe crab, coastal habitat degradation, and projected decrease in intertidal foraging habitat, the USFWS determined that *C.c.rufa* is a candidate species for listing under the ESA (1973, as amended).

Life History

The red knot nests in the high-central Canadian arctic and winter in austral South America, a sojourn of approximately 30,000 km (USFWS, 2006). The boreal winter is spent in Argentina and Chile, although some individuals, particularly juveniles, may winter further north (Harrington et al., 2001). A large percentage of the population winters in Bahia Lomas, Chile, thought to be the highest density of wintering red knot (Morrison and Ross, 1989). Northward migration begins as early as February, with individuals reaching the southeastern U.S. coast around March, and peak abundance occurs in April and early May (Harrington, 2001). Red knot arrive on Delaware and New Jersey coasts around the third week of April and remain through the first week of June, with peak abundance occurring in mid to late May, and few individuals remaining after June 5th (Robinson et al., 2003). The species is less prevalent in Massachusetts and eastern Canada during northward migration than during the late summer and early fall (Morrison et al., 1994).

The timing of arrival at Canadian breeding grounds has been poorly studied. Other red knot subspecies arrive in breeding territories in late May and early June, and typically begin establishing nesting territories within a few days (Parmelee and MacDonald, 1960). Eggs are laid in mid to late June and nesting is completed by mid July (Nettleship, 1974 *as cited in* Harrington, 2001). Red knots are known to have only one clutch per breeding season which typically consists of 4 eggs (Nettleship, 1974

as cited in Harrington, 2001). During fall migration individuals move south by mid-July, in Massachusetts numbers increase steadily until early August, then decrease between August 10 and August 20. First year juvenile birds may arrive latter and depart at the end of August, but tend not to concentrate at traditional staging areas like mature birds. The species is uncommon on the Southeastern U.S. coast before August during southward movement (Morrison and Harrington, 1979).

During spring and fall migration red knot stop on sandy shorelines, typically the intertidal zone near coastal inlets of bays and estuaries (Clark et al., 1993). Optimal foraging areas support a high density of infaunal prey organisms and/or horseshoe crab eggs, and are often associated with areas of high wave and current action, coincident with sandy substratum. Clark et al. (1993) demonstrated an association between areas of red knot foraging activity and close proximity to salt marshes, as well as a correlation between foraging activity and concentrations of other shorebirds. Red knot may be found on rocky or pebble beaches and in salt marshes and muddy areas where it exhibits foraging behavior similar to dowitchers (*Limnodromus* spp.) (Harrington, 2001). Nesting occurs most often on dry and elevated tundra, typically inland, and foraging occurs more frequently in non-marine areas during nesting (Harrington, 2001; Portenko, 1981).

Red knots wade in water to from 0.8 to 1.1 in (2-3 cm) deep and may forage on eroded peat banks, during stops along the New England coast. It hunts primarily for infaunal bivalves, small mollusks, marine invertebrates, and gastropods. The amount of habitat used to forage for invertebrates depends on prey diversity and prey availability, and may be influenced by disturbance factors and interspecific competition (Harrington, 2001; Piersma and Koolhaas, 1997). In Massachusetts mussel spat are the most common prey species taken in July and August, where red knot forage about 2 hours on either side of low tide (Schneider and Harrington, 1981). In addition to animal prey, red knot may eat vegetation, under some circumstances, such as early arrival at high arctic breeding grounds before adequate insect prey bases have developed.

Population Dynamics

Red knot use the eastern U.S. coastal flyway as their primary migration route (Engelmoer and Roselaar, 1998). Important stopover areas are in Delaware, New Jersey, Maryland, Virginia and New England (USFWS, 2006). Of particular importance is the Delaware Bay staging area, with abundant seasonal food resources and foraging habitat. Individuals often increase in body mass by between 50 and 80 percent during the few weeks spent foraging on horseshoe crab (*Limulus polyphemus*) eggs there (Tsipoura and Burger, 1999, Botton et al., 1994). The red knot population using the Massachusetts coastline is mostly migratory and are most abundant during the early fall at staging areas near Plymouth-Duxbury Bay, Nauset Marsh, Monomoy National Wildlife Refuge, Scituate, and Plum Island/Parker River (USFWS, 2006). During the 1970's, 60 to 90 percent of the entire suspected population was observed in Massachusetts and New Jersey, during southward migration (USFWS, 2006). The maximum count of red knot recorded is approximately 950 at Plymouth-Duxbury Bay Complex, 300 at Nauset Marsh, 3,000 at Monomoy NWR, 2,800 at Scituate, and 100 at Plum Island/Parker River (Chan, 2003).

Studies of staging areas along the western Atlantic coast and of wintering areas in South America demonstrate a clear demographic decline. Morrison et al. (1994) calculated a fifteen percent rate of annual decline in adult red knot at stopover sites in maritime Canada, between 1974 and 1991 with an overall 10-year decrease of 81 percent. Donaldson et al. (2000) documented a population decline of more than 13 percent from 1974 to 1998. Surveys conducted in 1986 and repeated in 2002 showed a 55 percent decline in red knot wintering in six South American study areas (Niles et al., 2006). In Delaware Bay a consistent decline in maximum number of migrants was observed each year from 1999 through 2004.

Status and Distribution

Recent population estimates vary widely from approximately 30,000 to 140,000 individuals (USFWS, 2006; Harrington, 2001). Research by Baker et al. (2004) determined that the red knot population would likely decline to very low numbers by 2010. Subsequent counts of wintering red knot in 2004 and 2005 demonstrated evidence of the demographic trends predicted by Baker. The population was estimated at $152,900 \pm 50,300$ during the spring of 1989 (Morrison et al., 1994) and Clark et al. (1993) estimated the population at 94,460 during peak abundances at Delaware Bay. Peak counts at Delaware Bay in 2004 and 2005 diminished to 13,315 and 15,345, respectively (USFWS, 2006). Although the observed fluctuations of red knot at stopovers in the mid-Atlantic and New England are appropriate estimates of trends in demographics and total abundances at those areas, they may not necessarily be appropriate estimates of the entire population (Morrison et al., 1994., Clark et al., 1993., Robinson et al., 2003). Nonetheless, Clark et al. (1993) and others have demonstrated a clear downward trend in population size, as evident in counts from both stopovers areas and wintering sites in South America.

One red knot was observed during one boat survey and no other individuals were observed during aerial surveys conducted by the applicant or by MAS.

Changes in the management of horseshoe crab stocks since 1997, coupled with better conditions on breeding grounds in recent years, give some positive indications of population stabilization (USFWS, 2006). Recent surveys of migrants at Delaware Bay and Virginia, in conjunction with censuses of wintering birds in South America, indicate that the population decline may have abated. A slight increase of approximately 2,000 individuals (from ca. 13,300 to 15,300) in peak migrant abundance was recorded between 2004 and 2005 at Delaware Bay (USFWS, 2006).

Threats

The primary factor for the status of the red knot is the decline in food resources at the Delaware Bay spring staging area (USFWS, 2006; Baker et al., 2004; Robinson et al., 2003; Tsipoura and Burger, 1999; Botton et al., 1994; Clark et al., 1993; Piersma, 1987; Morrison and Harrington, 1979). The commercial harvest of horseshoe crabs used for bait in other fisheries and for biomedical research has reduced the spawning population in the Delaware Bay area, and subsequently led to a substantial decline in eggs available for migrating red knot. Because the red knot and other shorebird species rely on the seasonally abundant food resources at a small number of staging areas along their migration route, the decimation of any one food resource may have implications for overall population health (Wilson and Barter, 1998). The reduction in available food resources in Delaware Bay has caused individuals to be “underweight” and less likely to reach breeding grounds in good health. Baker et al. (2004) found survival rates declined by more than 35 percent in adults and by more than 45 percent in juveniles between spring 2000 and spring 2001. This decline has been attributed to reductions in key food resources at the stopover site preventing individuals from reaching threshold weights for migration to the arctic. A number of management actions have been under taken since the 1990’s, by federal and state management agencies (i.e., ASMFC Horseshoe Crab Management Board) to limit the number of horseshoe crabs harvested.

Shoreline alteration and changes in long shore sediment drift patterns may also be a threat to red knot using the Massachusetts coastline (Niles et al., 2006). Of particular concern for conservation efforts is the species’ high fidelity to stopover sites. Of the 3,316 red knot banded by Harrington et al. (1988) in nine years of study at Scituate, Massachusetts, $1,661 \pm 724$ banded birds used the stopover site during peak periods of migration. Similar patterns have been observed in Delaware Bay (Baker et al., 2004). Loss and/or degradation of coastal habitat in South America attributed to changes in drainage patterns by farm irrigation practices coupled with widespread oil pollution may be effecting the red knot wintering population as well (USFWS, 2006).

During migration periods, direct human disturbance is also a threat, particularly along beaches where their behavior may alter the foraging behavior of migrants, or where boats are present near roosting sites (USFWS, 2006). Peters and Otis (2007) found that red knot avoided roost sites that had boat activity within 1000 m. Anthropogenic disturbance in suitable foraging habitat throughout the Atlantic seaboard, including Massachusetts, is reported to have “major negative impact(s)” on red knot (Niles et al., 2006). Disturbance in conjunction with losses of intertidal foraging habitat may cause red knot to forage in sub-optimal areas.

4.3 SOCIOECONOMIC RESOURCES AND LAND USE

This section assesses the existing socioeconomic resources and land use in the area to provide an understanding of the people who live in the area and the economic conditions that exist including information about housing, construction and manufacturing industries, service industries, waste disposal, energy industries and population statistics such as race and population density. This information provides a baseline from which to compare socio economic impacts as discussed in Section 5.

4.3.1 Socioeconomic Analysis Area

This section addresses the geographic scope of the study area and the sources of information used in the study.

4.3.1.1 Metropolitan Statistical Area

With respect to socioeconomic analysis, the MMS defined the region of impact (ROI) as four locations in Massachusetts; Barnstable County, Nantucket Island in Nantucket County, Martha’s Vineyard in Dukes County, and New Bedford in Bristol County in Massachusetts, and Quonset, in Washington County, Rhode Island,.

Barnstable County was included in the ROI because this would be the daily debarkation point for workers involved in construction and operation and would require the presence of an on-shore support base to support offshore construction and annual O&M activities, and the presence of on-shore infrastructure such as the 115 kV transmission cable system that would convey power from the project to the existing regional T&D system. Nantucket and Martha’s Vineyard would be included in the ROI due to their close proximity to the proposed action and possible contribution of workers. Quonset Rhode Island and Washington County Rhode Island were included in the ROI as this is where fabrication and assembly of the WTB components is likely to occur as well as the majority of construction and decommissioning activities would be staged here. Bristol County was included because maintenance vessels related to the proposed action would be operated out of New Bedford, in Bristol County. The manufacture and purchase of much of the specialized equipment that would comprise the WTGs such as the rotors, generators, and nacelles, etc. would occur outside the ROI.

Additionally, construction and operational employees may come from areas beyond the ROI, and that in a broader sense, the entire New England region would be affected by the proposed action via the electricity delivered into the New England electricity grid. However, the majority of the socio-economic impacts would be in the referenced ROI.

Socioeconomic data provided to describe existing socioeconomic conditions in this section came from the U.S. Census unless otherwise noted (<http://factfinder.census.gov>). The most recent available U.S. Census community data for Barnstable County, Massachusetts and Washington County, Rhode Island came from 2005 estimates, and the most recent available community data for Nantucket County, Dukes County, and Bristol County, Massachusetts came from the 2000 census. (U.S. Census, 2005 and U.S. Census, 2000).

4.3.2 Urban and Suburban Infrastructure

4.3.2.1 Housing

In 2005, there were approximately 100,000 housing units in Barnstable County, with approximately 80 percent of them owner occupied, and 20 percent renter occupied. The vacancy rate for owner occupied homes was approximately 1 percent and the vacancy rate for rental homes was 10 percent. Approximately 89 percent of those vacant units are considered to be seasonal or recreational in nature, which would leave approximately 1,200 units available for rent.

In 2000, there were approximately 9,210 housing units in Nantucket County, with approximately 25 percent of them owner occupied, and 15 percent renter occupied. The vacancy rate was approximately 2.4 percent for owner occupied homes and the vacancy rate was approximately 3.9 percent for rental homes. Approximately 56.1 percent of those vacant units are considered to be seasonal, recreational, or occasional use.

In 2000, there were approximately 14,836 housing units in Dukes County, with approximately 71.3 percent of them owner occupied, and 28.7 percent renter occupied. The vacancy rate for owner occupied homes was approximately 1.3 percent and the vacancy rate for rental homes was approximately 3.6 percent. Approximately 53.9 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

During the summer months vacancy rates in Barnstable County, Nantucket County and Dukes County decline as these areas are very popular summer vacation destinations for tourists and available vacant rental units help to address this seasonal demand.

In 2005, there were approximately 59,903 housing units in Washington County, with approximately 72.7 percent of them owner occupied, and 27.3 percent renter occupied. The vacancy rate for owner occupied homes was approximately 0.9 percent and the vacancy rate for rental homes was approximately 4.8 percent. Approximately 14.4 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

In 2000, there were approximately 216,918 housing units in Bristol County, with approximately 61.6 percent of them owner occupied, and 38.4 percent renter occupied. The vacancy rate for owner occupied homes was approximately 0.8 percent and the vacancy rate for rental homes was approximately 5.5 percent. Approximately 0.9 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

Median house values in all counties located in the ROI are considerably higher than the average applicable state median housing values indicating there is a high level of desirability and demand for housing stock in these locations. Further details on house prices are provided in Section 4.3.3.2 of this document.

4.3.2.2 Construction and Manufacturing Industries

In 2002, construction and manufacturing sectors employed 7.1 percent and 4.1 percent of the population of Barnstable County, respectively. From 1990 through 2002, the construction and manufacturing industries in Barnstable County have had an employment growth rate of 5.8 percent and -0.07 percent, respectively. In 2000, construction and manufacturing sectors employed 12.4 percent and 1.8 percent of the population of Nantucket County, respectively. From 1990 through 2000, the construction and manufacturing industries in Nantucket County have had an employment growth rate of -0.4 percent and 0.5 percent, respectively. In 2000, construction and manufacturing sectors employed 18.3

percent and 2.9 percent of the population of Dukes County, respectively. From 1990 through 2000, the construction and manufacturing industries in Dukes County have had an employment growth rate of 10 percent and 1.3 percent, respectively. In 2005, construction and manufacturing sectors employed 4.1 percent and 6 percent of the population of Washington County, respectively. From 1990 through 2005, the construction and manufacturing industries in Washington County have had an employment growth rate of 0.8 percent and -3.0 percent, respectively. In 2000, construction and manufacturing sectors employed 6.9 percent and 18.5 percent of the population of Bristol County, respectively.

4.3.2.3 Service Industries

The main service industries in the ROI include: Educational Services, Professional, Scientific and Technical Services, Admin, Support, Waste Management, Remediation Services, and Accommodation and food services. Additional information on business activity by job sector is provided in Section 4.3.3.2.2.

4.3.2.4 Waste Disposal and Transit Facilities

There are no waste disposal facilities in Barnstable County. Solid waste is collected at local and regional transfer stations and sent to the SEAMASS incinerator in Rochester, Massachusetts via rail or truck. Commercial solid waste is either taken directly to SEAMASS by a private hauler, or a fee is paid to the truck transfer station/railhead transfer station. Waste disposal in Rhode Island is handled by the Central Landfill, which spans across 1,200 acres and is located on Shun Pike in Johnston, Rhode Island. The Rhode Island Resource Recovery Corporation has owned and operated the Central Landfill since December 1980, and currently manages approximately 4,000 tons (3,628 kg) of residential and commercial waste per day.

4.3.2.5 Military Activity

The MMR is located on Cape Cod and consists of 21,000 acres (8500 hectares) of land split between the towns of Bourne, Mashpee, and Sandwich. Units operating at MMR include:

- Massachusetts Air National Guard (ANG), Otis ANG Base;
- Massachusetts Army National Guard (ARNG), Camp Edwards;
- U.S. Air Force's 6th Space Warning Squadron PAVE PAWS radar site (Cape Cod Air Force Station);
- USCG Air Station Cape Cod;
- Veterans Administration Cemetery; and
- U.S. Department of Agriculture (USDA).

4.3.2.6 Energy Industries

4.3.2.6.1 Electrical Generating Capacity

Canal Station, owned by Mirant Corporation, is the bulk electric generation facility that currently serves Barnstable County. The facility is located in Bourne, Massachusetts, and has a 1,120 MW generation capacity (560 MW peak unit) and is capable of being run on both number six fuel oil and natural gas. The electricity supply produced by the proposed action would be consumed primarily on the Cape and Islands. Since electricity follows the path of least resistance, the power would flow to the homes, schools and businesses of the Cape and Islands. Only when the proposed action is producing more power than demanded locally would some of the power cross the Cape Cod Canal via high voltage transmission lines. The expected production of 182 MWs of electricity in average wind conditions would meet three quarters of the 230 MW average electric demand of Cape Cod and the Islands.

4.3.2.6.2 Base and Surge Load Servicing

The electricity grid is built with redundancy to account for planned and unplanned outages from power production facilities. The New England Region electrical grid system is run by ISO-NE, an independent system operator, which ensures that adequate base load and peak demand capacity is available at all times. As part of the redundancy of the electrical grid system, ISO-NE requires a certain capacity of spinning reserves, which are sources of power available to start up quickly to compensate for any sudden drop in electricity production. During a power plant outage, whether a conventional plant or a wind plant, backup is provided by the entire interconnected utility system. The system operating strategy strives to make best use of all elements of the overall system, taking into account the operating characteristics of each generating unit and planning for contingencies such as plant or transmission line outages. The utility system is also designed to accommodate load fluctuations, which occur continuously. This feature facilitates accommodation of wind plant output fluctuations.

4.3.2.6.3 Transmission and Relay System

The existing transmission system on Cape Cod operates at 115kV and 345kV. Crossing the Cape Cod Canal, there are two 115 kV lines and two 345 kV lines. The 115 kV lines are capable of carrying 225 MW each and the 345 kV lines are capable of carrying 1000 MW each. The existing substation in the town of Barnstable, Massachusetts operates at 115 kV and, once it has been upgraded, would be able to accept and deliver the additional power from the two 115 kV lines from the proposed action.

4.3.3 Population and Economic Background

4.3.3.1 Demographics

4.3.3.1.1 Population

In 2005, Barnstable County had a household population of 221,000, with 116,000 (52 percent) females and 105,000 (48 percent) males. The average annual population growth rate from 1990 through 2005 was 1.2 percent.

In 2000, Nantucket County had a total population of 9,520, with 4,884 (51.3 percent) males and 4,636 (48.7 percent) females. The average annual population growth rate from 1990 through 2000 was 5.8 percent.

In 2000, Dukes County had a total population of 14,987 with 7,323 (48.9 percent) males and 7,664 (51.1 percent) females. The average annual population growth rate from 1990 through 2000 was 2.9 percent.

In 2005, Washington County had a total population of 123,322 with 60,221 (48.8 percent) males and 63,101 (51.2 percent) females. The average annual population growth rate from 1990 through 2005 was 0.7 percent.

In 2000, Bristol County had a total population of 534,678 with 256,747 (48.0 percent) males and 277,931 (52.0 percent) females. The average annual population growth rate from 1990 through 2000 was 0.56 percent. Further information on population of the ROI is provided in [Table 4.3.3-1](#).

4.3.3.1.2 Age

The median age in Barnstable County in 2005 was 45.6 years. Nineteen percent of the population were under 18 years, 6 percent were between 18 and 24 years, 24 percent were between 25 and 44 years, 28 percent were between 45 and 64 years, and 23 percent were 65 years and older.

The median age in Nantucket County in 2000 was 36.7 years. Approximately 20.7 percent of the population were 19 years and younger, 5.9 percent were between 20 and 24 years, 40.5 percent were between 25 and 44 years, 22.5 percent were between 45 and 64 years, and 10.5 percent were 65 years and older.

The median age in Dukes County in 2000 was 40.7 years. Approximately 24.5 percent of the population were 19 years and younger, 3.7 percent were between 20 and 24 years, 29.6 percent were between 25 and 44 years, 27.8 percent were between 45 and 64 years, and 14.4 percent were 65 years and older.

The median age in Washington County in 2005 was 40.5 years. Approximately 27.5 percent of the population were 19 years and younger, seven percent were between 20 and 24 years, 28.4 percent were between 25 and 44 years, 24.3 percent were between 45 and 64 years, and 12.7 percent were 65 years and older.

The median age in Bristol County in 2000 was 36.7 years. Approximately 27.3 percent of the population were 19 years and younger, 5.9 percent were between 20 and 24 years, 30.5 percent were between 25 and 44 years, 22.2 percent were between 45 and 64 years, and 14.2 percent were 65 years and older. Further information on age is provided in [Table 4.3.3-1](#).

4.3.3.1.3 Race and Ethnic Composition

In Barnstable County in 2005, of people who were one race, 96 percent of the population was White; two percent were Black or African American; less than 0.5 percent were American Indian and Alaska Native; one percent were Asian; less than 0.5 percent were Native Hawaiian and Other Pacific Islander, and one percent were some other race. In addition, one percent reported two or more races and two percent of the people in Barnstable County were Hispanic or Latino. Ninety-four percent of the people in Barnstable County were White non-Hispanic. (People of Hispanic origin may be of any race [U.S. Census, 2005]).

In Nantucket County in 2000, of people who were one race, 87.8 percent were White; 8.3 percent were Black or African American; 0.6 percent were Asian; and 1.6 percent were some other race. In addition, 1.6 percent reported two or more races and 2.2 percent of the people in Nantucket County were Hispanic or Latino.

In Dukes County in 2000, of people who were one race, 90.7 percent were White; 2.4 percent were Black or African American; 1.7 percent were American Indian and Alaska Native; 0.5 percent were Asian; 0.1 percent were Native Hawaiian and Other Pacific Islander; and 1.5 percent were some other race. In addition, 3.2 percent reported two or more races and one percent of people in Dukes County were Hispanic or Latino.

In Washington County in 2005, of people who were one race, 94.8 percent were White; 0.9 percent were Black or African American; 0.9 percent were American Indian and Alaska Native; 1.5 percent were Asian; and 0.5 percent were some other race. In addition, 1.4 percent reported two or more races and 1.4 percent of people in Washington County were Hispanic or Latino.

In Bristol County in 2000, of people who were one race, 91.0 percent were White; 2.0 percent were Black or African American; 0.2 percent were American Indian and Alaska Native; 1.3 percent were Asian; 0.0 percent were Native Hawaiian and Other Pacific Islander; and 3.1 percent were some other

race. In addition, 2.3 percent reported two or more races and 3.6 percent of people in Bristol County were Hispanic or Latino. Further information on ethnicity is provided in [Table 4.3.3-1](#).

Indian Tribes

Indian lands belonging to two groups of the Wampanoag Indians are located somewhat in the vicinity of the proposed action: One in Aquinnah (Gay Head) on the western end of the Island of Martha's Vineyard in Dukes County, and one in Mashpee, in Barnstable County, Massachusetts.

Wampanoag Tribe of Gay Head (WTGHA)

As of February 2005, the WTGHA had a population of approximately 1100 members enrolled. Approximately 68 live on tribal lands in the Town of Aquinnah and 298 live within the Tribe's service area (Dukes County). The Tribe owns approximately 485 acres (196 hectares) of land, including approximately 160 acres (65 hectares) of private and 325 acres (131 hectares) of common lands. (<http://www.wampanoagtribe.net>).

The WTGHA are descendants of Wampanoag people who traditionally inhabited the southeastern portion of present day Massachusetts, including Cape Cod, eastern Rhode Island and Martha's Vineyard since at least the late 15th century. Of eastern Algonquin linguistic stock, the Wampanoag were referred to as Pokanoket in early documents describing Native Americans in the area. A horticultural people, during the early 17th century, the Wampanoag occupied approximately 30 villages in this region. Best known in the literature for their relationship with the Plymouth Pilgrims, the Wampanoag's leader, Massasoit, welcomed the English and remained at peace with them until his death in 1661. By that time the Wampanoag had suffered grave population losses due to the introduction of epidemic causing disease and the usurpation of much of their ancestral land. The Wampanoag Nation was established in 1928 through the involvement of the two Mashpee men, Eben Queppish and Nelson Simons, in the Pan-Indian movement in the early part of this century.

(http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs/22massachusetts_2epdf/v1/22massachusetts.pdf)

In 1972 the Wampanoag Tribal Council of Gay Head, Inc. was formed to promote self-determination, to ensure preservation and continuation of Wampanoag history and culture, to achieve Federal recognition for the tribe, and to seek the return of tribal lands to the Wampanoag people. The WTGHA became a federally acknowledged tribe on February 10, 1987 through the Bureau of Indian Affairs (BIA). The WTGHA is governed by a popularly elected representative Tribal Council.

Maintaining and protecting tribal cultural resources is a top priority of the WTGHA. The Tribe is currently in the process of developing a Cultural Resource Protection Program that would incorporate the Tribe's responsibilities under the NHPA, the Archaeological Resource Protection Act (ARPA) and the Native American Graves Protection and Repatriation Act (NAGPRA).

Enterprises run by the WTGHA include several stores that sell tribal merchandise and the operation of a shellfish hatchery. The tribe also uses Vineyard Sound and surrounding waters for subsistence fishing.

Wampanoag Indian Reservation in Mashpee

The Mashpee Wampanoag Tribe was federally acknowledged on February 15th, 2007 (BIA, 2007). The Tribe has 55 acres (22.2 hectares) of tribally owned land and an adjacent reservation population of 890 (1994). The Mashpee Wampanoag Tribe owns 55 acres (22.2 hectares) in the town of Mashpee located on the western end of Cape Cod. This land is referred to by the Mashpee as the "Fifty-five Acres." It is common land owned by the tribe and serves as the tribe's land base. The 55 acres (22.2

hectares) is an anomaly in the well-developed summer resort area, being neither populated nor developed. The 55 acres (22.2 hectares) lies adjacent to the newly established 3,000-acre (1214-hectare) Mashpee National Wildlife Refuge. The tribal building on the 55 acres (22.2 hectares) is located off Great Neck Road in the town of Mashpee.

The Wampanoag Indians of Mashpee were the first to greet the pilgrims in 1620 and played host to them in the first Thanksgiving in 1621. Since that historic period, the Mashpee Wampanoag have served their tribal community and their fellow citizens in the town of Mashpee, the Commonwealth of Massachusetts, and the United States of America as neighbors and friends. Today, the Mashpee (whose name evolved from the aboriginal name Massipie, meaning "Land of the Great Cove") have the largest native population in Massachusetts. With approximately 1,500 members, the tribe has lived on its native homeland since at least the time of European contact in the early 16th century. The Mashpee pride themselves in honoring a heritage that pre-dates American Independence by 125 years. (<http://mashpeewampanoagtribe.com/History.htm>).

4.3.3.1.4 Education

In Barnstable County in 2005, 94 percent of the adult population had graduated high school and 36 percent had a bachelor's degree or higher (U.S. Census, 2005). In Dukes County in 2000, 90.4 percent of the adult population had graduated high school and 38.4 percent had a bachelor's degree or higher (U.S. Census, 2000). In Nantucket County in 2000, 91.6 percent of the adult population had graduated high school and 38.4 percent had a bachelor's degree or higher (U.S. Census, 2000). In Washington County in 2005, 90.6 percent of the adult population had graduated high school and 40.6 percent had a bachelor's degree or higher (U.S. Census, 2005). In Bristol County in 2000, 73.2 percent of the adult population had graduated high school and 19.9 percent had a bachelor's degree or higher (U.S. Census, 2000).

4.3.3.2 Economic Factors

4.3.3.2.1 Current Economic Baseline Data

In 2005, the median income of households in Barnstable County was \$54,439. Seventy-two percent of the households received earnings and 25 percent received retirement income other than Social Security. Forty-one percent of the households received Social Security. The average income from Social Security was \$14,696. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2005).

In 2005, seven percent of people in Barnstable County were in poverty. Nine percent of related children under 18 were below the poverty level, compared with 5 percent of people 65 years old and over. Five percent of all families and 18 percent of families with a female householder and no husband present had incomes below the poverty level (U.S. Census, 2005).

In 2005, the median income of households in Washington County was \$62,536. Eighty-one percent of the households received earnings and 24 percent received retirement income other than Social Security. Twenty-nine percent of the households received Social Security. The average income from Social Security was \$15,466. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2005).

In 1999, the median income of households in Dukes County was \$45,559. Eighty-three percent of the households received earnings and 15.1 percent received retirement income other than Social Security. Twenty-six percent of the households received Social Security. The average income from Social Security was \$11,008. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

In 1999, the median income of households in Nantucket County was \$55,522. Eighty-seven percent of the households received earnings and 12.2 percent received retirement income other than Social Security. Twenty percent of the households received Social Security. The average income from Social Security was \$11,567. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

In 1999, the median income of households in Bristol County was \$43,496. Seventy-seven percent of the households received earnings and 16.9 percent received retirement income other than Social Security. Twenty-eight percent of the households received Social Security. The average income from Social Security was \$10,237. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

4.3.3.2.2 Business Activity by Industrial Sector

Among the most common occupations in Barnstable County in 2005 were: management, professional, and related occupations, 32 percent; sales and office occupations, 27 percent; service occupations, 23 percent; construction, extraction, maintenance and repair occupations, 11 percent; and production, transportation, and material moving occupations, 6 percent. Seventy-three percent of the people employed were private wage and salary workers; 14 percent were Federal, state, or local government workers; and 13 percent were self-employed (U.S. Census, 2005).

Among the most common occupations in Dukes County in 2000 were: management, professional, and related occupations, 32 percent; sales and office occupations, 25 percent; construction, extraction, and maintenance occupations, 19 percent; service occupations, 16 percent; production, transportation, and material moving operations, 8 percent; and farming, fishing, and forestry occupations, 1 percent. Sixty-six percent of the people employed were private wage and salary workers; 22 percent were self-employed; and 12 percent were government workers (U.S. Census, 2000).

Among the most common occupations in Nantucket County in 2000 were: management, professional, and related occupations, 30 percent; sales and office occupations, 24 percent; construction, extraction, maintenance and repair occupations, 22 percent; service occupations, 17 percent; production, transportation, and material moving occupations, 6 percent; and farming, fishing, and forestry occupations, 1 percent. Sixty-two percent of the people employed were private wage and salary workers; 25 percent were self-employed; and 12 percent were Federal, state, or local government workers (U.S. Census, 2000).

Among the most common occupations in Washington County in 2005 were: management, professional, and related occupations, 40 percent; sales and office occupations, 22 percent; service occupations, 19 percent; construction, extraction, maintenance and repair occupations, 10 percent; production, transportation, and material moving occupations, 8 percent; and farming, fishing, and forestry occupations, 1 percent. Seventy-three percent of the people employed were private wage and salary workers; 19 percent were Federal, state, or local government workers; and 7 percent were self-employed (U.S. Census, 2005).

Among the most common occupations in Bristol County in 2000 were: management, professional, and related occupations, 31 percent; sales and office occupations, 26 percent; construction, extraction, maintenance and repair occupations, 10 percent; service occupations, 15 percent; production, transportation, and material moving occupations, 18 percent; and farming, fishing, and forestry occupations, less than 1 percent. Eighty-two percent of the people employed were private wage and

salary workers; 5 percent were self-employed; and 13 percent were Federal, state, or local government workers (U.S. Census, 2000).

4.3.3.2.3 Employment

In 2005, there was an estimated labor force of 113,026 in Barnstable County with an unemployment rate of 7.4 percent. In 2000, there was an estimated labor force of 5,788 in Nantucket County with an unemployment rate of 3.1 percent⁵. In 2000, there was an estimated labor force of 8,150 in Dukes County with an unemployment rate of 1.8 percent. In 2005, there was an estimated labor force of 71,286 in Washington County with an unemployment rate of 3.1 percent. In 2000, there was an estimated labor force of 132,883 in Bristol County with an unemployment rate of 5.3 percent.

4.3.3.2.4 Income and Wealth

In 2005, the median income of households in Barnstable County was \$54,439 versus the state of Massachusetts median income of \$57,184. In 2000, the median income of households in Nantucket County was \$55,522 versus the state of Massachusetts median income of \$46,753. In 2000, the median income of households in Dukes County was \$45,559 versus the state of Massachusetts median income of \$46,753. In 2005, the median income of households in Washington County was \$62,536 versus the state of Rhode Island median income of \$51,458. In 2000, the median income of households in Bristol County was \$43,496 versus the state of Massachusetts median income of \$46,753.

4.3.3.2.5 Property Values

In 2005, the median house value in Barnstable County was \$400,500 versus the state of Massachusetts median house value of \$361,500. In 2000, the median house value in Nantucket County was \$577,500 versus the state of Massachusetts median house value of \$185,700. In 2000, the median house value in Dukes County was \$304,000 versus the state of Massachusetts median house value of \$185,700. In 2005, the median house value in Washington County was \$349,900 versus the state of Rhode Island median house value of \$281,300. In 2000, the median house value in Bristol County was \$151,500 versus the state of Massachusetts median house value of \$185,700. In summary, the information shows that the counties within the ROI have considerably higher housing values than the overall housing values of the state in which they are located (with the exception of Bristol County), indicating the high demand for housing in these areas and relative wealth in these areas.

4.3.3.3 Environmental Justice Considerations

This section contains environmental justice statistics to determine whether the construction and operation of the proposed action would have a significant adverse effect on minority and low-income populations. As part of the environmental justice data, socioeconomic characteristics of the area of the proposed action have been examined to determine whether the proposed would disproportionately impact any minority or low-income population(s).

4.3.3.3.1 Federal Guidance

The USEPA Headquarters Office of Environmental Justice defines environmental justice as the following:

“Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development,

⁵ At the time of preparation of this DEIS, 2005 data was not available from the US Census on Nantucket County and Dukes County.

implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.”

The concept of performing an environmental justice analysis for the proposed action is related to the establishment of Executive Order 12898, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations” (February 11, 1994). The order requires Federal agencies to consider disproportionate adverse human health and environmental impacts on minority and low-income populations.

The focus of an environmental justice analysis is the determination of whether the construction and operation of a proposed action would have both adverse and disproportionate impacts on minority and low income populations. Minority populations are generally defined by USEPA as areas that have a “meaningfully greater” percent of minorities than the general population in the surrounding area, and low income populations are defined based on the U.S. Census poverty statistics. In performing the environmental justice analysis, the MMS used the methodology in USEPA’s “Final Guidance for Incorporating Environmental Justice Concerns in USEPA’s NEPA Compliance Analyses, April 1998.”

The poverty rate of Barnstable County was 6.6 percent in 2005, versus the state poverty rate of 10.3 percent. The poverty rate in Washington County was 6.3 percent in 2005 versus the state wide poverty rate of 12.3 percent. The poverty rates in Nantucket, Dukes, and Bristol Counties were 7.5 percent, 7.3 percent, and 10.0 percent, respectively in 2000 versus the state wide poverty rate of 9.3 percent. This poverty rate information shows that overall area of the ROI is in general more affluent than the rest of the state, which indicates it is unlikely to be an environmental justice area of concern.

The percent minorities in Barnstable, Nantucket, Dukes, and Bristol Counties were 6.6 percent, 13.1 percent, 10.0 percent, and 10.6 percent, respectively in 2000, versus a state wide percentage of 18.1 percent (U.S. Census, 2000)⁶. The percent minorities in Washington County was 5.1 percent in 2005 versus a state wide average of 17 percent. These statistics show again that the ROI in general is not an area of environmental justice concern as the ROI has a smaller percentage of minorities than the rest of the state. There are two tribes of Indians in the ROI, the WTGHA and the Wampanoag Indians of Mashpee. See Section 4.3.3.1.3 for a description of them, and see Section 5.0 for information on environmental impacts to these areas. The Environmental Justice Impact assessment is provided at Section 5.3.3.3.

Although the statistics for Barnstable County as a whole indicate that the area is not an environmental justice area of concern, the Massachusetts Environmental Justice GIS Map shows that there is a smaller census block group in and around Hyannis, Massachusetts that is an Environmental Justice Population (see [Figure 4.3.3-1](#)). The Mass GIS defines an Environmental Justice Population as any area that has: (1) greater than or equal to 25 percent minority population; or (2) less than or equal to a median household income of \$30,515; or (3) less than 75 percent of the households are English proficient; or greater than 25 percent of a foreign born population. (http://www.mass.gov/mgis/cen2000_ej.htm). The proposed action on-land cable portion of the proposed action is located outside of this area, but the

⁶ To obtain the total minority population, the “population of one race, white alone, was subtracted by the total population (to obtain all minorities), and divided by the total population (to obtain percent minorities). It should be noted that, using this methodology, any individual identified as “other race” or “two or more races” is considered a member of a minority.

existing substation where the cable connects is located within this area. Impacts are described in Section 5.3.3.3 of this document.

4.3.4 Visual Resources

Visual resources were surveyed and assessed via two main groupings: Visual Resources associated with Historic Areas, to address requirements of Section 106 historic review requirements, and visual resources associated with Recreational Areas, to address visual impact under the National Environmental Policy Act regulations. For the purposes of this work, recreational areas include but are not limited to beaches, parks, conservation lands, and ocean areas.

The land area surrounding the site of the proposed action has a variety of historic structures and recreational areas that would be in view of the proposed action. With respect to historic areas, there are both individual homes on the NRHP and larger historic districts on the NRHP that would have a view of the proposed action, including the entire island of Nantucket which is designated a National Historic District. With respect to recreational areas, Cape Cod, Nantucket, Martha's Vineyard and the waters of Nantucket Sound are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing, and bird watching. Marinas, yachts clubs, and public boat ramps line most of the harbors and inlets that have sufficient water depths.

4.3.4.1 Visual Resources Associated with Historic Structures

In order to assess visual impacts of historic structures, twelve simulation locations were selected in consultation with the MEPA and MHC as representative worst case impacts from historic structures (Report No. 4.3.4-1). Table 4.3.4-1 indicates the historic properties and districts in the area that were assessed and their distance to the proposed action and Figure 4.3.4-1 shows the location of these areas on a map. Figure 4.3.4-2 shows the existing view (prior to the proposed action) toward the site from the nearest unobstructed viewing area from each of the visual simulation locations plus a photograph of the historic structure that would be affected, and additional photographs that show the general visual character and context at each location.

A description of the visual character and setting at each of the 12 visual simulation locations is presented below, based upon field reconnaissance, background research, and review of NRHP Inventory Nomination Forms, where available, and other documentation in MHC files.

South Side of Cape Cod

Nobska Point Light Station, Woods Hole, Falmouth (VP-1 in Figure 4.3.4-1; Character photos on Figure 4.3.4-2, sheets 1-7)

The Nobska Point Light Station complex dates from 1876, when the existing white cylindrical tower was constructed to replace a navigational light atop a keeper's dwelling that had operated since 1828. The light is a major navigational aid located on a rocky headland near the entrance to Woods Hole Harbor. A photograph of the structure and the existing view toward the site of the proposed action is shown on sheet 1; locations of these photographs are shown on sheet 2. The complex consists of the 40 ft-high light tower with entry porch (1876), two keeper's dwellings (1876, 1990) connected by a porch, a brick oil house (1876), paint lockers (1876), garage (1931) and a radio beacon building (1937). The light has been unmanned and automated since 1985.

The Light Station complex is listed on the NRHP as part of the Lighthouses of Massachusetts Thematic Group. The 2.11-acre (0.009 km²) site is largely bare of vegetation and the white tower can be seen clearly from all directions. According to MHC's Lighthouse Information Form (MHC, 1981) "the

Light possesses integrity of location, design, setting, materials and workmanship as well as significant associations with the development of aids of navigation in Massachusetts. It is important for its scenic qualities, sited on a bluff overlooking Vineyard Sound, and for its strategic location. The complex meets criteria A and C of the NRHP on the state level.”

Visitors to the historic lighthouse are presented with open views of Nantucket Sound (see sheet 1) from the southeast to the southwest, including views of Martha’s Vineyard. The base of the light is publicly accessible, and a plaque provides historic information to visitors that park at a small adjacent lot.

Character photos of the area around the Nobska Light are shown in Viewpoint (VP) 1 photographs on sheets 4-6. Locations are shown on sheet 2. The area is generally characterized by low to medium-density residential land use, with commercial use in the village of Woods Hole to the northwest. Large homes are generally scattered along winding roads among low wooded hills. Views toward the water from most roads and residences are generally well screened by trees. Open views easterly toward the site of the proposed action are available from Fay Road, and are expected from the easterly and southeasterly-facing upper stories of area homes. Open views of the site of the proposed action were not found in Woods Hole village.

Other nearby viewpoints not selected for simulation

A representative historic structure and the view toward the proposed action from the southern end of VP 2, the locally-designated Woods Hole Historic District, are shown on sheet 6. The location of VP 2 is shown on sheet 2, and was the only ground-level location found within this district with some view of Nantucket Sound toward the site of the proposed action. The view is partially blocked by the point of land at Nobska Light and by Martha’s Vineyard.

VP 3 at the Woods Hole School on 24 School Street is shown on sheet 6. Photograph VP 3-CE-4 on sheet 7 shows no view of Nantucket Sound at this interior historic property.

A representative photograph of VP 4 in the locally designated East Falmouth Historic District is shown on sheet 7; the location is shown on sheet 3. No ground-level views of Nantucket Sound toward the proposed action were found in this historic district.

Cotuit (see Figure 4.3.4-1 for VP 5; Character photos in Figure 4.3.4-2, sheets 8-11), Town of Barnstable

The Village of Cotuit Historic District is included in the Town of Barnstable Multiple Resource Area (MRA), which was listed on the NRHP on November 10, 1987. Other Barnstable MRAs in the vicinity of the proposed action viewshed and described in this section include historic districts in Wianno, Craigville, Centerville, and Hyannis Port.

The Cotuit Historic District, westernmost of the villages in Barnstable, occupies a neck of land surrounded by Popponesset Bay to the west, Nantucket Sound to the south, and Osterville Harbor to the east. Most of the 107 buildings in the district are residential, although some commercial and institutional buildings have also been designated in the village colonial center. A representative historic structure is shown on sheet 8.

Character photos of the district are presented on sheets 10-11; locations are shown on sheet 9. Public access and views to the shoreline and south-southeasterly toward the site of the proposed action are limited. Street level views toward the water are generally broken/partially screened by vegetation and structures. However, views are likely available from many of the large shoreline homes, especially from the upper stories.

The National Register Criteria Statement found the Cotuit Historic District significant as a major collection of 19th and early 20th century buildings related to the maritime industries and summer resort activities. The district was determined to possess integrity of location, design, setting, materials, workmanship, feeling and association, and to meet criteria A, B, and C of the NRHP (MHC, Village Summary Sheet: Cotuit, 1987).

Cotuit was first settled in the early 1700s in the interior Santuit area, near what is now Route 28, to utilize fertile lands and early transportation corridors. As local economies shifted from land-based activities to the maritime industries in the early 19th century, the settlement shifted to the shore along the west side of Cotuit Bay. Key maritime activities included oystering, fishing, shipbuilding, coastal trade, and salt making. Many of the houses in the district were built by ship captains, and reflected their wealth. As the maritime trades ebbed in the late 19th century, summer residents discovered the village. Federal and Greek Revival architectural styles represent the district's early seafaring heritage, while later Italianate, Second Empire, Gothic Revival, Queen Anne and Colonial Revival structures reflect the area's later evolution into a quiet summer resort.

Most buildings are framed by mature wooded vegetation. Cotuit has retained a quiet, settled atmosphere due to its location several miles from busy main routes. Its small harbor offers moorings for many boats, and the village has an active local sailing program. The village is traditionally known for its oysters, which continue to be harvested in Cotuit Bay. Oyster Harbors, a gated community of large seasonal homes, is located across Cotuit Bay to the east and is not included in the Barnstable MRAs.

Wianno (see Figure 4.3.4-1 for location of VP 6; Character photos in Figure 4.3.4-2, sheets 12-16)

The Wianno Historic District in the Village of Osterville is comprised of 28 main buildings and 13 outbuildings on approximately 40 acres (0.16 km²) along Sea View Avenue and Wianno Avenue. The lands were originally assembled in the late 19th century by a consortium of businessmen and developed as a summer colony. The large well-kept lots on either side of Sea View Avenue along Nantucket Sound contain grand Shingle Style and Colonial Revival style summer houses, most of which were constructed between the late 19th century and World War I.

The focal point of the Wianno Historic District is the Wianno Club on Sea View Avenue, a massive three-story shingled main building and two-story rear ell, both with mansard roofs. The Wianno Club is shown on sheet 14, photograph VP 6-CE-10. The structure was designed by architect Horace Frazer of Boston (who also designed a number of private residences in the district). The Club overlooks Nantucket Sound on almost 1,000 ft (304 m) of beach frontage. The building is described as architecturally extremely significant, as much of its original and interior detailing survives. The structure was individually listed in the NRHP in 1979, and was listed as a Barnstable MRA in 1987.

On the Sound side of Sea View Avenue, which runs parallel to the shore, the structures are regularly spaced with open well-maintained lawns and unobscured views toward the site of the proposed action to the south. Across Sea View Avenue, views toward the site of the proposed action are limited to areas between intervening structures. Mature trees and large hedges also effectively screen views.

The National Register Criteria Statement found the Wianno Historic District in excellent condition, and possessing integrity of location, design, setting, materials, workmanship, feeling and association. It is significant as one of three well-preserved summer resort colonies developed in Barnstable in the late 19th century, and contains an extraordinary collection of Colonial Revival and Shingle Style architecture. The district is also significant for its association with a notable Boston architect and many prominent seasonal

residents. The district meets criteria A, B, and C of the NRHC (MHC, Wianno Historic District Form B, 1986).

Other nearby areas visited but not selected for simulation

No views toward the water to the south were found in the Village of Osterville.

Craigville, Town of Barnstable (see Figure 4.3.4-1 for location of VP 7; Character photos in Figure 4.3.4-2, sheets 17-20)

Craigville is located at the center of a large crescent-shaped sandy beach system bordered by headlands at Wianno in Osterville on the west and Squaw Island in Hyannis Port on the east. Open views of Nantucket Sound to the south are available from this large beach system. The busy shorefront area contains popular public, semi-private and private beaches and associated parking areas, as described in Section 5.3.3.4. The most open and extensive southerly views toward the water and the proposed action are from Craigville Beach, the bluff above the apex of Craigville Beach, and shorefront homes on Long Beach Road in Centerville.

The Craigville Historic District includes 33 buildings and one park within the larger village of Craigville. The southernmost boundary of the historic district is 0.25 miles (0.4 km) north and topographically low compared to the bluff overlooking Nantucket Sound, from which VP 7 was taken (see sheet 17; for locations see sheet 18.) The district is limited to the core of the original development of the earliest buildings associated with a camp meeting ground developed by the New England Convention of Christian Churches in the 1870s. Although most of the structures in the district are now privately owned summer homes, the Craigville Conference Center owns the Craigville Inn and runs religious retreats. The district is within the interior portions of Craigville, does not extend to the bluff above Craigville Beach, is well vegetated and has no open views of Nantucket Sound. Representative historic structures within the district are shown on sheet 20 (VP 7 CE-7 and CE-8). The structures on the bluff at VP 7 have not been determined eligible for listing on the NRHP.

The focus of the Craigville camp meeting ground was the Tabernacle, a simple wooden church constructed in 1887, at the head of a triangular shaped park. The Tabernacle is shown on sheet 20, VP 7-CE-8. The Craigville Historic District was determined to possess integrity of location, design, materials, workmanship and feeling, and meets criteria A and C of the NRHP. It was found to be significant for its association with the Christian camp meeting movement the 19th century, and contains a well-preserved collection of associated buildings (MHC, 1985).

The religious campground settlement was similar to other earlier Methodist camp meetings in Eastham, Yarmouth and Martha's Vineyard, and drew lay people and ministers who journeyed by train then carriage or barge for summer services. The architecture is very similar to the Yarmouth Camp Ground Historic District (MHC No. YAR.B), which is located in an interior wooded location just south of the mid-Cape Highway (Route 6) at Exit 7 and several miles north of Nantucket Sound. The Yarmouth Camp Ground Historic District also has no open views of Nantucket Sound.

Other nearby areas visited but not selected for simulation

The Centerville Historic District, which contains 49 buildings and one object along Main Street, does not offer ground-level views of Nantucket Sound toward the proposed action; representative character photographs of Centerville are provided on sheet 19.

Hyannis Port, Town of Barnstable (see Figure 4.3.4-1 for location of VP 8; Character photos in Figure 4.3.4-2, sheets 21 through 30)

The summer community in the Hyannis Port Historic District is characterized by large, well-maintained colonial and shingled Victorian beach homes. The district contains 127 buildings on 1,000 acres (4.0 km²), and is roughly bounded by Massachusetts Avenue and Edgell Road, Hyannis Avenue, Hyannis Harbor and Scudder Avenue. A representative historic structure is shown on sheet 21. Character photographs are shown on sheets 25 through 28; locations of the photographs are shown on sheets 22-24. Open views of the water to the south-southwest are available along the shorefront (see sheet 21, bottom photograph), and intervening structures and vegetation provide broken views from the road and near shore locations. Public access to the shoreline is very limited.

The Kennedy Compound is located along the shore within the Hyannis Port Historic District and is also represented by VP 8. The Compound was listed as a National Historic Landmark in 1972. The Compound contains approximately 6 acres (2.4 hectares) of waterfront property on Nantucket Sound, and includes the white clapboard residences that formerly housed Kennedy family patriarch Joseph P. Kennedy and his sons Robert F. Kennedy and John F. Kennedy (U.S. Department of the Interior [USDO], 1972). The largest is the Joseph P. Kennedy house, where the family summered starting in 1926, and where Rose Kennedy lived until her death in 1995. The smaller houses were purchased by the sons for their families, and together comprise the Kennedy Compound. The Compound was the base of John F. Kennedy's presidential campaign in 1960, and served as the Summer White House in 1961. Subsequent presidential summer stays were nearby at Squaw Island, which provided better security and privacy. Although the Compound itself was not visited during the field reconnaissance, observations from adjacent locations indicate that open views of the site of the proposed action would be available from the Kennedy Compound.

Other nearby areas visited but not selected for simulation

Other historic districts and properties visited during field reconnaissance in Hyannis, Yarmouth, Dennis, Harwich and Chatham are listed in Table 4.3.4-1. Locations are shown on Figure 4.3.4-1, and on the appropriate sheets in Figure 4.3.4-2. These locations either did not have open views of Nantucket Sound, or were not designated historic properties, and were therefore not selected for simulation.

Monomoy Point Lighthouse, Town of Chatham (see Figure 4.3.4-1 for location of VP 26, Character photo in Figure 4.3.4-2, sheets 31-33)

The Monomoy Point Lighthouse is located at the southern end of Monomoy Island, a coastal barrier beach island extending approximately 10 miles (16.1 km) south of the Cape's elbow at Chatham. The island is an uninhabited coastal dune and marsh complex, and comprises most of the Monomoy National Wildlife Refuge managed by the USFWS. The island is accessible only by boat, and little human disturbance or development is evident except for footpaths and the historic lighthouse and its associated buildings. The land form is characterized by rolling dunes and bluffs, with beach grass and sparse, scattered woody vegetation. Marshes and open water dominate views near the shoreline.

Wildlife such as gulls, terns and seals are abundant and add to the remote and undeveloped character of the island. The island is a National Wilderness Area, although the parcel that contains the lighthouse is not included in that designation. The MAS has owned the parcel since 1977. A lighthouse has occupied the site since 1823. The present light was constructed around 1871. The lighthouse complex is unmanned, and includes a brick light tower and a two-story keeper's house, both of which have deteriorated. The complex was determined significant in the areas of engineering, exploration and settlement, and transportation.

North and East Sides of Martha's Vineyard

Oak Bluffs, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 21, Character photographs Figure 4.3.4-2, sheets 45-50)

This island village area is characterized by fairly high-density residential and commercial land use. Topography is relatively flat, except for a steep shoreline bluff. The lack of topographic relief and abundant structures tend to screen views toward the water from the interior of the area. The most open easterly-northeasterly views toward the proposed action are available along East Chop Avenue, Sea View Avenue and Ocean Avenue, as well as from residences along these roads, and from the East Chop Lighthouse. Ocean Park on Ocean Avenue (the selected viewpoint) also offers unobscured views toward the proposed action.

The VP 21 is representative of open views from East Chop Light and the Dr. Harrison A. Tucker Cottage at 65 (formerly 42) Ocean Avenue in Oak Bluffs, which are both listed on the NRHP.

The Tucker Cottage was originally built in the American Stick Style in 1872, and then was substantially altered into a large Queen Anne summer house in 1877. The house and carriage house is part of the Ocean Park neighborhood of large, late 19th century summer homes, near the Methodist camp meeting ground at Wesleyan Grove (see Martha's Vineyard Campground Historic District, below).

The street pattern of Ocean Park is a curvilinear series of narrow streets around Ocean Park, a 7-acre (0.03 km²) semi-circular green space that faces Sea View Avenue and the Sound beyond. The Tucker Cottage overlooks the bandstand at Ocean Park on Ocean Avenue, the innermost crescent along the Park. The Dr. Harrison A. Tucker Cottage was determined to retain integrity of location, design, materials, workmanship, feeling, and association, and meets Criteria B and C of the NRHP (USDOI, 1990).

The East Chop Lighthouse is located on the highest bluff on East Chop, on the east side of Vineyard Haven Harbor. The cast-iron lighthouse was constructed in 1878, to replace a private lighthouse that was destroyed by fire. Open views toward the proposed action are available from this structure.

The West Chop Lighthouse, on the western side of Vineyard Haven Harbor, was originally constructed in 1817, replaced with the present brick tower in 1838, and was moved back from the sea in 1848 and 1891. Views toward the proposed action are screened by a line of white pines from roadside by the West Chop light, which is posted private property. Ground level views from the property itself are expected to be screened by the trees, although open views from atop the light are anticipated. Both East Chop and West Chop lighthouses have protected mariners entering Vineyard Haven Harbor since Colonial times, and both are listed on the NRHP's multiple listing of lighthouses on Martha's Vineyard.

Other nearby areas visited but not selected for simulation

Several other historic properties or districts in Oak Bluffs have more limited views of Nantucket Sound toward the area of the proposed action, due to screening provided by mature vegetation such as shade trees and intervening structures. These include the Martha's Vineyard Campground Historic District in Oak Bluffs (also called Wesleyan Grove), which contains 306 19th century cottages and 6 public buildings on 34 acres. The district is located close to, but does not border, Nantucket Sound. No ground level views of Nantucket Sound were found within this district. The campground was founded in 1835 as a summer Methodist meeting area; the first participants stayed in tents that were later replaced by small cottages. The focal points of the camp are the iron Tabernacle and the Trinity Methodist Church, both located on Trinity Park near the center of the campground. The typical campground cottage is a simple 1.5-story rectangular structure, approximately 15 ft (4.6 m) wide by 20 ft (6.1 m) deep. Porches, typically late 19th century additions, are heavily ornamented with trim. Much of the historic district is

shaded with mature trees and other vegetation. The Martha's Vineyard Campground is significant for its unique architecture, state of preservation, and its association with 19th century religious practices (USDOJ, 1978).

Religious activity in the 19th century caused the campground to grow rapidly. The original week-long religious meeting in August evolved as people began arriving earlier in the summer, sparking the resort development of the adjacent area. The resulting town of Cottage City was created in 1880, and was renamed Oak Bluffs in 1907.

The Oak Bluffs Christian Union Chapel (known as Union Chapel) is west of Ocean Park and close to the Methodist campground of Wesleyan Grove. The chapel was built in 1870 in the American Stick Style. The mature vegetation around the church partially obscures the chapel from contiguous streets, and fully screens the chapel from views of Nantucket Sound. The chapel exhibits integrity of location, design, materials, workmanship, feeling and association, and meets Criteria A and C of the NRHP (USDOJ, 1990).

The Flying Horses Carousel at 33 Oak Bluffs Avenue is located in the business district of Oak Bluffs. It is listed on the NRHP, and has also been listed as a National Historic Landmark since 1987. The carousel of 20 prancing horses and four chariots has operated at this location since 1889, and is indicative of the late 19th century interest in amusements and recreation at summer resorts such as Oak Bluffs. The Flying Horses Carousel possesses integrity of location (since 1889), design, material, workmanship and association, and is significant as the oldest platform carousel operating in the United States (USDOJ, 1979). No open views were available from this structure.

The Arcade at 31 (formerly 134) Circuit Avenue is a commercial building listed on the NRHP. No ground level views of the proposed action are available from this building, which is surrounded by other commercial buildings and shops along this busy street in downtown Oak Bluffs.

Limited views to the north-northeast are available from West Chop, a residential area in Tisbury. Views toward the site of the proposed action are not generally available from the center of Vineyard Haven.

Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 20; Character photos Figure 4.3.4-2, sheets 38 through 44)

This island colonial village area has relatively high-density residential and commercial land use, with well-maintained large homes, small shops, inns and restaurants connected by narrow streets. Public views toward the water from the village area are generally partially or fully screened by intervening structures and vegetation. Views toward the proposed action to the northeast are available from shoreline residences and associated private beaches. The only publicly accessible open northeasterly views are from Water Street and Lighthouse Beach. The selected viewpoint VP 20 is the most open view from a historic site (the Edgartown Lighthouse at the entrance to Edgartown Harbor). Almost all other views toward the site of the proposed action from Edgartown are partially blocked by Chappaquiddick Island.

The Edgartown Village Historic District comprises approximately 150 acres (60.7 hectares) along the west side of Edgartown Harbor. The district contains approximately 500 contributing buildings (constructed pre-1933), mostly wood frame houses of the 19th and early 20th centuries. A smaller, locally designated district (the Edgartown Local Historic District) is contained within the NRHP District. The village's two major periods of significance relate to late 18th to 19th century whaling activities, and late 19th century to present day summer tourism. Architectural styles vary from First Period Colonial (circa 1650's to 1750), late Georgian and Federal sea captains homes, Greek Revival, Victorian and Colonial

Revival. The boundaries of the historic district do not extend to Nantucket Sound except at Edgartown Light (also called the Harbor Light Lighthouse), but views of the Sound to the east and northeast are available from easternmost structures within the district.

The Edgartown Lighthouse is located on a rock breakwater off a spit along the northeastern side of Edgartown Harbor. The original lighthouse at the eastern end of the Harbor was built in 1828 and destroyed following the Hurricane of 1938. This structure was replaced by a cast-iron lighthouse that originally stood at Crane's Beach in Ipswich, and was disassembled and moved by barge to Edgartown in 1939. The structure is part of the Lighthouses of Massachusetts multiple listing on the NRHP, and is one of five lighthouses included on the listing within Martha's Vineyard.

Cape Poge, Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 19; Character photos in Figure 4.3.4-2, sheets 34-37)

This largely natural area on the north side of Chappaquiddick Island is protected by the Massachusetts Trustees of Reservations, a private land and property conservation organization. The area contains dunes and low coastal vegetation, bordered in places by a steep 20 to 30 ft (6.1 to 9.1 m) high sandy bluff at the ocean shoreline. The area is undeveloped other than perhaps 5 to 10 large homes and several unimproved sand roads. Cape Poge offers expansive views at and near the shoreline. Once away from the shoreline, including at the base of the lighthouse discussed below, the dunes and dune vegetation effectively screen most views toward the water.

The Cape Poge Lighthouse at VP 19 is one of the five lighthouses on Martha's Vineyard listed on the NRHP. Built in 1922 on the northeastern tip of Chappaquiddick, the present wood-shingled lighthouse replaced several earlier decaying towers, the earliest of which was constructed in 1802. Encircling the top of the tower is a simple cast iron balustrade. The windows and doorway are pedimented.

North Side of Nantucket

Nantucket Village is a densely settled classic colonial New England maritime community on the western side of Nantucket Harbor. The entire island, including Muskeget and Tuckernuck Islands to the west, comprises a NRHP and was also designated as a National Historic Landmark in 1966. Muskeget Island was designated as a National Natural Landmark in 1980, as the only known locality where the Muskeget vole is found and the southernmost area where the gray seal breeds (National Registry of Natural Landmarks, 1999).

The historic character of the village is defined by the clean pious lines of the houses of former sailors, fishermen and clergy as well as the grand federal-style mansions of former ship captains and owners. These varied structures are linked by cobblestone streets and shaded with large street trees. Views of the northwest toward the site of the proposed action are not available at ground level within Nantucket village itself (although views may be available from the upper stories of some buildings) or from the docks and wharfs along the western side of Nantucket Harbor. Representative photographs of Nantucket Village and locations are provided on sheets 52-58. The simulation location is discussed below.

Nantucket Cliffs along Cliff Road, North of Nantucket Village Center (see Figure 4.3.4-1 for location of VP 22; Character photos in Figure 4.3.4-2, sheets 51-58)

Upon leaving the village area and heading to the northwest, narrow roads traverse a landscape of rolling dunes and low-density residential development. The dunes and vegetation tend to block views toward the water. An open area atop the shore-facing bluff along Cliff Road (the selected VP 22) offers the first open views toward the proposed action. The beach below also offers unobscured views. The beach continues to the west to the Eel Point conservation area at Madaket. Homes along the north shore

and associated private beaches also have open views toward the proposed action, as does the shorefront area off Cliff Road to the east to Jetties Beach at West Jetty. Public access to the north-facing beaches is generally limited, and as one moves inland, views of the water toward the proposed action quickly disappear.

Great Point, Nantucket (see Figure 4.3.4-1 for location of VP 23, Character photos in Figure 4.3.4-2, sheets 59 through 61)

Great Point is a unique undeveloped beach area that forms the northeastern most part of Nantucket, and separates the Atlantic Ocean to the east from Nantucket Sound to the west. Characterized by crashing surf, rolling sand dunes, low beach grass and tidal marsh, the area is a remote and wild setting. The point is managed by the Trustees of Reservations, and is accessible only by four-wheel drive vehicle along a sand track. The Nantucket Light (also called Great Point Light or Sandy Point Light) and the immediately surrounding land constitute the historic property. Lighthouses have operated at Great Point since 1789. The existing unmanned masonry structure was constructed in 1818, and is one of the oldest existing lighthouse structures in the state.

Great Point Light was determined to possess integrity of location, design, setting, materials and workmanship, as well as significant associations with the development of aids to Massachusetts navigation. The tower is the first landfall on Nantucket seen from the Atlantic Ocean, and meets criteria A and C of the NRHP.

The Nantucket Conservation Foundation protects barrier beach south of the Great Point area. The area is remote and is characterized by ocean surf on the east, sand dunes and salt marshes. The area is largely undeveloped with only one or two private homes, a sand road, and the Great Point lighthouse, which is a visual focal point. Panoramic open views in all directions are available from many locations on Great Point, as well as along the sand access road, where not screened by sand dunes. The viewpoint from Great Point is representative of open views toward the proposed action from the Wauwinet area of Nantucket.

Tuckernuck Island (see Figure 4.3.4-1 for location of VP 24, Character photos in Figure 4.3.4-2, sheets 62 through 64)

Tuckernuck Island is roughly 2 miles (3.2 km) long and 1 mile (1.6 km) wide, and is located approximately 1 mile (1.6 km) west of Nantucket Island and 8 miles (12.9 km) east of Martha's Vineyard. This sparsely settled island off the western tip of Nantucket is accessible by boat only. The island is composed of moraine deposits (in the rocky northwestern portion of the island), sandy outwash plains along the south, and sand dunes.

The island contains about 30 to 40 seasonal cottages and larger homes, and a network of sand roads. The historic houses on Tuckernuck are clustered within two groupings, one around North Pond (on the northwest side of the island) and one around East Pond, and consist of wood-frame shingle-clad structures that generally reflect early fishing, hunting and livestock grazing economies. Topography is generally flat and vegetation consists of low to medium height shoreline scrub. Vegetation is taller and denser in the interior of the island, and more open and sparse near the shoreline. As a result of the level topography and scrub vegetation, views toward the proposed action are concentrated near the shoreline and from private residences.

4.3.4.2 Visual Resources Associated With Recreational Areas

Onshore Cape Cod, Nantucket, Martha's Vineyard (and the state waters of Nantucket Sound) are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing and bird watching. Marinas, yacht clubs and public boat ramps line most of the harbors and inlets with sufficient water depths. Large areas of undeveloped protected shoreline are found along Monomoy Island south of Chatham, Cape Poge on Chappaquiddick Island on Martha's Vineyard, and Tuckernuck Island and Great Point in Nantucket.

Sandy beaches nearly continuously rim the Cape and Islands landforms, supplied with sediments deposited by receding glaciers and reworked since then by fluvial processes (see Section 4.1.1). The shorelines around Nantucket Sound are generally developed with large seasonal shorefront homes or shorefront resorts and associated private beaches, most constructed during the 20th century. The public beaches attract thousands of recreational users in the summer months. Public and semi-private beaches (such as association and resident-only beaches) with expected open views toward the proposed action are shown on [Figure 4.3.4-3](#). This figure also indicates the locations chosen for visual simulations. The names of the recreational areas shown in [Figure 4.3.4-3](#) and their distance to the site of the proposed action are provided in [Table 4.3.4-2](#). Identification numbers on the table and figure pertain to those resources identified by the MassGIS databases; resources identified by other information sources were placed on [Table 4.3.4-2](#) in the rows between the nearest GIS-listed resources. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, open views were generally limited to recreational areas in the immediate vicinity (i.e., within approximately 300 ft [91 m]) of the shoreline.

Note that all twelve visual simulation locations chosen for historical structures referenced in 4.3.4-1 (see [Figure 4.3.4-2](#)) are also in fact representative of recreational and or park areas, as the historic structure simulation locations were taken from nearby beaches and or at parks to allow for unobstructed, worst case visual impacts.

The following is a description of recreational areas that would have a view toward the site of the proposed action.

South Side of Cape Cod

Nobska Point Light Station, Woods Hole, Falmouth (see [Figure 4.3.4-1](#) for location of VP 1; Character photos in [4.3.4-2, sheets 1-7](#))

Visitors to the historic lighthouse are presented with open views of Nantucket Sound from the southeast to the southwest, including views of Martha's Vineyard. The base of the light is publicly accessible, and a plaque provides historic information to visitors that park at a small adjacent lot. The surrounding area is residential, with large homes scattered along winding roads among low wooded hills. The popular Shining Sea Bike Path meanders through woods and along the shore near this area.

Heading easterly from Woods Hole to Cotuit (described below) are popular shorefront areas in Falmouth, and Falmouth Heights, as well as a number of small parks (see [Table 4.3.4-2](#)). The shoreline is nearly continuously rimmed with wide sandy beaches and contains large waterfront resorts, public beaches, and many seasonal homes with associated private beaches. These areas have open views of Nantucket Sound to the south.

Cotuit, Town of Barnstable (see Figure 4.3.4-1 for location of VP 5; Character photos in Figure 4.3.4-2, sheets 8-11)

Recreational resources in the vicinity of VP 5 are the Mashpee beaches, including South Beach State Park, the New Seabury beach, and Popponesset Beach, as well as Loop Beach in Cotuit. The New Seabury Country Club and golf course are also located in the vicinity of this viewpoint. The Waquoit Bay National Estuarine Research Reserve, a 3,000-acre (1214 hectare) Area of Critical Environmental Concern (ACEC), bordering Falmouth and Mashpee, offers opportunities for passive recreation such as bird watching. Sampson Island, a 15-acre (6.1 hectare) MAS Sanctuary and barrier island at the mouth of Cotuit Harbor between Cotuit and Oyster Harbors, and many local sailing and boating programs are located within Cotuit and Osterville Harbors.

Wianno (see Figure 4.3.4-1 for location of VP 6; Character photos in Figure 4.3.4-2, sheets 12-16)

A small Town Beach with limited parking is located on Wianno Avenue at the eastern end of Sea View Avenue. Open views of the proposed action would be available from this location. Wianno Beach and the larger Dowses Beach in Osterville are also located in the vicinity of VP 6. Boating is a popular activity in the Osterville area, which includes a number of marinas.

Craigville, Town of Barnstable (see Figure 4.3.4-1 for location of VP 7; Character photos in Figure 4.3.4-2, sheets 17-20)

Craigville is located at the center of a large crescent-shaped sandy beach system bordered by headlands at Wianno on the west and Squaw Island in Hyannis Port on the east. Open views of Nantucket Sound to the south are available from this large beach system. The popular public beaches of Craigville Beach, the Association Beach, and Covell Beach are located in the vicinity of this viewpoint, as well as associated beach parking areas. Several summer rental cottage communities are located on the opposite side of Craigville Beach Road, with a popular snack bar servicing beach-goers in the summer months.

The private Beach Club on Long Beach Road in Centerville abuts the western end of the large Craigville Public Beach. Private beaches are located adjacent to large shorefront homes down Long Beach Road. The Long Beach Conservation Area, a 3.5-acre (1.4 hectares) protected barrier beach at the west end of Long Beach Road, offers passive recreation with limited parking.

Hyannis Port, Town of Barnstable (see Figure 4.3.4-1 for location of VP 8; Character photos in Figure 4.3.4-2, sheets 21-30)

Private recreational resources near this viewpoint include the Hyannis Port Golf Club and the Hyannis Port Yacht Club, which have open views of the water to the south. Public access to the shorefront is extremely limited.

Heading easterly along the shore from Hyannis Port to Chatham are the communities of Hyannis around Lewis Bay, including the boat and ferry docks of Hyannis, the Hyannis beaches of Keyes, Sea Street and Kalmus Park, the private residential Point Gammon area, and the beaches and recreational areas in West Yarmouth, Yarmouth, Bass River, West Dennis, Dennis, Dennisport, Harwich, Harwich Port, Wychmere Harbor, and Chatham. These are listed in Table 4.3.4-2, along with the distances and directions of the resource from the nearest viewpoints.

Open views of Nantucket Sound to the south-southwest are available from immediate shorelines of these areas, which include resorts and other accommodations, as well large seasonal homes and associated private beaches. Intervening topography, structures and vegetation typically screens views to the south

and southwest from within Hyannis Inner Harbor and other smaller harbors to the east, such as Wychmere Harbor in Harwich Port.

Monomoy Point Lighthouse, Town of Chatham (see Figure 4.3.4-1 for location of VP 24, Character photo in Figure 4.3.4-2, sheets 31-33)

The 2,750-acre (1112 hectare) island comprises most of the Monomoy National Wildlife Refuge managed by the USFWS and is a National Wilderness Area, although the parcel that contains the lighthouse is not included in the designation. Monomoy is only accessible by boat, and visitation at night is prohibited. The island offers opportunities for swimming and boating, as well as passive recreation, such as bird and wildlife watching.

VP 24 is also representative of the views from the beaches of Harwich and Chatham, and from Harding Beach boat landing.

North and East Sides of Martha's Vineyard

Oak Bluffs, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 21, Character photographs Figure 4.3.4-2, sheets 45-50)

VP 21 at Ocean Park is also representative of open views from East Chop Light in Oak Bluffs. Ocean Park is a 7-acre (3 hectare) park overlooking Nantucket Sound, with a bandstand that offers musical and other outside entertainment. The East Chop Lighthouse is both a scenic and historic attraction.

The Flying Horses Carousel at 33 Oak Bluffs Avenue is located in the business district of Oak Bluffs. The carousel of 20 prancing horses and four chariots has operated at this location since 1889, and is a popular tourist attraction. No open views of Nantucket Sound are available from this structure.

VP 21 and VP 20 (below) are indicative of views from the bike path from Edgartown Beach Road between Oak Bluffs and Edgartown, and from beaches along this roadway. The viewpoints are also representative of views from Felix Neck Wildlife Sanctuary and Sarson's Island Bird Sanctuary, and the Farm Neck Golf Course.

Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 20; Character photos Figure 4.3.4-2, sheets 38-44)

Views at VP 20 are indicative of views at Lighthouse Beach and the Harbor Light Lighthouse, as well as recreational resources south of Oak Bluffs, as identified above.

Cape Poge, Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 19; Character photos in Figure 4.3.4-2, sheets 34-37)

This largely undeveloped area on the north side of Chappaquiddick Island is protected by the Massachusetts Trustees of Reservations. The area contains dunes and low coastal vegetation, bordered in places by a steep 20 to 30 ft (6.1 to 9.1 m) high sandy bluff at the shoreline. The Cape Poge Lighthouse is one of the five lighthouses on Martha's Vineyard listed on the NRHP. Built in 1922 on the northeastern tip of Chappaquiddick, the present wood-shingled lighthouse replaced several earlier decaying towers, the earliest of which was constructed in 1802.

A wide barrier beach open to the public extends to the south from Cape Poge Lighthouse. Several sand roads and a small number of large homes comprise the limited development. The Reservation offers expansive views across Nantucket Sound to the northeast, although once away from the shoreline

(including at the base of the lighthouse), the dunes and association vegetation effectively limit most views of the water. Fishing is popular along the barrier beach at Cape Poge.

North Side of Nantucket

Nantucket Cliffs along Cliff Road, North of Nantucket Village Center (see Figure 4.3.4-1 for location of VP 22; Character photos in Figure 4.3.4-2, sheets 51-58)

An open area atop the shore-facing bluff along Cliff Road (the selected VP 22) offers the first open views toward the proposed action when coming from Nantucket Village. Cliff Beach below also offers unobscured views, and is representative of views continuing westerly to Dionis Beach, Capaum Beach and to the Eel Point conservation area at Madaket. Homes along the north shore and associated private beaches also have open views toward the proposed action, as does the shorefront area off Cliff Road to the east to Jetties Beach at West Jetty. Public access to the north-facing beaches is generally limited.

Great Point, Nantucket (see Figure 4.3.4-1 for location of VP 23, Character photos in Figure 4.3.4-2, sheets 59-61)

Great Point is a unique nearly pristine beach area that forms the northeastern most part of Nantucket, and separates the Atlantic Ocean to the east from Nantucket Sound to the west. The point is managed by the Trustees of Reservations, and is accessible only by four-wheel drive vehicle along a sand track out to Nantucket Light.

The Nantucket Conservation Foundation protects barrier beach south of the Great Point area. The area is remote, and is characterized by ocean surf on the east, sand dunes and salt marshes. The area is largely undeveloped, with only one or two private homes, a sand road, and the Great Point lighthouse, which is a visual focal point. Panoramic open views in all directions are available from many locations on Great Point, as well as along the sand access road, where not screened by sand dunes. Beaches include Coskata Beach and Coatue Beach. The area offers opportunities for passive recreation.

Tuckernuck Island (see Figure 4.3.4-1 for location of VP 24, Character photos in Figure 4.3.4-2, sheets 62-64)

This island has several colonies of seasonal houses. No recreational resources available to the public were identified on the island itself.

4.3.4.3 On-shore Cable Route

Since the cable route would be located beneath public roadways or within the existing NSTAR easement, no historic properties listed or eligible for listing on the NRHP are located within the proposed action's Area of Potential Effect (APE) for ground disturbance along the onshore route. There are over 30 recorded buildings in the hamlets of West Yarmouth and Englewood in the vicinity of the landfall, which are included in MHC's Inventory. While not considered a historic district, a number of these buildings date from the early 1700s to late 1800s and are documented as belonging to sea captains or other wealthy residents of Yarmouth. The buildings are arranged in three clusters in Englewood. There are no other historic structures recorded along the route northward to the NSTAR ROW.

Two historic buildings and an historic cemetery are located in Barnstable, approximately 0.25 to 0.75 miles (0.4 to 1.2 km) north of the cable route along the NSTAR ROW. Both historic buildings are off Marstons Lane; the cemetery is located on Mary Dunn Road.

4.3.5 Cultural Resources

For the purposes of this analysis, the term “Archaeological Resources” refers to deposits of material remains of past human cultural activities, both historic and prehistoric, whether onshore or offshore. “Above-ground Historic Resources” will be used for onshore historical structures, districts and landscapes, and the term “Historic Archaeological Resources” will be used for onshore deposits of historic material that are at the ground surface and below.

4.3.5.1 Onshore Cultural Resources

4.3.5.1.1 Historic

An APE for a project is defined as that geographic area or areas within which construction/decommissioning, operation or maintenance of a project may directly or indirectly cause alterations in the character or use of historic properties [36 CFR Part 800 Section 16(d)].

The proposed action’s APE for the onshore component of the proposed action includes areas of physical ground disturbance during construction/decommissioning, operation and maintenance, such as the construction areas along the overland route to the tie-in at the Barnstable Switching Station, as well as those areas within view of the proposed action (such as those historic properties on Cape Cod, Martha’s Vineyard, and Nantucket from which open views of the visible components of the proposed action (aboveground or above water) would be available.

Historic Archaeological

Through consultation with the MHC, an archaeological survey was conducted to identify any historic archaeological sites that may be located within the proposed action’s APE ([Report No. 4.3.5-1](#)). No on-shore historic archaeological sites were identified in the proposed action’s APE. In a letter dated April 22, 2004, MHC accepted these recommendations that no on-shore historic archaeological sites would be impacted by requesting an additional copy of the final report.

Above Ground Historic Resources

Given the proposed location of the onshore electric transmission cable system underground beneath existing public roads and the NSTAR ROW, there are no physical impacts to historic structures, and the APE for visual effects focused on potential views of the offshore proposed action. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, it was found during field reconnaissance that open views were generally limited to historic resources in the immediate vicinity (within approximately 300 ft [91 m]) of the shoreline).

Known historic resources in communities within potential visual range of the offshore turbines were compiled based upon a review of available databases and records at MHC. Historic structures and districts were identified in the Towns of Barnstable, Falmouth, Yarmouth, Dennis, Harwich, Chatham, Nantucket, Oak Bluffs, Tisbury and Edgartown.

The initial inventory of historic resources within the APE followed the USACE guidance, and included only properties that were already listed on the NRHP. In response to comments received on the proposed action, the inventory was expanded to include properties included in MHC’s Inventory of Historic and Archaeological Assets of the Commonwealth, along with other properties noted in public comments (e.g., Ritter House and William Street Historic District on Martha’s Vineyard).

Twenty-two existing historic structures and districts listed or eligible for listing on the NRHP that may potentially be visually affected by the built proposed action were identified within the proposed

action's APE on Cape Cod, Martha's Vineyard, and Nantucket. A detailed description of these historic structures and their visual resources is provided in Section 4.3.4.

4.3.5.1.2 Prehistoric

Through consultation with the MHC, an archaeological survey was conducted to identify any prehistoric archaeological sites that may be located within the proposed action's APE along the onshore portion of the transmission cable route ([Report No. 4.3.5-1](#)). No onshore prehistoric archaeological sites were identified in the proposed action's APE. In a letter dated April 22, 2004, the MHC requested a copy of the final report.

4.3.5.2 Offshore Cultural Resources

The APE for offshore archaeological resources includes the footprints of the WTG structures on the sea bottom; the work area around each WTG where marine sediments may be disturbed; the jet plowed trenches for installation of the inner-array cables connecting the WTGs to the ESP; the jet plowed trenches for the transmission cable system from the ESP to the landfall, and associated marine work areas such as anchor drop areas.

A marine sensitivity assessment of approximately 15,360 acre (6215 hectare) of Nantucket Sound seafloor comprising the proposed action study area, as well as along the 115 kV transmission cable system route to the Yarmouth landfall, was conducted in 2003 ([Report No. 4.3.5-2](#)). Based on this assessment, a marine archaeological reconnaissance survey was conducted in the offshore study area in 2003 ([Report No. 4.3.5-3](#)). A follow-up marine archaeological reconnaissance survey was performed once the WTG array was revised ([Report No. 4.3.5-4](#)).

4.3.5.2.1 Historic

A geophysical survey prepared in 2003 in waters deeper than 3 ft in the offshore area of the proposed action and in Lewis Bay recorded 154 magnetic anomalies and 109 side-scan sonar contacts. Of the 263 magnetic anomalies, and side-scan sonar contacts all but 29 were determined to have a source that was non-cultural in nature or was interpreted as isolated debris, and, therefore, were eliminated from further consideration. Survey data for the remaining 29 anomalies, as well as for the anomalies detected in Lewis Bay, were post-processed and additional analyses were completed.

Analyses of the post-processed data associated with the 29 anomalies of interest and the data collected during September 2003 produced three targets with moderate probability of representing historic shipwrecks. All are in the vicinity of Horseshoe Shoal. Locations have been provided to MHC and the Massachusetts MBUAR, but are not publicly distributed to protect the integrity of these potentially significant sites.

4.3.5.2.2 Prehistoric

A marine archaeological sensitivity assessment and a marine archaeological reconnaissance survey indicate that a majority of the offshore study area has a low probability for containing submerged prehistoric archaeological resources. However, it also concluded that prehistoric archaeological deposits with contextual integrity might be present within limited parts of the eastern offshore study area where former natural soil strata (paleosols) may be present. Some of these areas occur in the location proposed for the proposed action. The turbine array has been adjusted to avoid these potential prehistoric site areas.

4.3.6 Recreation and Tourism

4.3.6.1 General Information on Recreation and Tourism

Cape Cod and the Islands receive a large percentage of their revenue from the tourism industry. The focus of most area tourism is the high quality recreational activities the area offers. The Cape Cod Chamber of Commerce estimates that approximately 44 percent of the economic base for Cape Cod comes from seasonal tourism. An estimated six million tourists visit Cape Cod annually, spending nearly one billion dollars. Almost two-thirds of these visitors vacation during the summer and fall seasons. Tourism on the Cape and Islands includes recreational activities such as: beach going, fishing, boating (including windsurfing and jet skiing), boat racing, golfing, hiking, picnicking, sightseeing (light houses and other historic areas, etc.), and shopping. Guided tours or charters are available for many of these activities including fishing; whale watching; wildlife, kayaking, canoeing tours, and bike tours.

Beaches that are within the viewshed of the area of the proposed action are located in the towns of Falmouth, Mashpee, Chatham, Harwich, Dennis, Yarmouth, Edgartown, and Oak Bluffs. Detailed estimates of the annual number of beachgoers is not available. However, using data from those towns who responded to inquiries of the number of beach stickers issued to residents and non-residents as an indicator (over 33,000 stickers between Mashpee, Chatham and Yarmouth alone) suggest that beachgoers within the viewshed number in the hundreds of thousands. A complete listing of beaches is provided in the [Table 4.3.4-2](#) of the visual impact section.

The construction of the onshore transmission cable system may temporarily affect the parking lot to a recreational resource at Englewood Beach, off of New Hampshire Avenue. However, any impact to this onshore recreational resource is expected to be minimal and limited to off-season beach visitors due to the onshore construction timeframe (Labor Day through Memorial Day).

The near shore and offshore waters of Nantucket Sound were also identified as important recreational resources and therefore economically valuable tourist attractions. The site of the proposed action is centrally located within Nantucket Sound. Peak recreational activity is during the warmer months of the year (typically April through October), corresponding with the peak tourist season.

Recreational users such as fishermen, windsurfers, swimmers, water skiers, jet skiers, and other boaters are active along the near shore and shoreline areas facing Nantucket Sound. Scuba diving is limited in the area because the soft sediment habitat is generally uninteresting. The offshore waters are used by larger power and sailboats.

4.3.6.2 Birding

Several locations on Cape Cod and the Islands focus on bird watching as a recreational activity. These include MAS's Felix Neck and Wellfleet Bay Wildlife Sanctuaries, Monomoy National Wildlife Refuge, and Cape Pogue Wildlife Refuge. In addition, the Cape Cod Museum of Natural History, and the Cape Cod Bird Club are organizations active in bird watching. The vast majority of birding takes place on shore. Birding that takes place offshore in Nantucket Sound is close to shore. MAS runs some trips in the vicinity of Monomoy National Wildlife Refuge and there are kayaking tours around Cape Pogue.

4.3.6.3 Federal or State Parklands and Reserves

Information regarding Federal or State Parklands and Reserves is provided in Section 4.3.4 along with a map showing these locations relative to the site of the proposed action. [Table 4.3.4-2](#) provides a breakdown of Federal or State Parklands and reserves in the area, their distance to the site, and reference to visual simulations from these areas or nearby representative locations.

4.3.6.4 Beach and Shoreline Activities

Onshore Cape Cod, Nantucket, Martha's Vineyard (and the State waters of Nantucket Sound) are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing, and bird watching. Marinas, yacht clubs and public boat ramps line most of the harbors and inlets with sufficient water depths.

Sandy beaches nearly continuously rim the Cape and Islands landforms, supplied with sediments deposited by receding glaciers and reworked since then by fluvial and coastal processes (see Section 4.1.1). The shorelines around Nantucket Sound are generally developed with large seasonal shorefront homes or shorefront resorts and associated private beaches, most constructed during the 20th century. The public beaches attract thousands of recreational users in the summer months. Public and semi-private beaches (such as association and resident-only beaches) with expected open views toward the proposed action are listed on [Table 4.3.4-2](#), as are conservation areas and other recreational resources such as golf courses and bike paths with expected open views toward the proposed action. Visual simulation locations from representative historic sites are provided in the tables for each resource, to capture a sense of the overall anticipated visual change at the recreational area due to the proposed action. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, open views were generally limited to recreational areas in the immediate vicinity (i.e., within approximately 300 ft [91 m]) of the shoreline. Recreational resources identified from the MassGIS database are shown on [Figure 4.3.4-3](#).

4.3.6.5 Recreational Boating and Water Activities

Boating on Nantucket Sound consists of a mix of commercial and recreational activity. Commercial activity includes passenger ferries, vessels, and barges carrying liquid and dry bulk goods, occasional cruise ship visits, commercial fishing vessels, charter fishing vessels, and research activity. Recreational activity includes fishing, sailing, cruising, boat racing, jet skiing (near shore), kayaking (near shore), and canoeing (near shore).

Recreational traffic in the Sound is seasonal with the summer months from June to October seeing a dramatic increase in water activities by recreational traffic both by boats that originate from the area marinas as well as recreational craft that visit the area from the entire New England and Mid Atlantic Region.

Nantucket Sound is a well known area that attracts all types of recreational craft from the smallest runabout to very large yachts; it is a very desirable location for yachtsman, with destinations on both Islands and the Cape Cod shore. These yachts not only include world class power boats/cruisers privately or corporately owned (*Lone Ranger Length 254 ft [77 m]/Acquisition 121 ft [37 m]*) but also sail boats of all sizes (*Southern Cross Maxi 88*). Many remain in the region for the entire boating season, while others use the area to transit to other ports of call along the New England and Mid Atlantic Coasts as well as Canada.

Coastwise and recreational vessels tend to use the Main Channel (south of Horseshoe Shoal) when transiting Nantucket Sound for points within Nantucket Sound and for the Atlantic Ocean. The Main Channel also serves as an inside passage for medium draft vessels to avoid Nantucket Shoals (south and east of Nantucket in the Atlantic Ocean). This channel is marked with aids-to-navigation, and has a minimum depth of approximately 30 ft (9.1 m) MLLW. However, the drafts of vessels using the Main Channel seldom exceed 24 ft (7.3 m) MLLW (NOAA, 1994).

The North Channel (north of Horseshoe Shoal) is used by vessels bound for the Cape Cod shore and by vessels transiting the Sound during northerly winds. This channel is marked with aids-to-navigation, and has a minimum depth of approximately 16 ft (4.9 m) (NOAA, 1994).

The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel's draft. Charted water depths on Horseshoe Shoal range from one to 45 ft (13.7 m) at MLLW, with the majority of the shoal covered by between 20 ft and 30 ft (6.1 and 9.1 m) of water at MLLW. As a result, larger vessels avoid Horseshoe Shoal and stay in the Main Channel and the North Channel. Changes in water depths over short distances and strong tidal currents (with peak currents often exceeding two knots [approximately 1 m/s]) also tend to create steep waves that break on the shoals, causing many shallow-draft boaters to avoid the shoals. In addition, the long distance from shore and the wave and tidal action also limit use by very small recreational vessels, such as open runabouts.

Recreational boating use data are available based on 53 total days of proposed action related field work during the summers of 2001, 2002 and 2003. According to this information, recreational vessels observed during the summer (Memorial Day through Labor Day) within the proposed action area at Horseshoe Shoal ranged from no vessels observed (30 percent of the field days) to 11 vessels observed (in one day). Using these field observations the estimated median number of recreational vessels observed daily is two.

To supplement these field observations, observations were made from the SMDS platform of vessel movements on and around Horseshoe Shoal over three summer weekend days (Saturday, June 12, 2004; Sunday, June 13, 2004; and Saturday, July 3, 2004) when recreational boating activities are generally at their highest. Weather conditions were clear and conducive to recreational boating. These observations involved visually scanning the Horseshoe Shoal area and the Main Channel at intervals of approximately 15 minutes to count the number of vessels observed. Vessels observed were characterized as being either on Horseshoe Shoal or in the Main Channel.⁷ Approximately 81 percent of the vessels observed were recreational vessels, and approximately 57 percent of the vessels observed were operating in the Main Channel. Recreational vessels observed on Horseshoe Shoal on these days ranged from no vessels observed in a 15 minute period to 12 vessels observed. On average, approximately 2 recreational vessels and/or one commercial vessel were observed during each 15 minute period. Additional information and discussion of boating activities is included in Section 4.4.3 of this document.

4.3.6.6 Recreational Fishing

Because of its location adjacent to several key vacation destinations (i.e., Cape Cod, Nantucket, and Martha's Vineyard), Nantucket Sound and the waters around the islands of Nantucket and Martha's Vineyard support a diverse array of recreational fishing activities. Top 10 species harvested that were reported on NOAA Fisheries recreational VTRs from 1994 to 2004 included the following species: scup, black sea bass, *Loligo* squid, summer flounder, tautog, bluefish, sea robin, channeled whelk, unidentified squid and striped bass. Further details on recreational fishing statistics and fish caught are discussed in Section 4.2.7.2.2.

4.3.7 Competing Uses in the Vicinity of the Proposed Action

In addition to the proposed action, other activities in the past, present or future which may contribute to competing uses of OCS space and would include submarine transmission cable or pipeline installations

⁷ For the purposes of the observations, the boundaries of Horseshoe Shoal were Buoy N2 to the west, bell buoy G5 to the north, the ferry route to the east, and the Main Channel to the south. This study area encompasses approximately 51 square miles and is significantly larger than the area of the proposed action.

and bottom founded structures, navigational features, sand mining and mineral extraction, commercial and recreational fishing and boating, military training, and other OCS alternative energy development. The following section describes the potential competing uses of the proposed action (i.e., the space use conflicts of the proposed action) on each type of use.

4.3.7.1 Pipelines and Cables

Presently, there are three existing submarine transmission cable systems located in Nantucket Sound that interconnect the mainland with the offshore islands to provide reliable island-wide power supply. There are no current proposals for new submarine pipelines in the Nantucket Sound area. One cable system interconnects Falmouth, on the mainland, to Martha's Vineyard at Vineyard Haven on the westerly side of Nantucket Sound approximately 13 miles (21 km) to the west of the proposed action locus. The other two submarine transmission cable systems connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 miles (13 km) east of the proposed action locus. The first submarine solid dielectric cable system was installed in 1995 and the second system was installed in 2006. The Martha's Vineyard Island submarine transmission cable systems have been in place for decades, with the most recent replacement cable installed in the seabed off of Falmouth in 1997. There are no publicly available plans at this time for any future submarine transmission cable system installations in Nantucket Sound except for those associated with the proposed action.

Other large offshore projects that could potentially be constructed in the future include two Liquefied Natural Gas (LNG) projects with submarine and upland gas pipelines that have been proposed by Excelerate and Neptune Energy. These projects are located in Massachusetts Bay north of Cape Cod and far from the site of the proposed action and could not be considered competing uses.

4.3.7.2 Navigation Features

There are two main shipping lanes, the Main Channel and the North Channel, used for safe navigation by larger vessels in Nantucket Sound. The USCG marks both of these areas with aids-to-navigation (buoys, lights, etc.). These shipping lanes are described as follows:

- The Main Channel starts in the West at the juncture of Vineyard Sound and Nantucket Sound at Nobska Point, passes north of West Chop and East Chop on MV, and passes south of Hedge Fence shoal. It then continues in a Southeasterly direction passing between Horseshoe Shoals to the North, and Hawes Shoal (Chappaquiddick Island) to the South. The channel is fairly wide in most areas being approximately 1.15 miles (1.9 km) across from edge to edge as marked on NOAA Chart 13237 for a draft of 30 ft (9.1 m). It constricts down to approximately 0.86 miles (1.4 km) wide directly south of Horseshoe Shoal at Cross Rip Shoal. It widens soon after heading eastward and immediately south of Half Moon Shoal hosts the channel heading toward Nantucket Island. The Channel width for the Nantucket Harbor is approximately 1 mile (1.6 km) in width. The Main Channel continues and turns East North East and then North East heading for the south of Monomoy Island and Butler Hole which provides the deep water for the channel as it bisects Monomoy Island and Bearse Shoal to the north and Monomoy Shoal to the South. The channel passage through this area is narrow. It is reported that vessels using the channel seldom exceed a draft of 24 ft (7.3 m) (NOAA, 1994).
- The other major channel is called North Channel, which skirts the south of Cape Cod and provides access to ports along the Cape Cod shore such as Falmouth, Hyannis, Yarmouth and Chatham. This channel runs north of Horseshoe Shoal and runs in an

East-West direction. The channel is well marked by aids to navigation and has a restricted depth of 16 ft MLLW.

- This channel is used mostly by vessels bound for the south shore of Cape Cod, and by vessels transiting the Sound during northerly winds.

In addition to these shipping channels, privately and federally maintained channels are located at the approaches to Cotuit Bay, Centerville Harbor, and Hyannis Harbor (see [Figure 4.3.7-1](#)).

The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage ground, known as “Anchorage I.” Floats or buoys for marking anchors or moorings in place are allowed in this area. Fixed mooring piles or stakes are prohibited (NOAA, 1994).

It is possible that additional dredging may occur at shore-based marinas supporting boating activities throughout the proposed action vicinity. Hyannis Harbor was dredged in 1985, 1991, and 1998. No future dredging activities are currently scheduled. However, any future USACE maintenance dredging in Hyannis Harbor would most likely be the subject of additional environmental assessment.

Quonset Point, which would be used for construction staging, assembly and loading of supplies onto marine vessels is an existing industrial port and equipped to handle the requirements of the proposed action during construction and decommissioning. Channel depth is sufficient for large vessels to dock in the vicinity of the area and such work would not interfere or compete with an existing use at the Quonset Point area.

Given that the shore-side facilities proposed for use have adequate channels to accommodate the necessary vessels during construction, operation and decommissioning, it is unlikely that any channel maintenance would occur in association with the proposed action.

4.3.7.3 Sand Mining and Mineral Extraction

Presently, there are no sand mining projects proposed within the site of the proposed action that would cause space use conflicts; however, the demand for sand to nourish eroding beaches has risen in recent years and would be expected to increase given the rising sea levels and eroding shorelines. For example, there is currently one proposal for an offshore sand mining project in the vicinity of Nantucket Sound. The Sconset Beach Nourishment Project is proposing a 345 acre (140 hectare) dredge site approximately 3 miles (4.8 km) east of Nantucket Island just outside the CIOS. The Sconset Beach Nourishment Project is under MEPA review and is contingent upon approval and licensing from several other state and Federal agencies including MMS and the USACE.

There is a current moratorium on oil and gas drilling off of the Atlantic coast with extended protections set to last until 2012.

4.3.7.4 Commercial Fishing and Boating

In response to comments on the draft EIS prepared by the USACE from the MDMF, NOAA Fisheries, and the Massachusetts Office of CZM, the applicant conducted a survey of recreational and commercial fishing activities ([Report No. 4.2.5-6](#)). The commercial fishing survey, conducted in the late summer, early fall of 2005 consisted of 18 surveyed commercial fishermen who owned a total of 21 boats that commercially fished Nantucket Sound for at least part of an annual fishing season. Of these boats, 16 (76 percent) hauled mobile gear and 5 (24 percent) hauled fixed gear. The reported mobile gear types utilized in Nantucket Sound among the survey group include trawlers (13 boats, also called draggers which drag the sea floor), and hook and line (3 boats). Fixed gear types included pots and traps (4 boats),

and gill nets (1 boat). Three of the 21 boats reported fishing in Nantucket 100 percent of the time and eight fished in Nantucket Sound the majority of the season.

As discussed in Section 4.4.3.9, various sources documented that over 70 fishing vessels varying from 30 - 60 ft in length and 4 - 8 ft in draft fish Nantucket Sound. Other references indicate that local fisherman attribute 50 - 60 percent of their livelihood to fishing Nantucket Sound. Actions by NMFS reducing “days-at-sea” by 40 percent average for ground fish may result in fishing vessels that fished away from the area returning to the Sound to comply with the at sea reduction to fill their ground fish quotas. It is also documented that 200 to 250 commercial fishing vessels, many from New Bedford, Massachusetts use the Main Channel across Nantucket Sound to gain access to fishing grounds on Georges Bank and elsewhere. These vessels range in size from 60 - 100 ft in length and have drafts of 8 - 15 ft.

The main vessel traffic patterns follow the Main Channel and North Channel as previously discussed in Section 4.3.7.2 and as shown in [Figure 4.3.7-1](#), which depicts main ferry routes in the area. The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel’s draft. Charted water depths on Horseshoe Shoal range from 1 to 45 ft (0.3 to 14.7 m) measured at MLLW. The majority of the Shoal is 20 to 30 ft (6.1 to 9.1 m) at MLLW. Analysis of the vessel make-up by type, size and service shows that only one quarter of Horseshoe Shoal has depths that allow the majority of the vessel types using the area to operate and/or drift without going aground.

Ferries out of Woods Hole and Hyannis servicing the Islands of Martha’s Vineyard and Nantucket use the North Channel (Falmouth and Hyannis) and then the Main Channel for their transits to and from the ports of Vineyard Haven and Oak Bluffs. Ferries operating out of Rhode Island enter the Nantucket Sound through Vineyard Sound and pick up the Main Channel at Nobska Point for their transits to Martha’s Vineyard and Nantucket. Those ferries transiting to Nantucket would follow the Main Channel until the Nantucket Channel Intersects in the vicinity of Half Moon Shoal (see [Figure 4.3.7-1](#)).

There are not any major or significant Port Facilities that handle large deep draft traffic and are engaged in commercial cargoes in the vicinity of the site of the proposed action. The closest port facilities that handle significant quantities of commercial products including containers and bulk cargoes are located in Providence, Rhode Island, Boston, Massachusetts and to a lesser extent New Bedford, Massachusetts. Deep draft ship traffic carrying containers and bulk cargoes do utilize Buzzards Bay for access to the Cape Cod Canal; however this vessel activity is well separated from the site of the proposed action by the Elizabeth Islands and thus would not be affected by the proposed action.

4.3.7.5 Recreational Fishing

Because of its location adjacent to several key vacation destinations (i.e., Cape Cod, Nantucket, and Martha’s Vineyard), Nantucket Sound and the waters around the islands of Nantucket and Martha’s Vineyard support a diverse array of recreational fishing activities. Results from the MMFS MRFSS from three counties surrounding Nantucket Sound (Dukes, Barnstable, and Nantucket) from 1990 through-2004 were summarized (this survey is also discussed in Section 4.3.6.6). In those fifteen years there have been 40,130 MRFSS surveys reported from Dukes, Barnstable, and Nantucket Counties. It is important, though, to note that the data obtained from these surveys cannot be directly related to Nantucket Sound. Even though the surveys were conducted in the counties surrounding the Sound, only a portion would have been engaged in recreational fishing activities in Nantucket Sound because these surveys likely include anglers engaged in fishing activities offshore, in waters further out on the Cape, further offshore to the south of Nantucket and Martha’s Vineyard, or even in portions of Buzzards Bay.

Information was summarized from the recreational fishing data including fishing effort by mode, fishing effort by hours fished as reported by individual anglers, type of gear used by individual anglers, number of fish reported by anglers, as well as the number of fish observed by interviewers during the surveys, and the fish species observed by the interviewers during surveys ([Report No. 4.2.5-5](#)).

Based on the surveyed population, the use of private or rental boats appears to be the most common mode of recreational fishing over the past 15 years. Approximately 45 percent of the anglers surveyed reported using private and/or rental boats when participating in recreational fishing activities. Those reporting the use of party or charter boats were far lower than private boats at only 15 percent. Fishing from shore was also more common than the use of charter and party boats. Approximately 40 percent of the surveyed population reported fishing from shore as the mode of fishing from 1990-2004. The average time spent fishing by surveyed anglers ranged from a low of 3.1 hours in 1993 to a high of 3.6 hours in 1997 and 2004.

The various fishing gear reported by surveyed anglers included hook and line, dip/A-frame net, cast net, gill net, seine, trawl, trap, spear, hand, or other. The majority surveyed (99.7 percent) reported hook and line as gear type used for recreational fishing. The use of a dip net ranked second in terms of gear used (0.105 percent). Some type of fish trap use was reported in only 20 of the 40,079 surveys from 1990 through 2004. Gill nets were reported one time over the fifteen-year period.

The Cape Cod, southern Massachusetts, Rhode Island and Martha's Vineyard and Nantucket areas are home to thousands of small craft, both power and sail and host to hundreds more cruising the waters of Nantucket Sound during the summer months (May through October). Significant recreational traffic can be found in the Ports of Hyannis, Chatham, Dennis Port, Harwich Port, Yarmouth, Falmouth and Woods Hole as well as the many inlets, bays and backwaters in between. On the Islands, harbors frequented by pleasure craft include Vineyard Haven, Oak Bluffs and Edgartown while on Nantucket Island they include Nantucket Harbor. These port facilities mainly consist of yacht clubs and marina type environments that are made up of small boat piers and quays and mooring areas for recreational boats and fish offloading and processing equipment for the commercial fishing fleet.

A complete discussion of recreational fishing and boating can be found in Section 4.3.6.6 and 4.3.6.5, respectively.

4.3.7.6 Military Training

There are no designated naval training areas within the site of the proposed action and submarine activity could not occur within Horseshoe Shoal due to insufficient depths.

4.3.7.7 Outer Continental Shelf (OCS) Alternative Energy

Other reasonably foreseeable offshore alternative energy projects include TISEC Devices, other offshore wind turbines, and wave turbine technology. TISEC devices are a similar technology to wind turbines except that they are installed in the water column and are moved by underwater tidal currents. At present, one such project is being considered in Vineyard Sound, approximately 10 miles (16.1 km) west of the site of the proposed action.

There is currently 804 MW of commercial offshore wind power in Europe, and a few other proposed offshore wind energy projects in the United States (Musial, 2005). With the ever-increasing demand and cost of energy, and the excellent-to-outstanding wind resources on the northern part of Cape Cod, the southern part of Cape Cod, and along the shore of Martha's Vineyard and Nantucket (according to the DOE Energy Efficiency and Renewable Energy (EERE),2005) the potential for further wind energy development is high.

Wave turbine technology can be defined as a system of reacting forces, in which two or more bodies move relative to each other, while at least one body interacts with the waves. At present no wave turbine projects are proposed in the area of the proposed action.

4.3.7.8 Onshore Competing Use Activities

The onshore portion of the proposed action includes the underground electric transmission cable system. As the cables would be entirely located under streets and underground in an existing electric transmission ROW, onshore competing uses that could affect the proposed action are limited to those specific locations. There are no known proposals for other utilities in these areas that would represent a competing use to the proposed action.

4.4 NAVIGATION AND TRANSPORTATION

4.4.1 Overland Transportation Arteries

The major overland transportation arteries in Barnstable County are U.S. Route 6, and State Routes 28 and 6A. The three towns in Barnstable County that would have traffic related to the construction and maintenance of the wind farm include Falmouth, Barnstable and Yarmouth. The major highway in Falmouth is State Route 28, and in Barnstable and Yarmouth both 28 and Route 6 are major arteries. Route 28 travels in a west to east direction terminating between Chatham and Orleans. U.S. 6 continues into Cape Cod as a freeway from Bourne to Orleans. North of Orleans, Route 6 becomes a surface road again to its terminus in Provincetown.

The Regional access to the Quonset Point, which would be used for manufacturing and assembly of components, and as a marine staging/loading area, is provided by Route I-95. Route 4, a limited access highway connects Route I-95 to Route 403, which provides access directly into the area. Route 403 is a winding two-lane road which Rhode Island Department of Transportation has plans of replacing. Route 1 also passes along the entrance to the area.

4.4.1.1 Roadways Located in the Vicinity of the On-land Transmission Cable

The installation of the proposed action's onshore transmission cable system would be located under New Hampshire Avenue, Berry Avenue, Route 28 between Berry Avenue and Higgins Crowell Road, Higgins Crowell Road, Buck Island Road, Willow Street, and at the Route 6 overpass. These locations are described further below.

4.4.1.1.1 New Hampshire Avenue

New Hampshire Avenue is a two-lane residential road allowing vehicle access in a north-south direction. The roadway is a dead-end roadway with a concrete retaining wall at its southern end. There are no sidewalks on either side of the roadway. In addition, there is no on-street parking. During the summer of 2002, over the course of multiple site visits, observations were made of the relative traffic volumes at various points along the proposed route. Mid-day volumes along New Hampshire Avenue were observed to be very light. The transmission cable would be installed within the east side of the roadway.

4.4.1.1.2 Berry Avenue

Berry Avenue is a two-lane residential road allowing vehicle access to travel in a north-south direction. There are sidewalks on both sides of the roadway. Mid-day volumes were observed to be light. The transmission cable would cross to the west side of Berry Avenue off of New Hampshire Avenue. No on-street parking was observed on Berry Avenue. Berry Avenue is approximately 22 ft (6.7 m) wide.

4.4.1.1.3 Intersection 1 - Route 28 between Berry Avenue and Higgins Crowell Road

The intersection of Route 28 with Berry Avenue and Higgins Crowell Road is a two-lane roadway with a painted divider. Vehicle access on Route 28 travels in an east-west direction. The intersection of Route 28 with Berry Avenue and Higgins Crowell Road is signalized. There are sidewalks on both sides of Route 28. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be installed underneath Route 28 using trenchless technologies.

4.4.1.1.4 Higgins Crowell Road

Higgins Crowell Road is a two-lane road with a painted divider. Vehicle access travels in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be placed on the east side of Higgins Crowell Road. The street width for this road is approximately 24 ft (7.5 m).

4.4.1.1.5 Intersection 2 - Buck Island Road

The intersection of Buck Island Road with Higgins Crowell Road is a two-lane roadway with a painted divider. Vehicle access on Buck Island Road travels in an east-west direction. The intersection of Buck Island Road with Higgins Crowell Road is signalized. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be installed beneath Buck Island Road using trenchless technologies.

4.4.1.1.6 Willow Street

Willow Street is a two-lane road with a painted divider. Vehicle access travels in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. Mid-day volumes were observed to be heavy. The transmission cable would be placed on the west side of Willow Street. The street width for this road is approximately 30 ft (9.1 m).

4.4.1.1.7 Intersection 3 – Route 6 Overpass

The transmission cable would be installed using trenchless technologies as it passes underneath the Route 6 overpass. Approximately 0.5 miles (0.8 km) past the Route 6 overpass, the transmission cable would cross to the west side and enter the NSTAR Electric ROW. The transmission cable would also cross under Route 6 from the NSTAR Electric ROW from north to south to connect with the Barnstable Switching Station. This crossing would also be accomplished using trenchless techniques.

4.4.2 Airport Facilities

There are three airports located in the vicinity of the site of the proposed action and Nantucket Sound. These include Barnstable Airport (Boardman-Polando Field) in Hyannis on Cape Cod, and Martha's Vineyard Municipal Airport and Nantucket Memorial Airport (ACK). Provincetown Airport is also in the region. The next larger commercial airports include Logan International Airport in Boston, Massachusetts; Providence T.F. Green Airport in Providence, Rhode Island and at a greater distance yet, John F. Kennedy Airport on Long Island near New York City. The nearest military installation is Otis ANG Base in the upper western portion of Cape Cod, immediately south of the Cape Cod Canal in Barnstable County, Massachusetts. It includes parts of the towns of Bourne, Mashpee, and Sandwich and abuts the town of Falmouth.

Barnstable Municipal Airport is a vital transportation link to Cape Cod and the Islands. The airport is home to Cape Air/Nantucket Air, Island Airlines, Colgan/US Airways Express and numerous other charter, corporate and general aviation aircraft. Local airlines operate flights to Boston, Nantucket,

Martha's Vineyard and New York. Aircraft operating from the airport range from J3 Piper Cubs to Cessna 402's, Falcon 50's and Boeing 727's. Barnstable's Primary Runway is has a length of 5,425 ft (1654 m) and a width of 150 ft (45.7 m). Its secondary runway has a length of 5,252 ft (1601.2 m) and a width of 150 ft (45.7 m).

Martha's Vineyard Airport is a municipal airport that serves as a vital transportation link to the mainland and to Nantucket. Cape Air regularly serves the Martha's Vineyard Airport, year-round, from many locations including: Boston's Logan Airport (BOS), New Bedford Regional Airport (EWB), Provincetown Municipal Airport (PVC), Hyannis' Boardman-Polando Field (HYA), and the ACK. U.S. Airways Express seasonally serves the Martha's Vineyard Airport from the following locations: New York's LaGuardia Airport (LGA), Washington D.C.'s Reagan National Airport (DCA), Philadelphia, Pennsylvania (PHL), and HYA. In calendar year 2004 the Martha's Vineyard Airport had 63,378 flight "operations" (an "operation" includes each landing and takeoff) and in 2005 the Airport had 60,627 flight operations. Martha's Vineyard Primary runway has a length of 5,500 ft (1,676.8 m) long and is 100 ft (30.5 m) wide. Its secondary runway has a length of 3,297 ft (1,005.2 m) long and is 75 ft (22.9 m) wide.

ACK is located in the heart of historic Nantucket Island. The airfield has three runways. The first runway is paved and is 6303 ft (1921.6 m) long and 150 ft (45.7 m) wide with pilot controlled lighting. The second runway is paved and is 3999 ft (1219.2 m) long and 100 ft (30.5 m) wide with pilot controlled lighting. The third runway is 3125 ft (952.7 m) long and 50 ft (15.2 m) wide, and also is paved. The airport can accommodate single and multi-engine aircraft, as well as corporate jets and helicopters. A control tower operates between the hours of 6:00 AM and 9:00 PM, and until 11:00 PM in the summer months. The airport has a variety of navigational aids including an instrument landing system and VOR, NDB, and GPS approaches. In 2004, airport operations totaled 144,267. Cape Air, Colgan Air, Continental, Island Airlines, Nantucket Airlines, Nantucket Shuttle, and US Airways Express service Nantucket from airports in Massachusetts, Rhode Island, and New York. Some of these airlines fly to the island seasonally.

Airlines

Cape Air operates a fleet of over 50 Cessna 402's with up to 850 flights per day during high season. Colgan Air operates as Continental Connection, United Express, and US Airways Express, with 36 SAAB 340 and 11 Beech 1900D aircrafts. Island Airlines and Nantucket Airlines all operate Cessna 402's.

4.4.2.1 Commercial Aviation Corridors

High Altitude Jetways (North America – Europe and East Coast U.S.) are not considered a factor in this proposed action and are not considered in this assessment.

The proposed turbine array is not located in the flight path of any low altitude Instrument Flight Rules (IFR) routes. The IFR routes are used by aircraft flying at night or in restricted visibility, on instruments and under the control of Air Traffic Control (ATC). There are three IFR routes established for Nantucket Sound, however, they are not in the vicinity of the Horseshoe Shoal proposed action. The IFR Route V167 that connects T.F. Green airport in Providence Rhode Island and Provincetown, Massachusetts comes from the direction of EWB and turns toward and passes north of Barnstable Airport approximately 2.3 miles (3.7 km) northwest of the proposed action at a minimum altitude of 1,600 ft (487.8 m). The IFR Route V141 from Logan Airport to Nantucket passes east of the site of the proposed action at a minimum altitude of 1,700 ft (518.3 m) and IFR Route V146 connects Martha's Vineyard with Nantucket at a minimum altitude of 2,000 ft (609.8 m) and is located approximately 9.8 miles (15.7 km) south of the proposed action. Another Route V46 that connects Nantucket with New York (Long Island) is not a factor since it lies south of Martha's Vineyard and south of V146 (Martha's Vineyard – Nantucket). IFR Route V34-58 from Block Island to Nantucket is also south of IFR V146 and north of IFR V46.

Analysis of recent aircraft flights between Rhode Island/Massachusetts and Nantucket/Martha's Vineyard revealed that most travel on the IFR routes at 3,000 to 5,000 ft (914.6 to 1,524.4 m) with some at 7,000 ft (2,134.1 m).

4.4.2.2 General Aviation Traffic

Like recreational boat traffic, general aviation (not commercial airlines or freight) is varied and increases for the summer season. Excluding high performance jet and turbo prop aircraft which generally file and follow IFR routes, general aviation use Visual Flight Rules or VFR. Low flying aircraft operating under VFR have to maintain a minimum 500 ft clearance from any structure or vessel as required by 14 CFR 91.119. Over water, in the absence of any structures or vessels, there is no minimum altitude restriction.

4.4.3 Port Facilities

4.4.3.1 General Description of the Area

As shown in [Figure 4.3.7-1](#), Nantucket Sound is bounded to the south by the islands of Martha's Vineyard and Nantucket, and to the north by Cape Cod. To the west of Nantucket Sound is Vineyard Sound, and to the east is the Atlantic Ocean. Horseshoe Shoal is located in the approximate middle of Nantucket Sound, with its geometric center at approximately 41°30'N; 70°20'W. The northeasterly tip of the shoal is known as "Broken Ground." The southeasterly tip of the shoal is known as "Halfmoon Shoal."

Nantucket Sound is used for navigation by recreational watercraft, commercial fishing vessels and commercial vessels engaged in waterborne commerce. Peak usage by recreational watercraft and commercial fishing vessels is during the warmer months of the year (typically April through October). Pilotage is not typically required for vessels transiting through central and eastern Nantucket Sound.

There are two main shipping lanes, the Main Channel and the North Channel, used for safe navigation by larger vessels in Nantucket Sound. The USCG marks both of these areas with aids-to-navigation (buoys, lights, etc.). These shipping lanes are described as follows:

- The Main Channel in Nantucket Sound is located south of Horseshoe Shoal. This channel is used by most of the vessels transiting through Nantucket Sound. It is reported that vessels using the channel seldom exceed a draft of 24 ft (7.3 m) (NOAA, 1994).
- The North Channel runs along the north side of Nantucket Sound, on either side of Bishop and Clerks, northward of Horseshoe Shoal, between Wreck Shoal and Eldridge Shoal, northward of L'Hommedieu Shoal, and through one of the openings in the shoals westward of L'Hommedieu Shoal into Vineyard Sound. This channel is used mostly by vessels bound for the south shore of Cape Cod, and by vessels transiting the Sound during northerly winds. The shallowest depth in the channel is approximately 16 ft (4.9 m) at MLLW.

In addition to these shipping channels, privately and federally maintained channels are located at the approaches to Cotuit Bay, Centerville Harbor, and Hyannis Harbor (see [Figure 4.3.7-1](#)).

The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage ground, known as "Anchorage I." Floats or buoys for marking anchors or moorings in place are allowed in this area. Fixed mooring piles or stakes are prohibited (NOAA, 1994).

The Coast Pilot describes Nantucket Sound as being located between the south coast of Cape Cod on the north, Nantucket Island and part of Martha's Vineyard on the south, and Vineyard Sound on the west. Nantucket Sound has a length of about 23 miles (37 km) in an east-west direction and a width of 6 to 22 miles (35.4 km) in a north to south direction. At the eastern entrance and within the sound are numerous shoals. Between the shoals are well-marked channels making the navigation of these waters comparatively easy for powered vessels and also sailing vessels with a fair wind. The shoals at the eastern entrance are subject to considerable shifting while those inside are somewhat more stable. Boulders are located along the shores in some locations.

Numerous fish traps are located in Nantucket Sound, particularly along the southern shore of Cape Cod. The Sound is home to many shoals and mariners need to stay sharp to safely navigate these waters with their currents, convection fog in summer months, high winds and relative choppy seas in winter storms, and for weather fronts moving through the area throughout the year.

The USCG has categorized the waters of Nantucket Sound as both Navigationally Critical and Environmentally critical through its Waterways Analysis and Management System (WAMS). This means that for the waterway, degradation of the aids to navigation system would result in an unacceptable level of risk of a marine accident affecting the national economy due to the physical characteristics of the waterway, difficult navigational conditions, aid establishment difficulties, or high aid discrepancy rates. Environmentally Critical Waterways are waterways where a degradation of the aids to navigation system would present either an unacceptable level of risk to the general public or to sensitive environmental areas, because of the transport of hazardous material or dangerous cargoes.

4.4.3.2 Ports and Marinas

There are no major or significant Port Facilities that handle large deep draft traffic and are engaged in commercial cargoes in the vicinity of the site of the proposed action. The closest Port Facilities that handle significant quantities of commercial products including containers and bulk cargoes are located in Providence, Rhode Island, Boston, Massachusetts and to a lesser extent New Bedford, Massachusetts. Deep draft ship traffic carrying containers and bulk cargoes do utilize Buzzards Bay for access to the Cape Cod Canal, however this vessel activity is well separated from the site of the proposed action by the Elizabeth Islands and thus would not be affected by the proposed action.

There are many small ports surrounding Nantucket Sound that are home to a plethora of both sail and motor, small and large recreational vessels, excursion/sight seeing vessels and private and commercial fishing vessels and passenger vessels. There are larger ports that are the ports of embarkation for the extensive Passenger/Vehicle/Cargo ferry System that connects Cape Cod and the mainland with the Islands of Nantucket and Martha's Vineyard. This ferry system operated by the Martha's Vineyard and Nantucket Steam Ship Authority (SSA) is a vital link between the Islands and the mainland. The ferry system provides goods and services to both residents and industry on Martha's Vineyard and Nantucket Islands. The SSA operates from Hyannis, Massachusetts with Ferries to Nantucket and from Woods Hole, Massachusetts with ferry service to Martha's Vineyard calling on their main year-round port at Vineyard Haven and their seasonal port of Oak Bluffs from May to October. The port of Oak Bluffs and Vineyard Haven are approximately 3.5 miles (5.6 km) apart. The SSA operates their Hyannis to Nantucket service year round also with the addition of a seasonal high speed ferry service that starts April and takes approximately one hour to make the transit from Hyannis to Nantucket Island. These ferries carry passengers, personal vehicles and large tractor trailers loaded with goods for the economy of both

islands. Other than transportation by air, the ferry service is by far the major means delivering essential goods to the islands and their economies.

There are other passenger ferries operating from Cape Cod (Falmouth) and Rhode Island taking passengers to Martha's Vineyard and Nantucket. Departing from New York, Clipper Cruise Lines operates a small passenger vessel that calls at Oak Bluffs or Vineyard Haven, on Martha's Vineyard and Nantucket Island during the summer months. Other than the SSA, none of these vessels require extensive port facilities other than a dock to off-load and on-load passengers for a day excursion. The SSA operates at port facilities that employ roll-on and roll-off capabilities and sufficient land area to stage waiting vehicular and tractor trailer cargo. None of the ports found surrounding Nantucket Sound have sophisticated and extensive cargo handling capabilities.

The Cape Cod, southern Massachusetts, Rhode Island and Martha's Vineyard and Nantucket areas are home to thousands of small craft, both power and sail and host to hundreds more cruising the waters of Nantucket Sound during the summer months (May through October). Significant recreational traffic can be found in the Ports of Hyannis, Chatham, Dennis Port, Harwich Port, Yarmouth, Falmouth and Woods Hole as well as the many inlets, bays and backwaters in between. On the Islands, harbors frequented by pleasure craft include Vineyard Haven, Oak Bluffs and Edgartown while on Nantucket Island they include Nantucket Harbor. These port facilities mainly consist of yacht clubs and marina type environments that are made up of small boat piers and quays and mooring areas for recreational boats and fish offloading and processing equipment for the commercial fishing fleet.

4.4.3.3 Commercial Ship Traffic and Berthing

Commercial ship traffic for the purposes of this report is defined as that traffic that either takes on passengers for hire or is involved in commercial trade which may involve the carriage of cargo. This would include the Passenger/Cargo/Vehicular Ferry Systems that operate from different ports in Massachusetts including Cape Cod as well as from Rhode Island; commercial fishing vessels (fish, shell fish and lobster for sale and not personal consumption) and other vessels that deliver goods and services to the islands and transit Nantucket Sound. Some of the commercial vessel traffic operates on a year round basis (SSA and commercial fishing fleet) and on a schedule while other commercial traffic operates on a seasonal basis (ferries from Rhode Island and fast ferry from Hyannis).

The USCG Waterway Analysis and Management System provides the following as commercial users of Nantucket Sound:

- Nantucket and Martha's Vineyard Steamship Authority operating out of Woods Hole and Hyannis, Massachusetts; Falmouth Ferries; Hy-Line Cruises; Patriot Party Boats; Freedom Cruise Lines; Hyannis Cruise Lines; Tisbury Towing (New Bedford, Massachusetts) and Shearwater Excursions.
- The Woods Hole Oceanographic Institute and NOAA operate several large oceanographic vessels that are home ported at Woods Hole and deploy throughout the world.
- Commercial Fishing vessels located throughout the many harbors surrounding Nantucket Sound with the highest concentration being in New Bedford, Massachusetts that transit through Nantucket Sound enroute to fishing grounds in the area and Georges Bank. An estimated two hundred to two hundred and fifty commercial fishing vessels transit this area to and from fishing grounds. It is also estimated that approximately 50 to 80 commercial fishing vessels fish in the Nantucket Sound itself.

- Large USCG Aids to Navigation cutters are stationed in Woods Hole, Massachusetts and smaller rescue boats at USCG Stations located at Menemsha, Martha's Vineyard, Brandt Point, Nantucket and Chatham, Massachusetts. These Stations are assigned the primary duties of patrolling and conducting search and rescue operations within Nantucket Sound and elsewhere.
- Clipper Cruises operating out of New York City also has a seasonal passenger vessel service that calls on ports in Martha's Vineyard and Nantucket.

From the Waterways Analysis the major ports that support commercial vessel operations surrounding Nantucket Sound include:

- Woods Hole, Falmouth and Hyannis in Barnstable County, Massachusetts
- Vineyard Haven and Oak Bluffs, in Dukes County, Massachusetts
- Nantucket Harbor in Nantucket County, Massachusetts

To support operation of these vessels, the ports have deep water piers and quays to allow these vessels to come along side and discharge their cargo and passengers. The SSA has a significant staging area to stack vehicular traffic awaiting arrival and the loading of ferries at both Woods Hole and Hyannis and at their ports of call in Martha's Vineyard and Nantucket.

The largest commercial vessels known to routinely operate in Nantucket Sound are in the order of 230 to 280 ft (70.1 to 85.4 m) in length; 13 to 20 ft (4 to 6.1 m) in draft and are approximately 1800 gross tons (1,632,932.5 kg). These ships are of the type operated by the SSA and other operators engaged in commerce with the Islands. The height overall for these vessels is approximately 70 ft (21.3 m). Other vessels, cruise ships, of up to 330 ft (100.6 m) (*Clipper Adventurer*) and 4,300 gross tons (3,900,894.4 kg) have called on ports in the area of study.

4.4.3.4 Ship, Container and Bulk Oil Handling Facilities

There are no ship and container handling facilities in ports surrounding Nantucket Sound. Containers are carried on SSA ferries as part of a tractor trailer rig and are on and off loaded by driving the rig onto or off the vessel on its vehicle deck. There are bulk liquid facilities at Vineyard Haven and Nantucket for offloading petroleum products that are transported by the T/V Great Gull and other barges. The largest ship handling facilities are those owned and operated by the SSA and the oil transfer facilities in Vineyard Haven and Nantucket.

4.4.3.5 Navigation Channels

Due to the characteristics of the waterway, most commercial traffic is restricted to navigation by its draft and for safety reasons to the navigation channels marked by the USCG. The area is transected by two named channels but only one major channel that provides a route for medium sized vessels to transit in an east/west direction in an area north of the Nantucket Shoals. Called the Main Channel, this passage way starts in the west at the juncture of Vineyard Sound and Nantucket Sound at Nobska Point, passes north of West Chop and East Chop on Martha's Vineyard, and passes south of Hedge Fence shoal. It then continues in a Southeasterly direction passing between Horseshoe Shoals to the north, and Hawes Shoal (Chappaquiddick Island) to the south. The channel is fairly wide in most areas being approximately 1.15 miles (1.9 km) across from edge to edge as marked on NOAA Chart 13237 for a draft of 30 ft (9.1 m). It constricts down to approximately 0.86 miles (1.4 km) wide directly south of Horseshoe Shoal at Cross Rip Shoal. It widens soon after heading eastward and immediately south of Half Moon Shoal hosts the channel heading toward Nantucket Island. The Channel width for the Nantucket Harbor is approximately 1 mile (1.6 km) in width. The Main Channel continues and turns east north east and then north east

heading for the south of Monomoy Island and Butler Hole which provides the deep water for the channel as it bisects Monomoy Island and Barse Shoal to the north and Monomoy Shoal to the South. The channel passage through this area is narrow.

The other major channel is called North Channel which skirts the south of Cape Cod and provides access to ports along the Cape Cod shore such as Falmouth, Hyannis, Yarmouth, and Chatham. This channel runs north of Horseshoe Shoal and runs in an east-west direction. The channel is well marked by aids to navigation and has a restricted depth of 16 ft (4.9 m).

The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel's draft. Charted water depths on Horseshoe Shoal range from 1 to 45 ft (13.7 m) measured at MLLW. The majority of the Shoal is 20 to 30 ft (6.1 to 9.1 m) at MLLW (see [Figure 4.4.3-1](#)). Approximately 91 percent of Horseshoe Shoal has charted depths of 30 ft (9.1 m) or less MLLW. This fact limits the vessels that can transit over the shoals at any given time. Analysis of the vessel make-up by type, size and service shows that only one quarter of Horseshoe Shoal has depths that allow the majority of the vessel types using the area to operate and/or drift without going aground. A further breakdown of vessel type, size, draft, and ability to navigate the depth limitations at Horseshoe Shoal is provided in the *Revised Navigational Risk Assessment (Report No. 4.4.3-1)*. Due to the swift currents and rapidly changing depths of water over very short distances steep short period waves are created that break on the shoal making operations more difficult.

Ferries out of Woods Hole and Hyannis servicing the Islands of Martha's Vineyard and Nantucket use the North Channel (Falmouth and Hyannis) and then the Main Channel for their transits to and from the ports of Vineyard Haven and Oak Bluffs. Ferries operating out of Rhode Island enter the Nantucket Sound through Vineyard Sound and pick up the Main Channel at Nobska Point for their transits to Martha's Vineyard and Nantucket. Those ferries transiting to Nantucket would follow the Main Channel until the Nantucket Channel Intersects in the vicinity of Half Moon Shoal (see [Figure 4.3.7-1](#)).

As stated previously, the width of the Main Channel is approximately 1.15 (1.6 km) except at the Gate of Red #20 and Green #21 where it is approximately 0.86 miles (1.4 km) across at Cross Rip Shoal. The constriction for the North Channel in the vicinity of the proposed action at the Red #8 and Green Can 11 is 0.8 miles distant. The typical spacing between WGT's in the proposed action is 0.62 miles (1 km) by 0.39 miles (0.6 km).

4.4.3.6 Cruise Ship Traffic

For purposes of this assessment, Cruise Ships are defined as vessels that take passengers for hire and provide an itinerary that requires over night accommodations and visits to a number of ports on a multi day cruise. Cruise Ships call on Ports in Martha's Vineyard and at Nantucket. Clipper Cruise Lines operating out of New York City have in the past and plan to continue to call on Martha's Vineyard and Nantucket. Their vessels the *Clipper Adventurer* and the *Yorktown Clipper* have called on the area in the past. The *Clipper Adventurer* is 330 ft (100.6 m) long with a beam of 53.5 ft (16.3 m) and a draft of 15.5 ft (4.7 m). The *Yorktown Clipper* is 257 ft (78.4 m) in length, has a 43 ft beam and has a draft of 8 ft (2.4 m). The *Nantucket Clipper* continues to be listed as a possible visitor to the area. American Cruise Lines offers a New England Island itinerary that sails out of Providence, Rhode Island and visits both Martha's Vineyard and Nantucket in two vessels, the *American Spirit* (which is about 214 ft (65.2 m) long and carries 93 passengers) and the *American Glory*. Both vessels operate on a similar itinerary from June through the end of September. Their voyage plan calls for them to enter Nantucket Sound from Vineyard Sound at Nobska Point and use the Main Channel for transit to a Port Call in Nantucket and then return to Martha's Vineyard for the second port call exiting the Sound through Vineyard Sound on route to Fall River, Massachusetts.

Due to the nature of the waterway, the harbor pilots state that they do not take vessels with drafts in excess of 24 ft (7.3 m) or greater east of a point located at 41-46.0N 70-54.3W just northeast of East Chop on Martha's Vineyard. Passenger vessels and cruise ships bound for a port call on Martha's Vineyard at Oak Bluffs or Vineyard Haven always approach these areas from the west (Vineyard Sound) and depart to the west at the termination of the port call. This track puts these vessels approximately 8 miles (13 km) NW from the nearest proposed WTG on Horseshoe Shoal.

4.4.3.7 Overwater Passenger Ferry Traffic

Passenger and freight ferries (including high-speed ferries) bound for both Nantucket and Martha's Vineyard operate out of Hyannis Inner Harbor and transit the area near Horseshoe Shoal. Steamship Authority vessels do not transit over Horseshoe Shoal. Ferries bound for Nantucket transit to the east of Horseshoe Shoal, while ferries bound for Martha's Vineyard transit to the north and west of the shoal (see [Figure 4.3.7-1](#)). According to USACE data for the 1998 through 2000 timeframe, an annual average of 1,305 vessel trips for vessels engaged in waterborne commerce were reported as passing Cross Rip Shoal, which is to the south of Horseshoe Shoal and the Main Channel.

The over water passenger ferry services in Nantucket Sound are the largest and most frequent users of the waterway; they carry thousands of passengers to and from the islands as well as most of the freight necessary to support the islands population and industry. The SSA operates a fleet of nine passenger/vehicle and freight/passenger ferries that service the islands from Hyannis and Woods Hole. The SSA operates 28 transits per day starting at 0600 to 2330 over the summer months between Woods Hole and Martha's Vineyard by two vessels (Each vessel has seven round trips or fourteen transits per day). The run takes approximately 45 minutes from dock to dock. The traditional passenger/vehicle service from Hyannis to Nantucket takes 2 hours and 15 minutes and there are 12 transits by two vessels (Each vessel makes three round trips or six transits per day). In the summer months, the fast ferry Flying Cloud also makes 10 transits or 5 round trips per day from Hyannis to Nantucket in one hour. While the normal ferries operate at 14 to 15 knots (7.2 to 7.7 m/s), the Flying Cloud operates at 34 knots (17.5 m/second) or about 40 miles (74.1 km) per hour to make the one hour transit between Hyannis and Nantucket. The SSA ferries have drafts ranging from 7 ft to 12 ft (2.1 to 3.7 m).

Falmouth Cruises operates a passenger ferry regularly from Falmouth Harbor to Oak Bluffs. Eighteen transits are made daily in the summer season.

Hy-Line operates year round high speed ferries from Hyannis to Nantucket and Martha's Vineyard as well as traditional passenger ferry services (seasonal) to both islands and inter-island. The high speed passenger-only ferries operate ten transits per day to Nantucket and ten transits per day to Martha's Vineyard. Hy-Line's tradition ferry that operates seasonally makes six transits to Oak Bluffs, Martha's Vineyard. The Nantucket Ferry operates at six transits per day during the summer season as well as a high speed ferry that operates between Martha's Vineyard and Nantucket two transits per day in the summer months.

Freedom Cruise Lines operate a traditional passenger only ferry from Harwich Port to Nantucket. Its schedule shows six transits per day during the peak summer season.

Most of the commercial vessels routinely using the Nantucket Sound area conservatively have drafts less than 20 ft (6.1 m), 46.3 percent of the proposed action (96 WTGs) is located in waters with depths greater than 20 ft (6.1 m).

4.4.3.8 Marinas and Recreational Boating

There are over forty marinas located in the immediate area surrounding Nantucket Sound. Most are located on Cape Cod. There are marinas and mooring areas located on both Martha's Vineyard and Nantucket predominately on Martha's Vineyard in Vineyard Haven, Menemsha, Oak Bluffs, and Edgartown. On Nantucket most marinas and moorings are located in the main harbor. Recreational traffic in the Sound is seasonal with the summer months from June to October seeing a dramatic increase on water activities by recreational traffic both by boats that originate from the area marinas as well as recreational craft that visit the area from the entire New England and Mid Atlantic Region.

Nantucket Sound is a well known area that attracts all types of recreational craft from the smallest runabout to very large and expensive yachts. These yachts not only include world class power boats/cruisers privately or corporately owned (*Lone Ranger Length 254 ft/Acquisition 121 ft*) but also sail boats of all sizes (*Southern Cross Maxi 88*). Many remain in the region for the entire boating season, while others use the area to transit to other ports of call along the New England and Mid Atlantic Coasts as well as Canada.

Recreational Marine Events

The website at USCG Sector Providence provides a partial list of marine events in its area of operations that include Nantucket Sound. This site lists contains several events in the Nantucket Sound area, however they are located near shore and in various harbors of the Cape and the Islands.

One event called the Figawi Race between Hyannis and Nantucket and back is held every year on Memorial Day. It involves sailboats with LOA's of 20 ft (6.1 m) or greater. The actual course varies from year to year but typically starts to the north of and proceeds around or over portions of Horseshoe Shoal. [Figure 4.4.3-2](#) shows the six courses published in the 2003 Figawi Race Sailing Instructions and similar to those published in the 2005 Figawi Race Sailing Instructions.

4.4.3.9 Commercial Fishing

As is the case for recreational traffic, sources of fishing vessel traffic using Nantucket Sound is too broad to list due to the independence and mobility of fishing activity and practices. Various sources documented that over 70 fishing vessels varying from 30 to 60 ft (9.1 to 18.3 m) in length and 4 to 8 ft (1.2 to 2.4 m) in draft fish Nantucket Sound. Other references postulate that local fisherman attribute 50 to 60 percent of their livelihood to fishing Nantucket Sound. Actions by NMFS reducing "days-at-sea" by 40 percent average for ground fish may result in fishing vessels that fished away from the area returning to the Sound to comply with the at sea reduction to fill their ground fish quotas.

It is also documented that 200 to 250 commercial fishing vessels, many from New Bedford, Massachusetts use the Main Channel across Nantucket Sound to gain access to fishing grounds on Georges Bank and elsewhere. These vessels range in size from 60 to 100 ft (18.3 to 30.5 m) in length and have drafts of 8 to 15 ft (2.4 to 4.6 m).

Many newer and more profitable fishing vessels are well maintained and equipped with an extensive array of navigation and fishing technology to support extended offshore operations and are staffed by seasoned and professional masters as well as adequate crew. Other fishing vessels are marginally seaworthy and minimally manned with only the most basic of navigation equipment. During bad weather or when making repairs, these vessels have been known to use the General Anchorages in the vicinity of the site of the proposed action.

4.4.4 Communications: Radar, Television, Radio, Cellular, and Satellite Signals and Beacons

4.4.4.1 Existing Conditions

The proposed action area encompasses a substantial amount of water within which a number of communications services are in use. These services fall into the following primary categories:

1. Recreational Communications (satellite, radio, TV, non-emergency cellular)
2. Navigation and Positioning Services
3. Safety and Emergency Communications
4. Aviation and Military Surveillance Radar

4.4.4.1.1 Communications Towers in Area

To evaluate potential impact to existing RF communications in the area, a search of the FCC antenna structure database was made to identify existing and proposed communications towers in the area around Nantucket Sound, including Cape Cod and the islands. A search radius of 40 km from the center of the turbine area was used. This search revealed 69 existing structures that have been notified to the FCC; 51 of these are on the mainland, 11 are on Martha's Vineyard, and 7 are on Nantucket. There are 12 other tower notifications that are in "granted" status, meaning that they have been approved but the FCC has not been notified of their construction. Nine of these are on the mainland, one is on Martha's Vineyard and two are on Nantucket.

The antenna structures found in the area are a mix of broadcast towers, cellular base station towers, local public safety communications towers, and towers for industrial and business use.

4.4.4.1.2 Broadcast Service in Area

On the AM broadcast band, there is one fulltime local station serving the Cape Cod area, WBUR on 1240 KHz, in West Yarmouth. There are also AM signals that are received from more distant stations.

There are 20 licensed full-service FM broadcast stations whose transmitters are within 25 miles (40 km) of the center of the turbine area. Seven of these are on the non-commercial band (88 to 92 MHz). Many of these stations are low-power (less than 6 kW) and may not cover the entire Cape Cod area. More distant FM signals are available from New Bedford, Plymouth and other communities.

On the TV broadcast band, local signals include WMPX-LP, a low-power station on Channel 33 in Dennis, and full-power station WDPX at Vineyard Haven (analog Channel 58, HDTV Channel 40). Barnstable, Dukes and Nantucket Counties are in the Boston Designated Television Market Area, but are also served by TV stations in Providence, Rhode Island.

4.4.4.1.3 Aviation and Military Radar Facilities

The closest public airport with a control tower is Barnstable Municipal/Boardman Polando Field in Hyannis. The control tower is more than 8 miles (12.9 km) from the nearest turbine site.

There are two Terminal Radar Approach Control (TRACON) stations within 57.5 miles (92.6 km) of the turbine area. TRACONs are FAA radar stations staffed by air traffic controllers that guide aircraft approaching and departing airports generally within a 34.5 to 57.5 miles (55.6 to 92.6 km) radius up to 10,000 ft (3048 m), as well as assure safe separation of aircraft flying in busy areas near airports. The two TRACONs are at Otis Air Force Base on Cape Cod, about 10 miles (16.1 km) from the nearest

turbine, and Theodore Francis Green State Airport in Providence, about 54 miles (87 km) from the nearest turbine.

The nearest Air Route Traffic Control Center (ARTCC) is in Nashua, New Hampshire, about 99 miles (159 km) from the nearest turbine. The purpose of an ARTCC is to guide aircraft at altitudes above 10,000 ft (3038 m) while in mid-flight.

There is a Long Range Joint Use⁸ Radar Station (ARSR) in the area, located near North Truro, Massachusetts. The station is about 36 miles (57.9) from the nearest turbine site.

The PAVE PAWS radar station in the north portion of the Massachusetts Military Reservation, near Sagamore, is about 17 miles from the nearest planned turbine. PAVE PAWS is an Air Force Space Command radar system providing detection of ballistic missiles and space surveillance.

⁸ "Joint Use" means that the radar station is shared by the FAA and the U.S. Military.

5.0 ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

5.1 IMPACT-PRODUCING FACTORS – NORMAL CONDITIONS

The identification and description of activities, equipment, materials, and processes that have the potential to create impacts on natural and human resources in areas proposed for use by the proposed action has been divided into two main categories, those items occurring under normal conditions, and under non-routine conditions. Normal conditions are discussed below, which are then followed by the non-routine conditions (Section 5.2). These factors are then used, as appropriate, in characterizing resource impacts in Sections 5.3 and 5.4, as well as to some extent in Section 6.0. It is important to note that these factors need to be considered within the larger context of other sources of the same or similar impact-producing factors that have occurred in the recent past, do currently occur, or could reasonably be expected to occur in the near future, within the site of the proposed action (refer to [Table 5.1.1-1](#) for a summary of Impact Producing Factors).

5.1.1 Maintenance or Construction Vessels and Crew boats

Impacts associated with vessels to be used during construction, operation, and decommissioning of the proposed action, many of which are common to most commercial vessels operating in Nantucket Sound, can be placed into three timeframes during transit, while on station, and while at staging areas. The characteristics of how and what impact factors are associated with these three timeframes are described in the following subsections.

5.1.1.1 Vessel Activity (in Transit, on Station, and at Staging or Maintenance Base)

The most probable scenario is that the majority of material and equipment would be staged onshore, most likely at existing port facilities in Quonset, Rhode Island, and then loaded onto various vessels for transportation to the offshore site, and ultimately installation. Construction personnel would be ferried by boat and/or helicopter depending upon weather conditions and other factors. Once loaded, if traveling from Quonset, the vessels would pass through Narragansett Bay to Rhode Island Sound then to Vineyard Sound, and then North of Martha's Vineyard to the Main Channel, a distance of about 63.3 miles (101.9 km). While these vessels are in transit, certain aspects of their operation have the potential to generate a number of impacts on marine resources. During construction and decommissioning, the majority of vessel berthing and loading would likely occur at Quonset. Smaller supply or crew boats may also operate out of Cape Cod ports, such as Hyannis. During the proposed action operation phase, maintenance vessels would operate out of Hyannis or similar Cape Cod port, under normal conditions. These ports have adequate facilities for berthing and loading of the maintenance vessel(s). The impacts from all vessel activity are described below.

5.1.1.1.1 Sumps, Ballast, and Bilge Discharges

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters greater than 13.8 miles (22.2 km) offshore if the oil concentration is less than 100 parts per million (ppm). Discharges may occur within 13.8 miles (22.2 km) if the concentration is less than 15 ppm. Ballast water is used to maintain stability and trim of the vessel and may be withdrawn from coastal or marine waters through structures in the hulls of ships called sea chests. Generally, the ballast water is pumped into and out of separate compartments or tanks depending upon the requirements to maintain proper vessel stability and trim as cargo is unloaded. Ballast compartments are not usually contaminated with oil as they are isolated from machinery and engines; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

In other instances, vessels that arrive empty or load and unload in different locations associated with the proposed action would also result in the discharge of ballast as cargo is taken on board. For example, a barge that is loaded with construction materials and equipment at the onshore staging area would have minimal ballast. After transit to the site of the proposed action and offloading materials as the WTGs are constructed, these vessels may take on ballast water to maintain trim and stability for the transit back to shore for re-loading. Ballast water withdrawals result in entrainment of planktonic marine life and then the discharge of these organisms at a different location. Withdrawal impacts are described further in Section 5.1.1.1.5. In addition to water quality concerns associated with ballast water discharge, an additional potential impact is the introduction of invasive species into local waters, from vessels coming from over seas or from other U.S. ports.

Impact characteristics that result from discharge from vessels described above are also similar to vessels in transit, except for the fact that vessels on station are discharging at a relatively constant location. Whereas vessels in transit have the advantage of a moving discharge resulting in greater dilution and dispersion of the discharged water, vessels on station rely on local currents and passive dispersion mechanisms to dilute the waste water within the receiving water. Should these discharges have characteristics that adversely affect water quality or marine organisms, such as low dissolved oxygen (DO) or pollutants, the severity of the localized impact may be greater than for a vessel in transit.

All vessels for the proposed action would comply with applicable mandatory ballast water management practices established by the USCG in order to minimize the inadvertent transport of invasive species as well as the potential for adversely impacting water quality.

5.1.1.1.2 Deck Drainage

Deck drainage includes all wastewater resulting from deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen. The quantities of deck drainage vary greatly depending on the size and location of the equipment. Large vessels employed during construction, operation, and decommissioning, particularly those with machinery operating on deck, such as cranes or generators, should be designed to avoid oily deck drainage discharge to the ocean.

5.1.1.1.3 Greywater Discharges

On board vessels, domestic wastewater originating from sinks, showers, laundries, and galleys is referred to as greywater. Sanitary wastewater originates from toilets and is referred to as blackwater, which is discussed in Section 5.1.1.1.4. For greywater, no solids or foam may be discharged. In general, operation of large vessels with crew quarters and full live-on-board capabilities would result in the generation of 50 to 100 gallons/person/day of greywater. Given the currents and volume of water in an open water setting, it is assumed that where allowed, discharges of greywater are rapidly diluted and dispersed. State and local governments regulate greywater from vessels when operating near shore. Unlike vessels in transit, wastewater discharges from vessels on station would occur more like a point source discharge, with less potential for dispersal and dilution. In these instances, local currents and water depth, would affect the dispersal and dilution factors, and the concentration of a wastewater plume would be higher in the localized area around the point of discharge compared to a vessel in transit. However, again, Horseshoe Shoal is essentially in an open ocean setting and greywater discharges are anticipated to rapidly dilute and disperse.

Discharge of greywater would not occur into the harbor while vessels are berthed. Instead, wastewater would either be held until offshore disposal can occur or would be pumped onshore for proper disposal. All vessel waste would be offloaded, stored and disposed of in accordance with all applicable local, state and Federal regulations.

5.1.1.1.4 Blackwater Discharges

In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet and maintain the requirement of total residual chlorine greater than 1 mg/L. In general, operation of large vessels would result in the generation and discharge of 35 gallons/person/day of treated sanitary wastes. All vessels with toilet facilities must have a Marine Sanitation Device (MSD) that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. Type I and II MSDs are systems mechanically chop up the sewage, chemically treat it, and discharge it through a screen. These MSD systems can not be used, however, in coastal waters that are designated as No Discharge Areas (NDAs). The NDAs are areas where discharge of any treated or untreated sewage is prohibited. There are currently eight NDAs in Massachusetts: the coastal waters of Plymouth, Kingston, and Duxbury, all of Buzzards Bay, Waquoit Bay in Falmouth, the coastal waters of Harwich, Three Bays/Centerville Harbor in Barnstable, Stage Harbor in Chatham, Wellfleet Harbor, and the coastal waters of Nantucket from Muskeget Island to Great Point, including Nantucket Harbor. All Rhode Island waters are also designated as No Discharge (www.mass.gov/czm).

Unlike vessels in transit, wastewater discharges from vessels on station would occur more like a point source discharge, with less potential for dispersal and dilution. In these instances, local currents and water depth, would affect the dispersal and dilution factors, and the concentration of a wastewater plume would be higher in the localized area around the point of discharge compared to a vessel in transit. However, Horseshoe Shoal is essentially in an open ocean setting and blackwater discharges are anticipated to rapidly dilute and disperse.

Discharge blackwater would not occur into the harbor while vessels are berthed. Instead, wastewater would either be held until offshore disposal can occur or would be pumped onshore for proper disposal. All vessel waste would be offloaded, stored and disposed of in accordance with all applicable local, state and Federal regulations.

5.1.1.1.5 Water Withdrawals

While no water withdrawal is associated with the operation of the proposed action's WTGs or electric service platform, water withdrawals by vessels would occur during transits and while on station for construction and maintenance. As indicated above, water withdrawals may occur for ballasting, but other water withdrawals would occur for vessel engine cooling, hoteling, and operation of on-board reverse osmosis water systems (for those vessels with such systems). Water withdrawals by themselves would not have a measurable impact on water quality or quantity in the site of the proposed action where vessels operate, but they can result in the entrainment of planktonic marine organisms, and to a lesser extent, impingement of poor swimming species on the grates of the sea chests. Impingement while under way is not usually an issue as there is a sweeping velocity across the sea chest grating, but while vessels are anchored or moored this sweeping velocity is minimal. Entrainment of organisms typically results in high mortality due to temperature changes and mechanical and hydraulic injury from pump impellers and passage through piping. Any use of a biocide to prevent fouling growth on the interior walls of pipes would further diminish survival of entrained organisms.

While some vessels are moored at the staging or maintenance base their engines would remain at idle speeds, requiring engine cooling water withdrawals. Typically these vessels are of the size of ocean going freighters. Smaller vessels, such as tugs or small crew or supply vessels would shut down engines overnight or for extended periods. In addition, as cargo is removed from freighters or supply barges, ballast water may be taken on while moored in order to maintain vessel trim and stability. As with vessels in transit and on station, water withdrawals have the potential to affect planktonic marine life through entrainment, or poor swimming fish through impingement.

5.1.1.1.6 Solid Waste and Trash Handling

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a shredding and screening device and can pass through a 25 mm mesh screen. All other trash and debris must be returned to shore for proper disposal at municipal or private solid waste landfill or recycling facilities.

5.1.1.1.7 Floating Debris and Trash

Trash and debris that may be lost overboard from WTGs, ESP and construction/maintenance vessels can wash ashore on Cape Cod and islands surrounding the proposed action. However, according to the Ocean Conservancy (formerly the Center for Marine Conservation), beachgoers are a prime source of beach pollution, with other sources of coastal trash including runoff from storm drains and antiquated storm and sewage systems in older cities and commercial and recreational fishermen. Cleanup of OCS trash and debris from coastal beaches adds to operation and maintenance costs for coastal beach and park administrators.

Other trash lost overboard may travel into the open ocean, or sink to the seafloor. Certain types of trash can be very harmful to certain marine organisms, such as clear or light colored plastic bags that are consumed by sea turtles which confuse them for jellyfish. Quite often, once consumed the plastic bags cause blockage in the digestive system, which can lead to death. Rope and cable that is lost overboard can become entangled on the fins or mouths of marine mammals, injuring them until the material falls off, or if not removed, can cause mortality through infected flesh wounds or inhibiting feeding.

5.1.1.1.8 Noise, Lights, and Vibration

All motorized vessels, including those involved in the construction and maintenance of the proposed action, transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. For vessels, noise and vibration are related, since both produce energy moving through the water in a wave or band motion. Vibrations associated with propulsion engines would be transmitted through the hull and into the water. The intensity of noise from maintenance vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). In the immediate vicinity of a vessel, noise could disturb marine mammals, fish, and sea turtles; with the intensity and duration of affect diminishing rapidly with distance from the source since the energy level associated with noise transmission diminishes with the cube of distance.

All vessels operating between dusk and dawn are required to have navigation lights turned on. In addition, temporary work lighting would illuminate work areas on vessel decks or service platforms of adjacent WTGs or ESP. In addition, cable laying may occur 24 hours a day during certain periods, and these vessels would be illuminated at night for safe operation. A number of factors can affect light transmission, both in air and water. In air, the transmission of light associated with deck and navigation lights on construction and maintenance vessels can be affected by atmospheric moisture levels, cloud cover, and type and orientation of lights. In water, turbidity levels and waves, as well as type of light, can affect transmission distance and intensity.

At least two types of vessels on station would generate noise and vibrations that do not occur with vessels in transit. The cable jetting vessel would create localized underwater noise and vibrations

associated with the water jets employed on the jet plow. In addition, the barges involved in pile driving of the monopile foundation, would create noise and vibrations that are well known from other pile driving activities. The sound source level for barges or tugs, typical types of construction/maintenance vessels that may be used for the proposed action, is 162 dB re 1 μ Pa at 3.3 ft (1 m) (Malme et al., 1989). Marine biota would be able to hear the vessel, but would no physical harm or behavioral effects would occur.

Because the maintenance base(s) of the proposed action would be at existing industrialized port(s), there would not be a substantial increase in noise or lighting above what is normally expected. However, use of these facilities would result in some increase in noise levels and lighting for a period of time that if the proposed action were not constructed, may not occur (unless the facilities were utilized by another industrial tenant). The proposed action's use of these areas would generate noise from the operation of machinery, such as vessel engines as they arrive or depart, cranes used to load or unload equipment and construction materials and supplies, and other smaller pieces of machinery such as fork lifts or delivery trucks. Lighting would be necessary for illuminating the work area on land, at the berth, and on the vessels while at berth. Because the area is designed as an industrial port, much of this lighting already exists, and the changes to background conditions would be negligible.

5.1.1.1.9 Bottom Disturbances and Anchoring

Operation of all vessels, including those expected to be used during construction, decommissioning, and routine maintenance of the proposed action would result in several sources of bottom disturbance. When operating in shallow water areas, typically waters less than 20 ft (6.1 m) deep, the propeller wash from large vessels could contact the bottom and cause some scouring and sediment resuspension. This can injure some types of benthic organisms, or make them more susceptible to predation. Most of the large construction vessels to be used are likely to be jacked up on hydraulic legs or utilize spuds for positioning, which would result in some direct impact to the seabed. In the case of the cable laying/jetting vessel, anchoring is the method used to move the barge along the cable route, and an anchor handling tug is employed to reposition anchors as the barge advances along the route. This vessel is positioned using a series of heavy anchors deployed in an array around the vessel. Winches on the barge or vessel adjust tension on the anchor cables to make adjustments in position. Anchors in the 10,000 lb range (the largest anchor estimated to be used on the cable installation vessels) tend to dig into sandy sediments to a depth of about 3 to 5 ft (0.91 to 1.5 m) depending upon sediment type (see Section 5.1.4.3 for more detail on jetting). When the anchors are retrieved, they are pulled out by the bottom and much of the sediment on the flukes falls back into the anchor scar area so that the anchor scar remains as only a shallow depression. Over time, the dynamic environment of Nantucket Sound would level the seafloor. In addition, as the vessel position is adjusted, a portion of the anchor cable nearest the anchor slowly drags across the seafloor surface, causing a shallow sediment disturbance. This action is minimized by the use of mid-line buoys on the anchor lines, which raise a greater amount of anchor chain off the bottom, reducing the amount of chain that is swept along the bottom as the vessel moves. The setting and repositioning of anchors in this manner has the potential to injure relatively sedentary benthic organisms, such as brittlestars, sand dollars, or whelks.

It is unlikely that direct bottom disturbance or anchoring would occur at the staging and maintenance bases since these vessels would use existing mooring structures. Prop wash might occur as vessels move in or out of berths, depending upon the draft of vessels relative to bottom depths, with the resulting resuspension of sediments and possible affects on benthos, fish, and water quality.

5.1.1.1.10 Air Emissions

The operation of vessels, other than sailboats, requires engine power for movement, and the combustion of fossil fuels, whether it is gasoline or diesel, results in the production of exhaust gases that are released to the environment. Types of waste gases are described more fully in Section 5.3.1.5, but

typically include carbon dioxide (CO₂), CO, nitrous oxides, sulfuric oxides, and water vapor. The release of these gases lowers air quality, and when compounds precipitate out of the atmosphere into the ocean or on land, can affect water quality, affect plant growth, and affect the health of animals and humans. The operation of vessels during construction, operation and maintenance, and decommissioning must be evaluated in the context of the other types and numbers of vessels that occur in areas to be transited by proposed action vessels.

5.1.1.1.11 Visual Aesthetics

During construction, operation, and decommissioning of the proposed action, there would be an increased number and types of vessels operating in the site of the proposed action. The presence of the proposed action-related vessels would alter the visual characteristic of areas transited by these vessels. The Nantucket Sound area has a rich maritime history that includes considerable vessel activity in and out of area ports, whether it is fishing vessels, ferries, various types of cargo vessels, and numerous recreational vessels. Nevertheless, proposed action vessels would increase the number of occurrences of vessels, and this would alter the visual environment. A number of the vessels to be used would be quite large, such as derrick crane barges, which would be visible at greater distances, whether day or night, than some of the smaller vessels that would also be used, such as crew and supply vessels.

This impact would be of greater magnitude during construction and decommissioning than operations, because of the larger and greater number of vessels involved. Also, during the time period of construction and decommissioning, nighttime work would require lighting of work areas, which would represent a visual intrusion in the nighttime view from areas on shore or passing vessels. During daylight hours, the large derrick barge(s), jack up barges, and cable laying vessel would represent larger vessels than normally occur in this portion of Nantucket Sound. Depending upon the individual, some people would be intrigued with the construction and decommissioning activities and not characterize the presence of these vessels as negatively affecting the visual aesthetics. In contrast, others would feel that these vessels are out of place and represent a degradation of the view across Nantucket Sound. As described in more detail in Section 5.3.3.4, there are a number of factors that affect the nature and extent of how the visual resource would be affected by the proposed action, such as distance from shore or meteorological conditions.

5.1.1.1.12 Channel Maintenance

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial, and vessel discharges and nonpoint sources, and can result in contamination of areas formerly isolated from major anthropogenic sources. The vicinities around harbors and industrial sites are most noted for this problem. Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around Nantucket Sound. Given that the shore side facilities proposed for use have adequate channels to accommodate the necessary vessels during construction, operation and decommissioning, it is unlikely that any channel maintenance would occur in association with the proposed action. However, connecting the offshore transmission cable system to the onshore transmission cable system involves HDD which does require the dredging of an offshore exit point pit and the placement of a temporary cofferdam within Lewis Bay to facilitate the HDD operation. The dredged sediments from within the cofferdam pit would be temporarily removed from waters of the U.S. and replaced upon completion of the offshore transmission cable system. Testing of the sediments proposed for dredging has shown them to be classified as Category One, Type A, the least toxic and least restrictive of the three classifications in the MassDEP criteria. The dredged sediments from within the cofferdam pit would be temporarily removed from waters of the United States and replaced upon completion of the offshore transmission cable system. Samples from vibracores of these proposed dredged sediments were collected and analyzed to determine bulk chemical and physical characteristics

and testing analyses were performed in accordance with the MassDEP Division of Water Pollution Control (MassDEP-DWPC) Regulations 314 CMR 9.00. This testing has shown the proposed dredged sediments are classified as Category 1, Type A, the least toxic and least restrictive of the three classifications in the MassDEP-DWPC criteria. Based upon these results the excavated material can and would be used to backfill the cofferdam following the completion of the HDD and offshore transmission cable installation. If necessary, the dredged backfill material would be supplemented with imported clean sandy backfill material to restore preconstruction contours.

5.1.1.1.13 Bottom Debris

While vessels would be required to avoid overboard loss of construction materials, supplies, or equipment, it is likely that some material would end up on the seafloor during the life of the proposed action. Based on experiences from the construction of offshore oil and gas rigs, some debris such as metal cuttings, wire clippings or strands, nuts and bolts, etc. would end up on the seafloor. In comparison, certain other marine activities result in bottom debris in quantities that exceed those expected on the proposed action. For example, commercial fishermen lose lobster traps, and trawlers, gill netters, and seiners also lose gear that comes to rest on the seafloor. However, unlike the oil and gas industry, there is very little on-site fabrication associated with the proposed action. Instead, the proposed action consists primarily of assembly of components brought to the site pre-fabricated.

5.1.2 Heliport Facilities

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward, and the underwater noise is generally brief in duration as compared with the duration of audibility in the air. From studies conducted in Alaska, a Bell 212 helicopter was 7 to 17.5 dB noisier (10 to 500 Hz band) than a fixed-wing Twin Otter for sounds measured underwater at 3 m and 18 m depths (Patenaude et al., 2002). Water depth and bottom conditions strongly influence the propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Interestingly, the amount of sound energy received underwater from a passing aircraft does not depend strongly on aircraft altitude. However, characteristics such as more rapid changes in level, frequency, and direction of sound may increase the prominence of sound from low-flying aircraft to marine mammals (Patenaude et al., 2002). Reactions by marine mammals to aircraft are most commonly seen when aircraft are flying less than 500 to 600 ft (152.4 to 182.9 m). Helicopters, while flying offshore, generally maintain altitudes above 700 ft (213.4 m) except perhaps when traveling between WTGs or the ESP and WTGs where they may fly at between 200 and 500 ft (61 and 152.4 m) on occasion.

5.1.2.1 Helicopter Activities During Construction

Helicopter hubs or “heliports” are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. There are a number of local airports that are adequately equipped to support helicopter use during proposed action construction, operation and decommissioning. Increased helicopter activity could result in increased noise and engine exhaust emissions at the heliport or along flight paths out to the proposed action. No other impacts from helicopter use are anticipated. Helicopter use during construction would occur much more frequently than during operations, but for a much shorter timeframe.

5.1.2.2 Helicopter Activities During Operations

The same heliport facilities that were available during construction may be used during operations. Helicopter traffic is a primary source of OCS-related noise in coastal regions. Sound generated from this activity is transmitted through both air and water, and may be continuous or transient. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. Helicopter

sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). The level of underwater sound detected depends on receiver depth and aspect, and the strength/frequencies of the noise source. The duration that a passing airborne source can be received underwater may be increased in shallow water by multiple reflections (echoes). Maintenance helicopters related to the proposed action may add noise to broad areas. Sound generated from maintenance helicopter traffic is transient in nature and variable in intensity.

The use of a helicopter would allow for maintenance crews to be deployed to the ESP during periods when wind and wave conditions are unsuitable for boat transfers. The helicopter platform would also allow for emergency evacuation of any individuals who may become injured. Therefore, helicopter activity is expected to be fairly infrequent.

5.1.3 Construction and Maintenance Staging Facilities

There is an existing, underutilized, industrial port facility in Quonset, Rhode Island that has the attributes required for staging an offshore construction project of the magnitude of the proposed action. The Quonset Davisville Port & Commerce Park is located on Narragansett Bay in the town of North Kingstown, Rhode Island and is owned and controlled by the RIEDC. This site is a portion of what once was a much larger government facility known as the U.S. Naval Reservation – Quonset Point, part of which is still actively utilized as a civilian airport and base for an Air National Guard Reserve squadron. Following the downsizing of the U.S. Naval Reservation – Quonset Point, the Commerce Park was created in order to develop prime industrial sites, create job opportunities and to improve the economic conditions throughout the region. The potential staging of the proposed action from the Quonset Davisville Port & Commerce Park is consistent with the Park's stated purpose.

5.1.3.1 Solid Wastes and Trash

As with any large construction project, a variety of solid wastes would be produced at the staging area, ranging from paper and wood products to scrap metal, oily wastes, and garbage. Because much of the materials used for the facility would arrive pre-fabricated, rather than built on-site, the quantities of solid waste generated are likely to be less than an equivalent sized electric generating station. For example, the large structural components such as the turbine rotors, generators, monopiles, foundation piles and electric cables would most likely arrive via over-water shipment to Quonset for staging the work in Nantucket Sound. The applicant has stated that construction and maintenance activities would be performed by contracted firms and, as part of the contract agreements, these entities would have responsibility for the proper handling and disposal of solid waste and trash generated during construction and maintenance activities.

5.1.3.2 Oily or Hazardous Wastes

Since no substantive construction or fabrication is expected to occur at the staging area, the creation of oily or hazardous wastes is anticipated to be minimal. Typically, whenever machinery is used and equipment using hydraulic power is used on construction projects, there is the potential for generation of waste oil and fluids resulting from maintenance and repair activities on the machinery and equipment. Any oily or hazardous wastes that are produced would be properly disposed of in accordance with all applicable laws and regulations.

5.1.3.3 Stormwater and Wastewater

Staging areas to be used for the proposed action are most likely to be associated with existing facilities that accommodate these types of activities. As such, stormwater and wastewater handling systems would have been previously designed and operated by the site owner/operator and the use of these properties in association with the proposed action is not likely to measurably alter existing

conditions. Any changes in the stormwater and wastewater collection, treatment, and disposal systems that are attributable to the proposed action would need to be dealt with in accordance with all applicable laws and regulations.

5.1.3.4 Landfills

The applicant would contract firms to construct and maintain the proposed action. Landfills likely to be used would be at the discretion of the entity producing the waste. As indicated in Section 5.1.3.1, contractors would be responsible for waste disposal at landfills in accordance with all applicable laws and regulations. Applicable disposal sites are described in Section 4.3.2.4.

5.1.3.5 Noise, Lights, and Vibration

Noise associated with the staging area would be typical for an industrial port, where cranes are used to load and unload materials from ships. Since the Quonset Davisville Port & Commerce Park is already approved for this type of activity, if utilized there would be no substantial increase in noise levels above what would be typically expected at this facility. Similarly, smaller industrial ports on Cape Cod, that could handle much of the maintenance support for the proposed action, already involve the loading and unloading of vessels at different times of the day, using cranes, winches, davits, etc similar to what would be needed to support maintenance vessels and activities. Therefore, the noise, lights, and vibrations associated with these types of activities already occur, and the proposed action would represent only a small incremental increase in these factors.

5.1.4 Wind Turbine Generator, ESP, and Cable Installation

Installation (may also be referred to as construction) of the proposed action would involve a number of different activities requiring the use of specialized marine construction equipment and vessels, some of which would be operated in a portion of Nantucket Sound that has not historically been subject to construction activities. Impact producing factors associated with vessels are discussed in Section 5.1.1 and helicopters in Section 5.1.2, and are not repeated in Section 5.1.4. Other portions of the proposed action would involve construction using conventional construction equipment operating in areas that have already been developed. The WTGs would be constructed in a grid pattern with minimum 0.39 miles (0.6 km) by 0.63 miles (1 km) spacing. Inner-array cables would be installed in the seafloor between WTGs and between WTGs and the ESP. Lastly, two parallel transmission cables would be installed in the seafloor between the ESP and the south shore of Cape Cod, with on-land continuation to an existing substation.

5.1.4.1 Visual Aesthetics

The factors that could adversely affect the aesthetics of the coastline are oil spills and residue, tarballs, trash and debris, pollution, increased vessel and air traffic, and the presence of WTGs visible from land. Visibility is dictated not only by size and location of the structures and curvature of the Earth but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation (ground level, in a 2-story house, or in a 30-story condominium) and the viewer's expectations and perceptions. It should be noted that during the installation process, activities associated with construction that could affect visual aesthetics would consist of both relatively stationary (such as jack up barges) and mobile (cable jetting vessel) components. Vessels are discussed in Section 5.1.1. In contrast, as the construction proceeds, fixed components would become more prevalent until all 130 WTGs and the ESP are constructed and the proposed action goes into operation. Hence, the visual attributes of the proposed action would develop over time.

5.1.4.2 Noise and Vibration

The monopiles would be installed into the seabed by means of pile driving ram or vibratory hammer and to an approximate depth of 85 ft (26 m) into the seabed. This would be repeated at all WTG locations. At Point Gammon in Yarmouth, the temporary sound of construction could be audible when pile driving is done for the monopiles in the northeast corner of the proposed action closest to shore (sounds up to 41 dBA when winds are onshore) when existing sound levels are very low (possibly as low as 35 dBA). At Cape Poge on the northeast tip of Martha's Vineyard, the temporary sound of construction could be audible when pile driving is done for the monopiles in the southwest corner of the proposed action closest to the Vineyard (sounds up to 40 dBA when winds are onshore) when existing sound levels are very low (possibly as low as 40 dBA). Even in these instances, however, the temporary short-term sound levels would be low and would not interfere with any activities.

For the ESP installation, six piles would be driven through pile sleeves to the design tip elevation of approximately 150 ft (46 m). The piles would be vibrated and hammered as required. This would cause underwater noise and vibrations that could affect a variety of marine organisms, both in the water column and within the sediments.

The principal sound from construction would be temporary pile driving of the WTG monopiles. The anticipated duration of installing all of the monopiles from start to finish is expected to be approximately eight months, plus any delays due to weather. It would take 4 to 6 hours to drive each monopile. The driving rate would be in the range of 2 to 36 impacts per minute. The predicted construction impacts are 31 dBA to 76 dBA when the receiver is 1/3 to 1 mile (0.5 to 1.6 km) downwind of the pile driving activity and 7 dBA to 49 dBA when the receiver is 1/3 to 1 mile (0.5 to 1.6 km) upwind of the activity. Existing average sound levels (L_{eq}) at sea in the vicinity of the proposed action are approximately 46 to 51 dBA. These existing levels represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind in light wind conditions. For such boaters, the acoustic modeling results reveal that sometimes the temporary pile driving activity would be audible (i.e., above existing levels) and sometimes it would not, depending on a boater's distance from the monopile being driven and whether he is upwind or downwind of the activity. It should also be noted that occupants of sailboats tacking upwind or motorboats would experience higher baseline sound levels, and for these boaters it is less likely that temporary sound from proposed action construction would be audible.

Sound source data for construction effects underwater were provided by GE Wind Energy from recent tests at the Utgrunden and Gotland Projects ([Report No. 4.1.2-1](#)) which have similar environmental conditions to Nantucket Sound and provide the best available data. Data obtained during pile driving at the Utgrunden Project revealed underwater L_{max} sound levels of 177.8 dB at 1,640 ft (500 m). Noise levels of pile driving at the SMDS were found to range from 145 dB to 167 dB at a distance of 1,640 ft (500 m). The higher Utgrunden pile driving sound level data were utilized in the modeling analysis because the monopile foundations for the proposed action would be similar in size to those used at Utgrunden, and because of similarities in environmental conditions between Nantucket Sound and the Baltic Sea. Baseline underwater sound levels under the design wind condition are 107.2 dB.

5.1.4.3 Cable Jetting

The jet plow embedment process for laying submarine power cables with a cable barge produces no sound beyond typical vessel traffic in Nantucket Sound. For burial, the cable barge tows the jet plow device at a safe distance as the laying/burial operation progresses. The offshore cables are deployed from the vessel to the funnel of the jet plow device. The jet plow blade is lowered onto the seabed, water pump systems are initiated, and the jet plow progresses along the pre-selected offshore cable route with the simultaneous lay and burial operation, creating a trench approximately 4 to 6 ft (1.2 to 1.8 m) wide (top width) to a depth of 8 ft (2.4 m) below the present bottom into which the offshore cable system settles

through its own weight. Temporarily re-suspended in situ sediments are largely contained within the limits of the trench wall, with only a minor percentage of the re-suspended sediment traveling outside of the trench. Any re-suspended sediments that leave the trench tend to settle out quickly in areas immediately flanking the trench depending upon the sediment grain-size, composition, and hydraulic jetting forces imposed on the sediment column necessary to achieve desired burial depths.

Other potential water quality impacts associated with fluidizing sediments during jetting include release of nutrients or sediment-bound contaminants into the water column. In areas of high organic content, resuspension of sediments can increase the oxygen demand in the water, thereby causing localized depression of DO levels.

The cable laying/jetting vessel would utilize a system of anchors as the method to move the barge along the offshore cable routes, and an anchor handling tug would be employed to reposition anchors as the barge advances along the routes. This impact producing factor is discussed in Section 5.1.1.1.9.

Another component of the cable jetting process that could cause impacts is the high pressure water jets cutting into the sediments, intended to loosen and liquefy sediments, but also potentially injuring or causing mortality of benthic organisms. Vibrations associated with the jetting would likely cause more mobile species such as lobsters, crabs, flounder and skates to move out of the way. However, infauna or slower moving epifauna, such as polychaete worms, razor clams, sand dollars, brittlestars, or hermit crabs may suffer tissue or organ damage, could become exposed and more susceptible to predation, or may suffer mortality. The jet plow embedment process will produce no audible sound for nearby marine life beyond the sound of rushing water and that from the surface vessel used to transport materials to the site.

5.1.4.4 Solid Waste and Trash Handling

Solid waste and trash generated during installation would be contained on vessels or at staging areas, and is discussed in the following sections.

5.1.4.5 Floating Trash and Debris

Floating trash and debris generated during installation would largely occur from vessels associated with the installation process, and is therefore covered in Section 5.1.1. One additional source of floating trash and debris could result from installation activities on the ESP. Once the ESP piles and base are constructed, installation of other equipment and components of the ESP would occur as a combination of fixed platform and vessel support. As transformers and other electrical components are installed, it is possible that material would fall off or blow off the ESP platform. Good housekeeping practices would be employed to minimize this occurrence.

5.1.4.6 Bottom Debris

Bottom debris is defined as material resting on the seabed (such as cable, tools, pipe, drums, anchors, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that are accidentally lost (e.g., during hurricanes) or tossed overboard from facilities. Bottom debris generated during installation would largely occur from vessels associated with the installation process, and is therefore covered in Section 5.1.1. One additional source of bottom debris could result from installation activities on the ESP. Once the ESP piles and base are constructed, installation of other equipment and components of the ESP would occur as a combination of fixed platform and vessel support. As transformers and other electrical components are installed, it is possible that material would fall off the ESP platform. Good housekeeping practices would be employed to minimize this occurrence.

Appropriate precautions would be taken to avoid the overboard loss of materials related to the proposed action and the quantity of bottom debris per operation would be kept to a minimum.

5.1.4.7 Bottom Disturbance

Installation of the WTGs and ESP would involve the use of jack up barges and/or vessels that utilize spuds to secure their position. These vessels would have some direct temporary impact to the seabed from the jack up pads, which typically range from 10 to 20 ft (3 to 6 m) in length and width, respectively. Once the jack-up legs are deployed, the barge is raised out of the water to create a stable work platform that is not influenced by tides, currents, or waves. The vessels that are anticipated for the WTG and ESP installation would not utilize anchors. Spud moored barges typically use between 2 and 4 legs that can be raised and lowered along the sides of a barge to hold the barge in place. Depending upon the size of the barge, the spud legs tend to range between 2 and 4 ft (0.61 and 1.2 m) in diameter or width. Unlike jack up barges, spud barges remain floating and are subject to tides, currents, and waves. Deployment and retrieval of jack up legs and spud legs can result in resuspension of sediments, while the lowering of legs results in direct disturbance of the sediments and mortality of infaunal and slow moving epi-benthic organisms within the footprint of the legs. After the barge has been moved, the former locations of the legs remain as small depressions in the seafloor, with the depth dependent upon factors such as length of time the barge has remained in one location, the type of sediment, and the water depth.

Minimal disturbance of sand and sediment would take place as a result of pile driving activities. The piles are hollow, and would enclose bottom material that is displaced in the pile. After installation, some localized scour around the monopile foundations may occur, depending on the location of the WTG on Horseshoe Shoal and local sediment transport conditions. Scour control mats and/or rock armor would be installed for scour protection.

Connecting the offshore transmission cable system to the onshore transmission cable system involves HDD which does require the dredging of an offshore exit point pit and the placement of a temporary cofferdam within Lewis Bay to facilitate the HDD operation. The dredged sediments from within the cofferdam pit would be temporarily removed from waters of the United States and replaced near the end of the offshore transmission cable system installation process. Testing of the sediments proposed for dredging has shown them to be classified as Category 1, Type A, the least toxic and least restrictive of the three classifications in the MassDEP criteria. These criteria are the MassDEP-DWPC classification criteria found in 314 CMR 9.07 for dredging and dredged material disposal, based on both physical and chemical characteristics. Based upon these results the excavated material can and would be used to backfill the cofferdam following the completion of the HDD and offshore cable installation. If necessary, the dredged backfill material would be supplemented with imported clean sandy backfill material to restore preconstruction contours.

5.1.4.8 New or Unusual Technologies Deployed

While some of the equipment and methods may be specialized for the construction of the proposed action, they have all been used before in other locations such as Europe. The construction of an offshore wind energy project is in itself something that has not been proposed before in the United States, Canada, or Mexico and could therefore be considered new technology deployed in this location.

5.1.4.9 Displacement of OCS Space

There would be temporary restrictions to certain areas during the construction of the proposed action. Construction vessels would also temporarily utilize space that would restrict recreational and commercial fishermen. For example, the anchoring spread around the offshore cables installation spread requires that other vessels not enter the area between the anchors and the barge, but this temporary exclusion moves as

the barge moves. With respect to construction impacts on navigational activity in channels, the proposed action would be constructed in phases, and marine traffic would only be restricted in the immediate vicinity of ongoing construction activities (estimated to be one to two WTG locations at any one time) for protection of public safety. The remaining areas of the site of the proposed action would be open to unrestricted navigational access. The WTG that is closest to the Main Channel is approximately 1,190 ft (362.8 m) from the charted Main Channel edge and approximately 6,900 ft (2103.7 m) east of the Main Channel's narrowest point. The work vessels used to construct the WTGs are approximately 400 ft (122 m) long. This leaves ample room for vessels to transit past any ongoing construction. These work vessels would not need to occupy or block the Main Channel during construction. Therefore no restrictions or closures of the Main Channel to transiting vessels are anticipated. The USCG routinely deconflicts waterways and channels around marine construction activities and it is anticipated that such procedures could be implemented in Nantucket Sound during construction of the proposed action. The applicant would not prohibit vessels from entering or operating in the area of the proposed action and does not intend to establish exclusionary zones. Once the proposed action is constructed, the OCS space occupied by the WTGs, ESP, and scour protection (assuming rock armoring) is less than 50 acres. Cable installations would occupy over 80 linear miles (128.7 km) of seafloor but in an approximate 1 ft (0.3 m) width, and would be buried at least 6 ft (1.8 m) below grade. The installation of the cables would only preclude a few potential ocean uses while allowing many others to continue.

5.1.4.10 Displacement of Aviation Space

The presence of the construction equipment would require that aviators avoid the local area around the equipment, and as WTGs are erected, increasing numbers of obstacles would become present over the Horseshoe Shoal area. These areas would be added to aviation charts and FAA notices would serve to communicate the area of the proposed action to the aviation community. However, in most instances, air traffic in the middle of Nantucket Sound is flying at heights greater than the airspace occupied by the proposed action, and the occupation of this area has been determined by FAA to not be a significant issue or concern for aviation safety.

5.1.4.11 Post Lease Geological and Geophysical Field Investigations

Prior to the construction process, a post lease geological and geophysical field investigation would be conducted. The activity would require the deployment of a vessel to do mapping of the sea floor as well as require geological boring to collect subsurface geotechnical and sediment samples. The process of boring would result in minor localized turbidity near the bore hole.

5.1.5 Proposed Action Operations

Based on both offshore and onshore WTG operational experience, five days per year per turbine has been established as an anticipated maintenance requirement.

5.1.5.1 Discharges to the Sea

The structures associated with the proposed action would not produce discharges to the sea during operations. The only discharges to the sea that are anticipated are those associated with vessels performing maintenance, and these are discussed in Section 5.1.1. Accidental or unintentional discharges to the sea are discussed in Section 5.2.

5.1.5.2 Bottom Disturbances and Anchoring

During normal operations, there are no activities anticipated to require disturbance of the bottom. Maintenance vessels are unlikely to anchor and it is not anticipated that any of the offshore cables would require exposure for maintenance during the life of the proposed action. The most likely scenario resulting in bottom disturbances would probably stem from work on the scour protection on any

monopiles or ESP piles that appear to be experiencing scour. These disturbances should be localized and infrequent, but could result in disruption of nearby sediments.

5.1.5.3 Floating Trash and Debris

During operation of the proposed action, the generation of floating trash and debris is likely to be limited, with a greater possibility at the ESP than at the WTGs. The overall quantity of floating trash and debris is likely to be small since the majority of maintenance activities are unlikely to produce much of this type of material.

5.1.5.4 Bottom Debris

During operation of the proposed action, the generation of bottom debris is likely to be limited, with a greater possibility at the ESP than at the WTGs. The overall quantity of bottom debris is likely to be small, associated with maintenance activities, and consists of non-toxic materials such as nuts and bolts, small hand tools, pieces of wire, etc.

5.1.5.5 Air Emissions

Any OCS activity that uses equipment that burns a fuel would cause emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. The only air emissions anticipated from the proposed action would result from the maintenance vessels. The vessel emissions represent a mobile source and would not result in a lowering of air quality in a specific location within Nantucket Sound or surrounding areas. However, the use of at least two maintenance vessels for a majority of the days each year does represent an overall, but incrementally small, increase in air pollutants being added to the Nantucket Sound area. The WTGs would utilize the wind as the fuel to generate electricity, and would emit no air pollutants.

5.1.5.6 Visual Aesthetics

During operation of the proposed action, the presence of 130 WTGs and the ESP would be visible at different distances under different light and weather conditions. Nighttime or low light condition lighting would be employed as discussed in Section 5.1.5.8. The proposed action facilities would be visible from a number of locations along the shorelines of Cape Cod and the islands and therefore represent a change in the viewshed and an alteration of the aesthetics of the Horseshoe Shoal portion of Nantucket Sound. Opinions vary as to whether the facilities would have a negative or positive affect on the visual aesthetics. The monopile color has been selected to be as neutral as possible. The offshore cables would not affect the visual aesthetics, other than perhaps a slight reduction in some woody vegetation along the NSTAR transmission line ROW.

5.1.5.7 Noise and Vibration

As discussed in Section 5.1.1, all vessels, including maintenance vessels for the proposed action, transmit noise through both air and water. The normal operational/maintenance activity is anticipated to include two vessel trips per working day (252 days/year), which would include one crew boat from Falmouth and the maintenance support vessel from New Bedford. In addition, an occasional second round trip from Falmouth could take place in times of fair weather or for emergency maintenance.

The WTGs would also produce sound when operating. Existing sound levels are 60 to 65 dBA and represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind when the average surface wind speed is 16 mph. Occupants of a sailboat tacking upwind or a motorboat would experience higher baseline sound levels. For such boaters, proposed action operational sound levels of 40 to 45 dBA are well below existing sound levels of 60 to 65 dBA, and the proposed action would not create a pure tone (ESS, 2007 and Table 6 in [Report No. 5.1.5-1](#)); therefore, again, the proposed action is

expected to be largely inaudible to recreational boaters. As was the case with the cut-in wind speed condition, the frequency-specific modeling results (ESS, 2007 and Figures 14 and 15 in [Report No. 5.1.5-1](#)) also reveal that low-frequency sound from the proposed action is below the threshold of human hearing and would be inaudible regardless of the baseline sound levels. Accordingly, no noise impacts on recreational boaters are anticipated due to operation of the proposed action at either the cut-in or design wind speed conditions.

The proposed action would be equipped with foghorns for boating safety. Several different devices would be deployed around the perimeter of the proposed action, each with a different characteristic sound. The horns would operate only when fog is present, day or night, and would have a ½-mile audible range. Thus, boaters traveling near the proposed action in dense fog would certainly hear these warning devices, just as they now hear various gongs and bells in Nantucket Sound from fixed buoy locations. Persons on land (5+ miles [8+ km] away) would not hear the foghorns.

In Lewis Bay and onshore locations along the shore of Cape Cod and Martha's Vineyard the calculated maximum operational sound levels of 12 to 26 dBA are well below existing sound levels associated with cut-in to design wind speeds (41 to 71 dBA), and the proposed action would not create a pure tone. The proposed action is anticipated to be inaudible at shoreline locations.

The calculated maximum operational sound levels of 13 to 21 dBA are well below existing sound levels associated with cut-in to design wind speeds (46 to 60 dBA), and the proposed action would not create a pure tone (ESS, 2007 and [Report No. 5.1.5-1](#)), therefore the proposed action is also anticipated to be inaudible under these conditions. The frequency-specific modeling results (ESS, 2007 and Figures 16 through 37 in [Report No. 5.1.5-1](#)) also reveal that low-frequency sound from the proposed action is below the threshold of human hearing and would be largely inaudible regardless of the baseline sound levels. For example, at Lewis Bay, Yarmouth, the calculated cut-in sound levels for the low frequency of 16 Hz is only 50 dB, while the hearing threshold (the level of sound needed at this frequency in order for it to be heard) is 92 dB. At 250 Hz, the calculated cut-in sound level is only 6 dB, while the hearing threshold is 14 dB. Calculated project sound by frequency falls to 0 dB beyond 250 Hz, and would also not be audible. A similar example is found for Edgartown, Martha's Vineyard, where the calculated cut-in sound level at 16 Hz is 49 dB, and at 250 Hz is only 2 dB. Accordingly, no noise impacts are anticipated at any onshore locations due to proposed action operation for either the cut-in or design wind speed conditions.

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Existing underwater sound levels for the design condition are 107.2 dB. The calculated sound level from operation of a WTG is 109.1 dB at 66 ft (20 m) from the monopile (i.e., only 1.9 dB above the baseline sound level), and this total falls off to 107.5 dB at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 361 ft (110 m).

An analysis of predicted underwater sound levels perceived by marine biota from proposed action operation show that no injury or harassment to sea turtles are predicted, even if an individual were to approach as close as 66 ft (20 m) to a monopile.

5.1.5.8 Wind Turbine Generator Navigation Lights

The WTGs have been designed with the required USCG Private Aids to Navigation lighting. Two flashing amber lights would be located on the lower access platform about 35 ft (10.7 m) above sea level. The flashing amber lights on the ESP and perimeter WTGs are designed to be visible within distances of 2.3 miles (3.7 km). WTGs located within the perimeter of the area of the proposed action would be equipped with ATON lights of lower intensity, visible between approximately 0.29 and 0.58 miles (0.4

and 0.9 km). This lower intensity lighting is adequate to allow a vessel within the area of the proposed action to navigate from WTG to WTG, a maximum distance of 0.63 miles (1 km). Lights would flash at a frequency of 20 flashes per minute (FPM). A description of navigational lighting is provided in the Visual Section in Section 5.3.3.4.

5.1.5.9 Monopile Stability and Foundation Scour

The estimated impact to the seabed was calculated to determine plan areas of the scour ellipses around the WTGs based on the dimensions predicted in the ESS revised *Scour Report, 2005* (Report No. 4.1.1-5). The total estimated impact to the seabed by the rock armor scour protection for all 130 WTGs is approximately 47.4 acres (0.19 km²). If scour control mats are utilized the total estimated impact is approximately 2.4 acres (9712 m²).

5.1.5.10 WTG Blades in Motion

While in motion, the blades of the WTG have the potential to increase the risk of collision to birds. Refer to Sections 4.2.4.3 and 4.2.4.4 for further information. In addition, the rotating blades have the potential to contact the mast of any sailing vessels or superstructure of any large vessel that exceeds a height off the water of about 75 ft (22.9 m). However, given the water depths throughout much of the proposed action, vessels of this size are unlikely to transit through the proposed action. Navigation charts would be appropriately labeled to indicate the potential hazards associated with navigation within the area of the proposed action, so the probability of this occurrence is remote.

Under specific weather conditions, ice could theoretically form on the blades, and then become detached, striking vessels navigating under the area occupied by the blades. Because the WTGs have vibration sensors, it is likely that the automatic shutdown mechanism would be activated under ice formation, which would reduce the potential for flying ice to extend further than the rotor diameter. Since this is likely to be an infrequent occurrence it is discussed more in Section 5.2.2.3.

Blade throws are a potential danger as well. Turbine blades could become loose and fall off. Possible types of blade throws include root connection failure; partial failure from lightning; failure at outboard aerodynamic device; tower strike; partial failure due to defect; or extreme load buckling. Potential causes include unforeseen events out of the design envelope; failure of control system; human error; incorrect design for fatigue or ultimate loads; or poor manufacturing quality. The probability of a turbine blade throw is one-in-ten-thousand (10⁻⁴) per year (Larwood, 2005). This study did not analyze the probability of impact of mobile targets; however, the likelihood of a mobile vessel sailing under the turbine at the time of a blade throw is even less.

5.1.5.11 Monopiles as Fish Attracting Devices (FAD)

The WTG monopile foundations and ESP piles may attract fish and fouling organisms, thereby acting as FADs. Bombace (1997) states that man-made submarine structures can serve to reduce the mortality rate during the critical recruitment phase, increase food availability, and provide shelter for reproductive adults. Bohnsack (1989) states that species most likely to benefit from artificial structures, such as the monopiles, are those with demersal, philopatric, territorial, and reef-obligate life histories. Several fish species within the Proposed Site and other shoals in Nantucket Sound display these characteristics in some or all of their life history stages, and thus may benefit from the presence of the monopiles. These species include Atlantic cod, black sea bass, cunner, tautog, and scup. However, the vertical structure that would be created from the installation of wind turbine towers is not anticipated to result in adverse impacts to the ecology of the immediate area of the proposed action or to Nantucket Sound. Although the walls of the towers represent a source of new hard substrate with a vertical orientation in an area that has a limited amount of such habitat, this new substrate is not favorable for colonization or reef formation due

to its low complexity and rugosity (the steel material used has much lower surface roughness than comparable wood or concrete structures) (CARPG, 1998). As a result of this and along with the WTGs within the area of the proposed action being spaced approximately 0.39 by 0.63 (629 by 1,000 m) apart, the overall environment and fish species composition in the area of the proposed action is not predicted to substantially change from pre-proposed action conditions.

Should the monopiles function as FADs, a secondary affect could be realized, namely, the creation of both recreational diving and fishing opportunities. Given the general lack of offshore hard structure reefs within the relatively protected waters of Nantucket Sound, combined with the proximity to many small ports, the WTGs could become target recreation locations.

5.1.6 Proposed Action Decommissioning

5.1.6.1 Discharges to the Sea

Discharges to the sea resulting from decommissioning activities are associated with the operation of vessels performing the work, and as such are discussed in Section 5.1.1. No discharges of wastewater or liquids are anticipated to occur from the WTGs or ESP during the decommissioning process.

5.1.6.2 Bottom Disturbances and Anchoring

As with the proposed action construction, decommissioning activities would require the same kinds of vessels, resulting in similar types of bottom disturbances and anchoring as are discussed in Sections 5.1.1.1.9 and 5.1.4.7. Once the proposed action is decommissioned, there would no longer be any bottom disturbances resulting from the former facilities.

5.1.6.3 Sea Bed Site Clearance

The applicant has committed to removing offshore cables installed in the seabed, as well as the removal of piles to a depth of approximately 15 ft (4.6 m) below the natural sea bottom elevation. To the extent that scour control mats can be retrieved they would be, but depending upon how buried they are and the extent of deterioration, they may fall apart during removal with remnant fragments remaining commingled with sediments. Based on the decommissioning plans, the areas occupied by offshore cables would be cleared of proposed action materials, and each of the monopiles and the ESP, no aboveground materials would remain, other than the potential for a small amount of bottom debris that is too small to detect and recover, such as nuts and bolts, short pieces of wiring, etc.

Once the tower has been removed during decommissioning, the sediments inside the monopile would be suctioned out to a depth of approximately 15 ft (4.6 m) below the existing seabottom in order to allow access for cutting of the pile in preparation for its removal. The sediments would be pumped from the monopile and stored on a barge. Prior to the removal of the cut pile any adjacent scour protection (either scour mats or rock armor) would be removed. Armor stones would be removed using a clamshell dredge or similar equipment, placed on a barge, and disposed of at an upland location. Once the scour control has been removed, the pile would be cut from the inside and placed on a barge for removal. The assembly may be cut into pieces depending on the capacity of the crane available. The sediments from inside the monopile would be returned to the excavated pile site using the vacuum pump and diver assisted hoses in order to minimize sediment disturbance and turbidity.

It should be noted that any environmental impacts related to the removal of the armor stones would be avoided by leaving the rock armor in place following the removal of the WTG foundations. Over the operational lifespan of the proposed action it is possible that regulatory changes may allow for minimizing environmental impacts by leaving scour protection in place. However, if current regulations

remain in effect and require the removal of the armor stones it can be expected that environmental impacts related to the removal of the stones would include temporary and localized impacts to benthics, sediments, fish, marine mammals, and navigation similar to those expected during offshore cables installation and/or decommissioning. It is estimated that removal of the rock armor stones would take approximately one half day per WTG site. The armor stones would be re-used at an off-site location (to be determined) pending all necessary approvals.

5.1.6.4 Floating Trash and Debris

As with most construction/removal activities that occur in the ocean or along the shoreline, the decommissioning of the proposed action has the potential to create floating trash and debris. Given the de-assembly nature of the decommissioning and lack of on-site fabrication that would require more destructive means of removal, the proposed action does not have the potential to create much in the way of floating material during decommissioning activities. Once the proposed action is decommissioned, there are no incidental materials that might unintentionally be left on site that have the potential to float.

5.1.6.5 Air Emissions

Air emissions during decommissioning would result from the operation of the construction equipment and vessels. For the period of decommissioning activities, air emissions of the combustion by-products of diesel fuel and gasoline would be increased in the local area over those occurring during operations, similar to those discussed in Section 5.1.1 for the construction period. Once the proposed action is decommissioned, there would be no air emissions resulting from the former proposed action.

5.1.6.6 Visual Aesthetics

Decommissioning consists of removing the proposed action's visual elements WTGs thereby removing any visual impacts to receptors within the proposed action's APE and returning the seascape to pre-existing conditions.

During the actual decommissioning process, there would be an increase in vessel activity compared to the operational timeframe, including nighttime lighting of work vessels that would alter the visual aesthetics. This would be a temporary situation.

5.1.6.7 Noise and Vibration

Similar to, but to a lesser extent, decommissioning activities would result in a temporary increase in the amount of noise and vibration. The noise and vibration would primarily be associated with the operation of vessels and equipment involved in the decommissioning, and once all proposed action facilities are removed or decommissioned in place, there would be no noise or vibrations associated with the former proposed action. The biggest difference between construction and decommissioning noise and vibration is that during decommissioning there would be no pile driving noise, which avoids the higher intensity sound levels associated with pneumatic and vibratory pile driving.

5.1.6.8 Navigation Lights or Beacons

As with the construction timeframe, during decommissioning there would be a temporary increase in the amount of lighting present within the area of the proposed action in association with decommissioning work vessels, such as derrick barges. Once all proposed action structures are removed, all lighting would be removed and the area would become similar to pre-proposed action conditions.

5.1.6.9 Essential Fish Habitat Degradation With Monopile and Cable Removal

Several fish species within the site of the proposed action and other shoals in Nantucket Sound may be attracted to the monopiles in some or all of their life history stages, and thus may benefit from the presence of the monopiles even though the smooth steel monopile design minimizes opportunities for benthic organism colonization or fish habitat creation. These species include Atlantic cod, black sea bass, cunner, tautog, and scup. However, because the proposed action is not predicted to substantially change the overall environment and fish species composition in the area of the proposed action, it is also predicted that the impacts of removing the WTGs would be minor.

5.1.6.10 Restoration of Outer Continental Shelf Space

The 130 WTGs, the ESP, 115 kV offshore transmission cable system, 33 kV inner-array cables, and associated scour control devices (rock armoring) require approximately 115 acres of submerged land within Nantucket Sound. Therefore, after the decommissioning process is complete, 115 acres of OCS space would be restored.

5.1.6.11 Restoration of Aviation Space

As the WTGs and ESP are removed from Horseshoe Shoal, the airspace formerly occupied by these structures would become restored to pre-proposed action conditions, and any restrictions or hazards associated with flying within the area of the proposed action would be removed.

5.1.7 On-shore Impact Producing Factors

From the landfall at the end of New Hampshire Avenue in the Town of Yarmouth, an approximate 4.0-mile (6.4 km)-long onshore 115 kV transmission cable system would be installed in an underground conduit system within existing roadways until it intersects the existing NSTAR Electric ROW at Willow Street in Yarmouth. From this point, the onshore transmission cable system would proceed west and south for approximately 1.9 miles (3.1 km), in an underground conduit system, along the existing NSTAR Electric ROW to the Barnstable Switching Station. Impact producing factors associated with the onshore transmission cable installation, operation, and decommissioning are described below.

5.1.7.1 Transmission Cable Installation

Construction of the onshore 115 kV transmission cable system would first include installation of ductbanks, conduits, and vaults and then installation of the onshore 115 kV transmission cable system. Construction of the onshore cable system would follow a set of sequential operations including vegetation removal, trenching, and backfilling. The entire process would be coordinated in such a manner as to minimize the total time a parcel of land is disturbed and therefore exposed to erosion and temporarily precluded from normal use.

5.1.7.1.1 Vegetation Removal

Clearing and grading along the roadways and existing NSTAR Electric ROW would remove trees, large rocks, brush, and roots from the construction work area and level the surface of the ROW across its width to allow operation of construction equipment. Trees would only be removed when necessary for construction purposes. Timber and other vegetative debris may be chipped for use as erosion-control mulch, burned, cut and stacked along the ROW, or otherwise disposed of in accordance with applicable regulations. Burning of brush would be conducted in such a manner as to minimize fire hazard and prevent heat damage to surrounding vegetation.

The degree of impact on vegetation would depend on the type and amount of vegetation affected, the rate at which vegetation would regenerate after construction, and the frequency of vegetation maintenance

conducted on the ROW during onshore transmission cable system operation. Clearing of trees would result in long term and permanent impacts to these vegetation communities given the length of time needed for the community to mature to pre-construction conditions. All trees within the permanent ROW would be permanently removed and prevented from reestablishing through the periodic mowing and brush clearing required for onshore transmission cable system operation. The cutting, clearing, and/or removal of existing vegetation would also affect wildlife by reducing the amount of available habitat. The degree of impact would depend on the type of habitat affected and the rate at which vegetation regenerates after construction. To minimize impacts on vegetation within the construction and permanent ROWs and to improve the probability of successful revegetation of disturbed areas, the ROW would be managed in compliance with NSTAR's vegetation management plan.

5.1.7.1.2 Sedimentation and Erosion

Construction activities associated with the onshore transmission cable system including clearing, grading, trench excavation, backfilling, heavy equipment traffic, and restoration along the construction ROW may result in adverse impacts on soil resources. Clearing removes the protective vegetative cover and exposes soil to the effects of wind, sun, and precipitation, which could potentially increase soil erosion and the transport of sediment to sensitive areas (i.e., wetlands and waterways). Grading and equipment traffic can compact soil, reducing porosity and percolation rates, which can result in increase runoff potential.

Temporary erosion control measures such as sediment barriers (silt fences) would be installed during the clearing and grading phase. After onshore transmission cable system installation, temporary erosion control measures would be regularly inspected and maintained throughout the duration of construction or until permanent erosion control measures are installed and the temporary measures are no longer needed.

5.1.7.1.3 Trenching and Soil Disturbance

A combination of trackhoes, backhoes, trenching machines, and mechanical rippers would be used to excavate the onshore transmission cable system trench. Little, if any, blasting is anticipated; however, any necessary blasting would be conducted in accordance with all applicable laws and company standards. Where rock substrates are found, the rock would either be segregated during trenching or during backfill activities using segregating machines. In residential areas, subsoil and rock would be stockpiled separately from topsoil. After the ductbanks, conduits, and vaults are lowered into the trench and the 115 kV transmission cable system is installed, the trench would be backfilled. Previously excavated materials would be pushed back into the trench using bladed equipment, backhoes, or auger type backfilling machines. Following backfilling, a small crown of material may be left to account for any future soil settling that might occur over the trench.

As described above, onshore transmission cable system construction activities along the construction ROW, including trenching, may result in adverse impacts on soil resources. Impacts to terrestrial wildlife resulting from construction activities would be short-term and minimal because most terrestrial species are reasonably mobile and are expected to temporarily relocate to similar adjacent habitats during construction activities. Some smaller, less mobile wildlife, such as small mammals, amphibians and reptiles, would likely experience direct mortality during clearing, grading, and trenching activities. Impacts to wildlife resources would be minimized through restoration of the ROW and much of the area affected by construction would be allowed to revert to pre-construction conditions following construction.

5.1.7.1.4 Noise and Vibration

Construction activity and associated noise and vibration levels would vary depending on the phase of construction in progress at any one time. These construction phases include site grading,

clearing/grubbing, trenching, installation, etc. The highest level of construction noise and vibration is assumed to occur during earth work; however, these effects would be short-term and limited to the duration of construction. Since nighttime construction is not proposed there would be no alteration of nighttime ambient noise quality along the onshore transmission ROW route.

5.1.7.1.5 Air Emissions

Construction impacts on air quality are mainly due to potential fugitive dust released during construction activities. Proper maintenance of construction equipment, watering of the construction sites for fugitive dust control, if necessary, and minimizing soil disturbances to areas necessary for construction are measures that would be implemented to minimize impacts in air quality during construction. In addition, because the construction equipment would only be operated on an as-needed basis and only during daylight hours, the emissions resulting from the operation of construction equipment should be further minimized.

Open burning during construction activities also has the potential to impact air quality. If required, open burning would be regulated through the local permitting processes. Any necessary local open burning permits would be obtained prior to conducting such activities and the local open burning ordinances would be followed during such activities. Emissions from construction-related activities would not significantly affect local or regional air quality and would not cause nor contribute to an exceedance of the ambient air quality standards.

5.1.7.1.6 Dewatering Discharges

After the ductbanks, conduits, and vaults have been inspected and approved, they would be lowered into the trench using side-boom tractors and/or backhoes. Prior to lowering-in, the trench would be inspected to ensure that all foreign material has been removed. Trench dewatering may be necessary at certain times during the lowering-in process. Any trench dewatering would be accomplished in a manner designed to prevent heavily silt-laden water from flowing into wetlands or waterways.

5.1.7.1.7 Traffic Management

Construction of the onshore transmission cable system across major paved roadways, railroads, and unpaved roads where traffic cannot be interrupted would be accomplished by boring under the roadbed. Most smaller, unpaved roads and drives would be crossed by open trenching and then restored to pre-construction or better condition. If an open-cut road requires extensive construction time, provisions would be made for detours or other measures to permit traffic flow during construction. Consultations with landowners would be conducted to determine the best way to cross privately owned roads. All road damage caused by construction of the onshore transmission cable system would be repaired. The onshore transmission cable system would be buried to the depth required by applicable road crossing requirements and would be designed to withstand anticipated external loadings. Railroad crossings would be installed (typically using a bore) in accordance with the requirements of the railroad.

5.1.7.2 Transmission Cable Operation

5.1.7.2.1 Vegetation Maintenance

Routine vegetation maintenance clearing could occur within the existing permanent ROW no more than once every three years. However, to facilitate surveys, a corridor no more than 10 ft (3 m) wide centered on the onshore transmission cable system could be maintained by mowing or a similar means on an annual basis, in accordance with NSTAR's vegetation management plan.

5.1.7.2.2 Electro Magnetic Fields (EMF)

For electrical cables, EMF would be highest adjacent to the cable and decrease as the distance from the cable increases. Electric fields are attenuated by objects, and are completely shielded by electrically conducting material such as metal, the earth, or the surface of the body. Magnetic fields penetrate most materials.

Humans are exposed to a wide variety of natural and man-made electric and magnetic fields from sources including natural fields and overhead transmission and distribution lines. Electric and magnetic fields from different sources may partially cancel or be additive at a given location. A number of epidemiologic studies have reported a small degree of association between measures of EMF and several diseases (e.g., childhood leukemia) while other studies have failed to find an association. A causal basis for the EMF associations is not supported by laboratory and biophysical evidence, and the actual basis remains unexplained.

Terrestrial animals (e.g., birds and honeybees) likely use the earth's DC magnetic field for orientation, navigation and migration. Aside from orientation and navigation, other potential effects of low-frequency EMF on ecological systems have been investigated, but the findings have been uncertain and there is no consistent evidence to establish an adverse-effect level.

Because the electric field of the onshore transmission cable system would be contained within the body of each cable, by its grounded metallic shield, the addition of the onshore transmission cable system would not change electric field levels. The electric field within the existing NSTAR Electric ROW would be effectively contained within the body of each underground onshore transmission cable system by its grounded metallic shield. No external electric field would be produced. Upon completion of the onshore transmission cable system the electric fields within the existing NSTAR Electric ROW are expected to be approximately the same as the existing condition, due primarily to the presence of the existing overhead 115 kV lines.

5.1.7.3 **Transmission Cable Decommissioning**

Decommissioning of the onshore transmission cable system components would be a reverse process of the construction activities and would include leaving in place the conduits, ductbanks and underground vaults beneath the roadways and the existing NSTAR Electric ROW.

During decommissioning, the onshore transmission cable system would be disconnected and pulled out of the underground conduit system. The onshore transmission cable system would be reeled and the reels would be transported to the staging area for further handling. It is expected that all material from the onshore transmission cable system would be reused via recycling.

5.2 **IMPACT-PRODUCING FACTORS – NON-ROUTINE CONDITIONS**

5.2.1 **Maintenance or Construction Vessels and Crew Boats**

5.2.1.1 **Oil or Fuel Spills**

Oil is a mixture of different hydrocarbon compounds that begin reacting with the environment immediately upon being spilled. Once spilled, oil begins to spread out on the water surface. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which results in the original mass spilled being partitioned to the sea surface, the atmosphere, the water column, and the bottom sediments. Weathering, the type and amount of cleanup, and the existing meteorological

and oceanographic conditions determine the length of time that the slick remains on the surface of the water, as well as the characteristics of the oil at the time of contact with a particular resource.

Oil and fuel spills have the potential to adversely affect a number of resources within Nantucket Sound, including but not limited to birds such as sea ducks, gulls, cormorants; water quality through the release of toxic byproducts; benthos as some of the spilled hydrocarbons may congeal into tar balls and sink to the seafloor; intertidal habitats such as beaches and mud flats; and marine mammals and sea turtles.

5.2.1.2 Vessel Collisions

Vessel collisions during any phase of the proposed action are a remote possibility, particularly given that proposed action vessels are unlikely to be operating during any phase under poor weather conditions, when risk of collision is greatest. However, engine or steering failure could occur on any vessel at any time. Given that most vessels employed during construction and decommissioning would be moving slowly, less than 10 knots (5.1 m/s), the risk of collision is further minimized. Smaller crew and supply boats may travel at speeds up to 20 knots (10.3 m/s), but these vessels do not have the same momentum and are easier to bring to an emergency stop. Vessels operating during maintenance activities would generally be similar to the smaller crew and supply boats used during construction, and only when necessary to remove a generator, rotors or other large components in the nacelle would a derrick crane barge be used during operations.

The risk of a vessel colliding with a WTG is low, given the proposed action's location away from typical vessel routes, the small diameter of the towers (approximately 16.75 ft and 18 ft (5.1 m and 5.5 m) as described in Section 4.0) and the large spacing between the WTGs. The small diameter of the WTGs would prevent all but the smallest vessels (those with LOA of approximately 16 to 18 ft [4.9 to 5.5 m] or less) from being shielded from view of another vessel by a WTG. When the WTG blade is in its lowest position, it would be approximately 72 ft (21.9 m) above MHW, and approximately 23 ft (7.0 m) from the WTG tower. Therefore, vessels with mast or structure heights less than 72 ft (21.9 m) would pass under the WTG blade should they get within 23 ft (7.0 m) of the WTG.

The location of the site of the proposed action relative to established vessel routes, physical water depth restrictions on Horseshoe Shoal and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG. Despite this, the possibility for damage in the unlikely event of a collision was studied, as presented in [Report No. 5.2.1-1](#).

5.2.1.3 Cable Repair

The potential for a fault occurring during the operational lifetime of a buried offshore cable systems is minimal, based on industry experience. Impacts associated with a cable repair would result from temporary turbidity and some deposition of sediments during the repair process. Specifically, turbidity would be caused by the jetting of sediments to uncover the damaged portion of the cable, hoisting of the cable after it is cut, laying the cable back down, and then jetting of sediments after the repaired cable is placed back into the seabed. Cable repair procedures are discussed in Section 2.4.6.

5.2.2 WTG in Operation

5.2.2.1 WTG and Electric Service Platform Fluid Spills

The oil storage components of the ESP consist of four 115 kV power transformers. The 115 kV power transformers contain 10,000 gallons each of dielectric cooling oil (40,000 gallons total). In the unlikely event that an oil spill was to occur, the oil is most likely to travel toward the south shore of Cape

Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent). It has a 90 percent chance of impacting the shoreline somewhere. The directions of the potential spill movement in the winter and fall are more variable than in the spring and summer, with the spills equally likely to impact Cape Cod, Martha's Vineyard, or Nantucket. Martha's Vineyard has the highest likelihood of impacts from spills in the spring due to prevailing wind directions from the north and east. The south shore of Cape Cod has the highest likelihood of impacts during the spring and summer due to prevailing winds from the south and west, while the likelihood of impacts to Nantucket at all times of the year are far less (<10 percent). Refer to [Report No. 4.1.3-1](#) for further information.

In addition to the materials stored in the ESP, the turbines would house certain system components within the nacelle that contain smaller amounts of lubricants and cooling fluid. Total oil storage at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). The expected oil storage components are the drive train main bearing containing 19 gallons of Mobil SCH 632; the drive train main gear box containing 140 gallons of optimal synthetic A320; the drive train cooling system which holds 21 gallons of optimal synthetic A320; the hydraulic system brake and hydraulic system rotor lock that use 2 gallons and 19 gallons of Mobil DTE 25, respectively; the hydraulic crane cylinder containing 5 gallons of ATF 66; the yaw system, two pitch systems which contain 7 gallons of Mobil SHC 630, 0.25 gallons Mobil SHC XMP 220, and 1 gallon Mobil SHC XMP 460, respectively. The worst case scenario for a single incident is 42,000 gallons from the ESP; however, given the controls in place, this is an unlikely scenario. According to the Oil Spill Probability Analysis ([Report No. 5.2.1-1](#)), the estimated number of spills from both the ESP and WTGs over five, ten, and thirty years of operation are 0.31, 0.62, and 1.862, respectively. Furthermore, the analysis shows that only 7 percent of all spills expected in Nantucket Sound during a 30 year period could be attributed to the addition of the proposed action facility. Also, the fluids used in the WTGs and service platforms are easily dispersible (often on their own) and would typically float on the surface.

Oil and fuel spills have the potential to adversely affect a number of resources within Nantucket Sound, including but not limited to birds such as sea ducks, gulls, cormorants, water quality through the release of toxic byproducts, benthos as some of the spilled hydrocarbons may congeal into tar balls and sink to the seafloor, intertidal habitats such as beaches and mud flats, and marine mammals and sea turtles.

5.2.2.2 Monopile Collapse

Given the relatively sheltered nature of Horseshoe Shoal, compared to an open coastline setting, the probability of monopile collapse due to ocean conditions is remote. The proposed action has been designed with a margin of safety to allow for the conditions anticipated during the proposed action's lifespan. Similarly, the magnitude and frequency of seismic events likely to occur within Nantucket Sound are unlikely to result in monopile collapse, either from fluidization of sediments or stress on the structure resulting from ground motion.

5.2.2.3 Wind Turbine Generator and Ice Build Up and Safety

Although rotor blades would have a slick surface for aerodynamic efficiency, which would allow most ice to slide off prior to any significant buildup, ice may collect on the WTG structure and blades under certain meteorological conditions (i.e., a combination of high relative humidity, freezing temperatures, and overcast or nighttime sky). This ice usually takes the form of a thin sheet as it attaches to wind turbines (similar to how ice attaches to an airplane's wings during flight). Temporary icing of a rotor blade would activate vibration sensors causing turbine shutdown in order to prevent rotor damage or hazard to proposed action maintenance staff or others from falling ice. Conditions conducive to icing would be evaluated by continuous monitoring of meteorological conditions and by monitoring the WTGs remotely (via camera). If conditions warrant, manual shutdown of the WTGs experiencing icing

conditions would be initiated. The ice would remain attached until meteorological conditions allow it to melt. If the WTG is no longer operating due to icing, the melting ice would break apart into fragments in the same manner as ice falls off buildings, trees, and power lines, and fall down to the water surface under the WTG. If the WTG is operating, it is possible that the ice sheet attached to the WTG blade could be thrown from the blade as it rotates. However, as the ice sheet pieces are thrown from the blade, wind resistance would work to break them into much smaller fragments as they fall.

5.2.3 Electrical Service Platform

5.2.3.1 Oil or Fuel Spills

Because the ESP would contain 40,000 gallons of dielectric cooling oil, there is the potential for a spill of some or all of this material into the waters of Nantucket Sound. A model was created to anticipate the full release of 40,000 gallons of fluid oil from the ESP which would represent a worse case scenario; more information on the inputs used to run the model are provided in [Report No. 5.2.1-1](#). If an oil spill were to occur, the model results indicate that oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent), it has a large probability of impacting the shoreline somewhere (>90 percent), the directions of spill movement in the winter and fall spills are more variable than in the summer and spring, with the spills equally likely to impact Cape Cod, Martha's Vineyard, or Nantucket, Martha's Vineyard has the highest likelihood of impacts from spills in the spring due to prevailing wind directions from the north and east, the south shore of Cape Cod has the highest likelihood of impacts during the spring and summer due to prevailing wind directions from the south and west, and the likelihood of impacts to Nantucket is always small (<10 percent).

In addition, during construction and decommissioning there would be an increased number of vessels operating around Horseshoe Shoal, which leads to a potential increase in vessel collisions. Depending upon the severity of such a collision, and the type of vessels involved, oil or fuel could be released.

As described Section 2.4.3 of the FEIR for the Cape Wind Project, during the 20-year operational life of the proposed action there would be boats or other motorized floating vessels used to support and perform ongoing maintenance activities.

The vessels used during the operating life of the proposed action would carry a variety of liquids. The crew transport, maintenance support vessels and the special duty supply vessel would be carrying sufficient diesel fuel to move back and forth from port as well as operate for an entire day with some additional capacity for contingency. These vessels may also carry some supplementary diesel fuel and gasoline for use in powered equipment that may be used during maintenance activities. The smaller boat used for crew movement would be gasoline powered and have sufficient gas on board to run for more than an entire day.

Other liquids to be carried would include machine oils and lubricants that would be used both for proposed action generating equipment and, as necessary, for the powered equipment used for maintenance activities. Paints and paint thinners would be transported and used in quantities appropriate for the periods of the touch-up or repainting of the proposed action's components warranted by aging over the lifetime of the operations. Antifreeze and water necessary for equipment and vessel maintenance would also be carried. Drinking water for the maintenance crews would also be carried on crew transport and movement boats.

While not expected, collisions or other failures of the vessels used during the proposed action's operations could cause the release of some or all of these fluids. In order to minimize the potential adverse impacts that may be caused by the release of these fluids, Cape Wind would address the liquids

carried on work and crew vessels in its OSRP prior to the start of operations (see [Table 5.2.3-1](#) for a list of vessels and use frequency).

The accidental release of oil or fuel may also occur during construction and decommissioning as a result of refueling operations that occur on the water. For instance, jack up or spud barges as well as the cable jetting vessel would not return to port to refuel, but would rather be serviced by a supply or fuel supply vessel, that would transfer fuel while the vessels are on station. This is a normal operation performed during offshore construction activities, and adequate safeguards should be in place to minimize the potential for accidental release, as well as to minimize the affects, should a release occur. Such safeguards include an OSRP and an Emergency Response Plan (ERP). Each of these safeguards, as well as others, is discussed in more detail in Section 9.3.2.

Oil and fuel spills have the potential to adversely affect a number of resources within Nantucket Sound, including but not limited to birds such as sea ducks, gulls, cormorants, water quality through the release of toxic byproducts, benthos as some of the spilled hydrocarbons may congeal into tar balls and sink to the seafloor, intertidal habitats such as beaches and mud flats, and marine mammals and sea turtles. A discussion on potential impacts to wildlife within the area of the proposed action can be found in [Appendix C](#), which provides information on T&E species and potential effects to T&E species. The spill probability for the proposed action has been broken down for transiting vessels and the WTG Array/ESP over a thirty-year period by spill volume. The probability of a one gallon spill occurring from transiting vessels over thirty years is 90 percent, whereas the probability of a spill of 2,106 gallons occurring over that same period from transiting vessels is one percent. Likewise, there is a 90 percent probability of a spill of 50 gallons occurring from the operation of the WTG/ESP and a one percent probability of a spill of 10,198 gallons occurring from the WTG/ESP over thirty years ([Report No. 5.2.1-1](#)).

Given the relatively sheltered nature of Horseshoe shoal, compared to an open coastline setting, the probability of ESP collapse due to ocean conditions is remote. The proposed action has been designed with a margin of safety to allow for the conditions anticipated during the proposed action's lifespan. Similarly, the magnitude and frequency of seismic events likely to occur within Nantucket Sound are unlikely to result in ESP collapse, either from fluidization of sediments or stress on the structure resulting from ground motion.

5.2.4 Electrical Transmission Cables

5.2.4.1 Snagging or Severance

While the design of the electric cable systems, both inner-array and the offshore transmission cable systems, are intended to adequately bury the cables to a depth where they would not become exposed or be located at a depth below the seabed surface where they could be snagged by anchors or mobile fishing gear, as described in the geology section, there are parts of Nantucket Sound where sand waves reveal the mobility of bottom sediments. In the event that a section of cable no longer remains at the design depth in the sediments, it is possible that an anchor or mobile fishing gear may snag the cable. It is possible that the results of a snagging may be no damage to the cable, damage to the cable but not loss of service, or sufficient damage as to make the cable inoperable. Since the cables would be marked on navigation charts with appropriate warnings, snagging of the cables is considered a remote occurrence.

Even more remote is the possibility that some future activity may occur over a cable that results in the cable being severed. Future placement of other utilities in Nantucket Sound would need to be sited and designed to either avoid the cables or cross them in a manner that avoids snagging or severing them. Future sand mining or dredging, if not properly located relative to the proposed action cables could result

in snagging or severance of cables. There are several protective layers around the core of the cable, and the cable would have to be very stressed in order to be severed. Depending upon the circumstances, snagging of the cable may result in it being pulled out of the sediment for a short section and left on the seafloor surface until repair or reburial can occur.

In the event of cable snagging or severance, repair equipment would be mobilized to repair the cable and re-bury it. These activities would result in short term and localized sediment disturbance that could affect benthos and water quality.

5.2.4.2 Exhumation

It is anticipated that the uncovering of the offshore cables due to natural processes is unlikely due to the minimum 6 ft burial depth below present bottom and because it would be inspected periodically to ensure adequate coverage is maintained. If problem areas are discovered, the offshore cables would be reburied. To rebury an exposed section of cable, a jetting vessel would be deployed and the cable re-jetted to a target depth of 6 ft (1.8 m). These activities would result in short term and localized sediment disturbance that could affect benthos and water quality.

5.2.4.3 On Land Cable Damage or Severance

The electric transmission cable on land could be damaged or severed due to the actions of others, particularly if they fail to use Dig Safe during activities that involve excavation near the cable. The use of duct banks reduces the potential for damage as the concrete provides some protection for the cables. If the cables were to be damaged or severed, repair might include the need to expose the duct bank in that section, perform the repair, and then backfill and restore the area. If the repair is required along the NSTAR transmission line segment, then minor vegetation clearing may be required, and wildlife would be temporarily displaced from the location due to the construction activity and noise. If the repair is required along the street segment, then traffic may need to be re-routed and nearby residents would experience temporary noise and construction dust.

5.3 IMPACTS ON PHYSICAL, BIOLOGICAL, SOCIOECONOMIC, AND HUMAN RESOURCES – PROPOSED ACTION

5.3.1 Physical Resources

5.3.1.1 Geology

5.3.1.1.1 Construction/Decommissioning Impacts

Description of Numerical Models and Engineering Analysis

Numerical models and engineering analysis of site specific data related to oceanographic processes were used to assess, simulate, and predict potential impacts to geologic resources for construction of the proposed action. Analyses performed were as follows:

Jet Plow Sediment Transport and Deposition

Simulations of sediment transport and deposition from jet plow embedment of the offshore transmission cable system and the inner-array cables were completed using two models, HYDROMAP to calculate currents and SSFATE to calculate suspended sediments in the water column and bottom deposition from the jet plow operations.

The SSFATE model was run for five offshore transmission cable system routes. One was a simulation of the jetting process to bury one of the 115 kV offshore transmission cable systems from the Yarmouth landfall in Lewis Bay to the ESP. Burial of four of the 33 kV inner-array cable routes from the ESP (Electric Service Platform) to their respective ends were also simulated. These four routes were chosen to be representative of the burial of the cable connecting the WTGs. The modeling and results are considered to be representative of sediment conditions throughout the area of the proposed action since they represent locations covering the range of water depths, wave conditions, currents, and sediment characteristics in the Horseshoe Shoal area.

The results of the analysis are discussed in the impact section and presented in [Report No. 4.1.1-2](#).

Seabed Scar Recovery and Possible Cable Exposure

A slight depression, estimated to be between 0.5 and 2 ft (0.15 and 0.61 m) deep, is anticipated as a result of installation of the inner-array cables and the offshore transmission cable system. The applicant completed an evaluation to determine the seabed recovery time after jet plow installation of the offshore cable systems. Using the methodology of van Rijn (1993) to calculate bedload sediment flux on Horseshoe Shoal, estimated recovery rates for jetting scars along the cable routes were determined, and an analysis of the potential for localized scour was completed. The results of the analysis are discussed in the impacts section below and presented in [Report No. 4.1.1-3](#).

Scour Analysis for Wind Turbine Generator Piles

Analysis of scour at the proposed WTGs was completed. Marine scouring methods developed by Sumer and Fredsoe (USACE, 2002) were used to predict the amount of scour based on wave, current, and sediment characteristics within the proposed turbine array. The analysis resulted in a predicted scour hole size at the wind turbine arrays that could be used to support scour mitigation analysis.

The results of the analysis are discussed in the impacts section and presented in [Report No. 4.1.1-5](#).

Post-Lease Geological and Geophysical Sampling

Post-lease G&G investigations would be completed by the applicant to support final design. The sampling would include the following:

- Approximately 50 vibracores would be collected along the proposed 115 kV offshore transmission cable system routes (approximately 2 vibracores per mile [1.6 km]) and along the inner array 33 kV cable routes (1 vibracore approximately every 3 miles [4.8 km]). The diameter of the core barrel is approximately 4 inches (102 mm), and the cores are advanced up to a maximum of 15 ft (4.6 m). The vessel is anchored during coring.
- Approximately 20 borings would be advanced at selected WTG sites. The analytical program is designed to address liquefaction potential, gas concentrations in sediments, pressure regimes of gaseous sediments, and gas saturation versus shear strength properties of sediments. The borings would be advanced from a truck-mounted drill rig placed upon a jack-up barge that rests on spuds lowered to the seafloor. Each of the four spuds would be approximately 4 ft (1.2 m) in diameter. The barge would be towed from boring location to location by a tugboat. Borings generally can be advanced to the target depth (100 to 200 ft [30.5 to 61 m] depending on location) within 1 to 3 days, subject to weather and substrate conditions. Drive and wash drilling techniques would be used; the casing would be approximately 6 inches in diameter.

- CPT rig or an alternative subsurface evaluation technique (appropriate to site-specific conditions) would be used, as necessary, to evaluate subsurface sediment conditions. A CPT rig would be mounted on a jack-up barge similar to that used for the borings. The top of a CPT drill probe is typically up to 3 inches (76 mm) in diameter, with connecting rods less than 6 inches (152 mm) in diameter.

Detailed descriptions of the post-lease G&G investigation are presented in Section 2.0. Impacts to geological resources from G&G are expected to amount to temporary increases in turbidity and would be negligible.

Sediment Deposition and Transport

During installation of the inner-array cables and the offshore transmission system cables with a jet plow, some sediment would be mobilized and transported from the trench area by currents. Potential impacts to the sediment resource are the suspension and transport of sediments, formation of a seabed scar, and re-deposition of sediments at a distance away from the jet plow trackline, which would potentially include a sorting process whereby finer-grained sediments get transported and deposited at further distances.

In general, and assuming similar currents, the coarse sediments that predominate Horseshoe Shoal and Nantucket Sound would remain in suspension in the water column over a shorter duration than the finer-grained material found in Lewis Bay, and would not disperse as far. However, areas of higher currents could offset the differences in grain size/mass such that larger particles in higher currents may be transported distances equal to or farther than those of fine sediments in lower currents. At all locations along the offshore cables, the suspended sediment would return to the seabed.

An analysis was performed to estimate the amount of suspended sediment and subsequent deposition during the cable burial process. Two models were utilized for modeling, HYDROMAP for currents and SSFATE for suspended sediments in the water column during jetting operations. Parameters included the following:

- Water Depth: Due to the complex nature of Nantucket Sound bathymetry, the hydrodynamic model domain was extended to relatively deep waters (approximately 660 ft [201.2 m]) in the south and east directions, to Block Island in the west direction and the north end of Massachusetts Bay to the north.
- Current Speed and Direction: Three tidal stations, Woods Hole, Edgartown, and Nantucket were used for tidal constituents in the hydrodynamic model, which is used to drive the sediment transport model simulations.
- Sediment Characteristics: Sediment characteristics were based on actual samples collected from vibracores on Horseshoe Shoal and along the proposed 115 kV offshore transmission system cable route.
- Operational Details: The SSFATE model was used to simulate jetting operations for burial of representative cables in trenches. Assumptions based on the proposed action estimates and past studies included a trench cross section of 32 ft² (3.0 m²), a trenching speed of 91 m/hr (300 ft/hr), and that 30 percent of the trench volume was injected into the water column.

For the offshore cable routes located in the coarse sediment of Nantucket Sound from Yarmouth to the ESP and the WTGs to the ESP, the modeling results indicated that re-deposition of sediment would

occur within a few hundred yards of the cable route. A larger portion would be deposited adjacent to the cable route, with a thickness estimate of 0.8 to 1.8 inches (20 to 46 mm) and a thin veneer of finer-grained sediment would extend within a few hundred yards of the trench at 0.04 to 0.2 inches (1.0 to 5.0 mm) ([Report No. 4.1.1-2](#)).

As a result, a seabed scar would form. It is estimated that the seabed scars would be 6 ft (1.8 m) wide and 0.75 to 1.7 ft (0.23 to 0.52 m) deep. The seabed scars are anticipated to recover naturally, through normal sediment migration and deposition through the scar area, from tidal and storm events. Seabed scars are estimated to recover within days on Horseshoe Shoal, within 1 to 38 days along the cable route, and over many months or possible years until a major storm occurs within Lewis Bay ([Report No. 4.1.1-3](#)).

The impact to the geologic resource from re-deposition of sediment and the formation of the seabed scar during jetting operations for offshore cable installation are considered minor as the resource would recover completely without mitigation.

Placement of the monopiles would result in circular areas of the sediment on the seafloor being enclosed within the hollow monopile. This would result in a loss of available sediments to the environment, which would become available upon decommissioning.

The total surface area affected by monopiles is estimated at 0.67 acres (29,185 ft² [2,711 m²]). The total estimated combined area of impacted seafloor by the inner-array cables and the offshore transmission cable system is 5.89 acres (256,568 ft² [23,836 m²]). Accordingly, geological impacts as a result of land and seafloor occupation would be expected to be minor.

Impacts related to decommissioning of proposed action-related structures including wind turbine towers, foundations, scour control mats, the ESP, inner-array cables and offshore transmission cable system would result in temporary seafloor impacts and temporary re-suspension of bottom sediments.

During decommissioning, the scour mats would be removed by divers and a support vessel in a similar manner to installation, and this is expected to result in greater amounts of suspended sediments than levels associated with the original installation of the mats. It is anticipated that the sandy nature of the bottom material over most of the site of the proposed action would result in rapid settling of the suspended sediment material. Impacts to sediment from scour mat removal would be minor. In those locations where rock armoring has been used for scour protection, armor stones would be removed using a clamshell dredge or similar equipment and placed on a barge. It is estimated that removal of the rock armor stones would take approximately one half day per WTG site. The armor stones would be re-used at an off-site location (to be determined) pending all necessary approvals.

There would be no excavation around the outside of the monopile prior to the cutting, because the cutting would be done from inside the monopile following the removal of the sediments within the pile. Sediment removal to a depth of approximately 15 ft (4.6 m) below the seabottom would be accomplished hydraulic dredging/pumping with storage of the material on a barge. Once the cutting takes place, approximately 15 ft (4.6 m) below the mudline, the cut pile would be removed. Following the removal of the cut pile and any adjacent scour protection (either scour mats or rock armor) the sediments would be returned to the excavated pile site using the vacuum pump and diver assisted hoses in order to minimize sediment disturbance and turbidity. Impacts to geologic resources are considered minor for the proposed decommissioning activities.

Onshore

Transition from Lewis Bay

At the Lewis Bay landfall, a temporary sheet pile cofferdam is proposed to support HDD activities. The dredging of approximately 840 yd³ (642 m³) of sediments to an elevation of approximately -10 ft (-3 m) MLLW would be required. Following installation of the offshore cables, the cofferdam excavation would be backfilled with originally excavated material. The dredged backfill material would be supplemented with imported clean sandy backfill material to restore pre-construction contours, if necessary. Once the dredged area is restored, the sheet pile cofferdam would be removed from Lewis Bay.

To transition from the nearshore to onshore route, HDD techniques would be utilized. The HDD is a trenchless method that is an alternative to traditional open-cut cable installations. The result is very little disruption to surface activities and less working space requirements.

The HDD method involves drilling a small pilot hole, using technology that allows the drill to be steered and tracked from the surface. The pilot bore is launched from the surface at an angle between 8 and 20 degrees to the horizontal, and transitions to horizontal as the required depth is reached. A bore path of very gradual curvature or near-straight alignment is normally followed to minimize friction and to stay within the allowable joint deflection and the allowable curve radius for the pipe. This minimizes the chance of getting the pipeline “hung up” in the soil or damaging the pipe.

The pilot hole is enlarged (usually approximately 1.5 times the largest outside diameter of the new pipe) by pulling back increasingly larger reamers, or reaming heads, from the pipe insertion point to the rig side. After the pre-reams, the pulling head and connecting product pipe are attached to the reamer using a swivel, a device that isolates the product pipe from the rotation of the HDD drill pipe. The product pipe is then pulled behind the final reamer back through the HDD path to the exit pit on the rig side.

Drilling mud is normally utilized to lubricate the cutting head during the drilling operation and stabilize the reamed bore path prior to and during pull-back. Drilling mud is primarily a mixture of water and bentonite clay. Bentonite is a naturally occurring clay mineral that forms a mud when mixed with water. The applicant has proposed a formal monitoring program to monitor for drilling fluid release and a contingency plan to stop and cleanup an unexpected release of drilling mud to Lewis Bay.

The potential impact to geological resources during the HDD transition from offshore to onshore is considered minor.

Onshore Excavation

The installation of onshore cable vaults would result in the excavation and offsite disposition of some surficial material. It is likely that much of the excavated material would be suitable for re-use as fill with a local recycler.

Onshore transmission cable ROW easements may result in certain restrictions on the unconsolidated geologic resource, such as sand quarrying, though no existing quarrying activity was identified. Certain portions of the ROW are proposed along existing transportation and utility corridor routes, such as the first four miles (6.4 km) of the onshore route below existing roadways.

The potential impact to geological resources from the installation and operation of the on-land cable route would be negligible.

Conclusion

Overall, the construction and decommissioning impacts to geologic resources would be minor, as they would be temporary, and relatively localized in Nantucket Sound. The minor impacts are largely reversible following decommissioning. Onshore excavation is targeted for existing roadways and a utility ROW. The onshore impacts to geologic resources would be negligible.

5.3.1.1.2 Operational Impacts

Description of Numerical Models and Engineering Analysis

Numerical models and engineering analysis of site specific data related to oceanographic processes were used to assess, simulate, and predict potential impacts to geologic resources for operation of the proposed action. Individual analyses are presented below.

Effects of Wind Turbine Generator Piles in Nantucket Sound

The zone of influence of the WTG piles on currents, waves, and sediment transport was evaluated. The zone of influence experiences active sediment transport, dominated by the presence of coarse grain sediments and bedforms such as sand waves. The approach used was to assess the zone of influence of a single pile and then use the resultant information to evaluate the potential interaction of multiple piles to determine the cumulative zone of influence.

The results of the analysis are discussed below in the impacts section and presented in [Report No. 4.1.1-4](#).

Scour Protection

Two scour mitigation methods were evaluated; scour mats and rock armor.

Two Seabed Scour Control Mats were installed on the SMDS' southwest batter pile in October 2003. No scour mats were installed on the SMDS' north and southeast batter piles to allow these piles to provide points of comparison for scour that occurred over time. In June 2005, an underwater inspection occurred to visually inspect the scour mats around the southwest batter pile and to compare the conditions at the other two unprotected SMDS piles with the protected pile. The presence of the scour mats enhanced the accumulation of sand around an installed pile suggesting the scour mats are effective at preventing scour around installed piles.

A conceptual rock armor design for scour protection was developed using methodologies presented in the Federal Highway Administration publication *Bridge Scour and Stream Instability Countermeasures – Experience, Selection, and Design Guidance* (FHWA NHI 01-003, March 2001) and the USACE engineering manual, *Coastal Engineering* (USACE, 2002). Using the same wave and current data as those used for the scour mat analysis, stone size and layer thickness were estimated for the environmental conditions anticipated.

The methods and results for this analysis are discussed in the impacts section and presented in [Report No. 4.1.1-6](#), [4.1.1-7](#), and [Report No. 4.1.1-8](#).

Cable Repair

In the event of a cable failure, the applicant would have a Cable Repair Plan in place to minimize or eliminate environmental impacts. The elements of the Cable Repair plan are detailed in Section 2.0.

Environmental impacts related to cable repair would include temporary and localized impacts to sediments and are expected to be similar to those during offshore cable installation and/or decommissioning, and would be dependent upon the amount and extent of cable damage and the duration that repair vessels are on site. The potential impact to geological resources from the repair of the cable offshore or on-land would be considered negligible.

Sediment Scour

Sediment scour would occur at the pile foundations for each WTG and the six 4 ft (1.2 m) diameter piles for the ESP, if mitigation measures are not employed. Sediment scour on piles in the marine environment is a result of the orbital motion of water produced by waves and currents and the resultant vortices produced as water flows past a pile. As water flows around a pile, the capacity of the local sediment transport system increases, sediment erosion occurs and a scour hole is formed. The sediment is suspended and transported away from the pile until the sediment transport system returns to equilibrium. At this point the sediment is deposited back to the seabed. This process would occur during the ebb and flood tides.

An analysis to predict scour factors and predicted scour depths and equilibrium conditions at the WTG and ESP was performed ([Report No. 4.1.1-5](#)). Site specific hydrographic surveys, physical analysis of sediment, and estimates of wave and current conditions across the site of the proposed action were inputs to scour prediction methods outlined by Sumer & Fredsoe in their 2002 publication titled *The Mechanics of Scour in the Marine Environment* and the USACE *Coastal Engineering Manual* (Sumer & Fredsoe, 2002; USACE, 2002). The methods and calculations described in these documents were used to create spreadsheets to predict the extent and depth of scour at each WTG location. The parameters used in the calculations included:

- Return period for wave events: 50 year;
- Wave height (locally generated average of highest 10th of waves): 13.2 ft (4 m);
- Spectral peak period (locally generated waves): 6.2 seconds;
- Current speed: 8.35 ft (2.5 m/s (5.5 ft (1.7 m/s wind-generated plus 2.85 ft (0.9 m/s tidally generated));
- Current direction: not required for methodology used;
- Water depth: between 12 and 56 ft (3.6 and 17 m) (dependent on WTG location);
- Median sediment grain size: between 0.215 mm and 0.485 mm (dependent on WTG location and nearest vibrocore sediment characteristics);
- WTG monopile diameter: 16.75 ft (5.1 m) or 18 ft (5.5 m) (dependent on water depth at WTG location);
- ESP pile diameter: 4 ft (1.2 m);
- Angle of internal friction for sediment: 27 degrees;
- Assumed angle for wake vortex shedding: 15 degrees;
- Slender pile regime used to estimate predicted scour depth if diffraction parameter (D/L) less than 0.1; and
- Large pile regime used to estimate predicted scour depth if diffraction parameter (D/L) greater than 0.1.

The predicted scour extent and depth presented are conservative estimates or a “worst case scenario” of the estimated maximum scour depth.

After reviewing trends and predictions on scour depth and distance at the 130 WTG locations, the 130 WTG locations were divided into two scour scenarios to develop a conceptual design for scour protection. A water depth of 40 ft (12.2 m) was selected as the dividing line between each scenario. At the WTG locations, the range of scour extent is predicted with widths of 42 to 45 ft (12.8 to 13.7 m), lengths of 88 to 94 ft (26.8 to 28.7 m), and depths of 13.7 to 14.7 ft (4.2 to 4.5 m) ([Report No. 4.1.1-5](#)). An illustration of this predicted scour extent at the monopiles, without scour protection, is presented in [Figure 5.3.1-1](#).

At the ESP, six 4 ft piles are proposed, in a two by three layout, 75 ft (22.9 m) apart. The same methods used to predict the WTG scour were used for the ESP, with a known water depth of 28 ft (8.5 m). At the ESP location, the scour extent is predicted with a width of 18 ft (5.5 m), a length of 55 ft (16.8 m), and a depth of 9.2 ft (2.8 m) ([Report No. 4.1.1-5](#)). Due to the distance between the piles, the scour footprints are predicted to overlap in the absence of any mitigation measures. An illustration of this predicted scour extent at the ESP, without scour protection, is presented in [Figure 5.3.1-2](#).

The applicant evaluated and has requested the use of two engineered scour mitigation methods, scour mats and rock armor. The specific type of engineered scour mitigation method proposed for each location has not been determined. Final consideration would be based on an assessment of potential environmental impact and scour performance. Long-term field monitoring of two types of scour mats are ongoing at the meteorological tower site. The multi-year pilot study is testing the effectiveness and durability of scour mats of different designs. Results would be incorporated in the final decision regarding which scour mitigation method is most effective and has the least environmental impact, and in the case of scour mats, which type is best for the particular application. More precise qualitative and quantitative evaluations are proposed for the final design process. Each method proposed, including information on the ongoing scour mat pilot study, is discussed below.

The scour mats proposed use synthetic fronds, made of buoyant polypropylene and polyester webbing designed to mimic seafloor vegetation. The fronds reduce particle velocity as suspended sediment passes over them. As the particle velocity decreases, sediment is deposited onto the scour mats. When they are attached to the bottom as a network, these synthetic fronds trap sediments and eventually become buried. The result of this sediment trapping mechanism forms a scour protection system that is of low bottom relief, similar to existing conditions.

The scour mats are placed on the seabed by a crane or davit onboard a support vessel. Final positioning is performed with the assistance of divers. To secure the scour mats to the seafloor, each scour mat section is fitted with pre-attached anchors spaced at regular intervals along the mat. The anchors are certified for 1 ton of anchor hold down capacity, with each providing 0.64 ton of hold down capacity per square meter of the mat. Additional anchors may be attached to the mats by divers. After the mat is placed on the bottom, divers use a hydraulic spigot gun fitted with an anchor drive spigot to drive the anchors into the seabed. As the mats are anchored, there is some possibility that there may be some movement of the scour control mats if the anchoring systems should become loosened.

In October 2003, two seabed scour control mats were installed on the sediment surface around one of the three piles of the SMDS. During installation, the two scour mats were positioned such that their long axes were nearly north/south on both sides of the pile. The southern, near-side corners were placed closer together than the northern, near-side corners. The observed currents were nearly perpendicular to the long axis of the mats. The fronds used in the scour mats were 4.1 ft (1.2 m) long. At the time of scour mat installation, a ratchet strap was placed on the three piles at a distance of 48 inches (1.2 m) above the

present sand bottom for use during future monitoring. No scour mats were installed on the SMDS' north and southeast piles to provide control points without scour control.

In June 2005, an underwater inspection was performed to visually inspect the scour mats around the southwest batter pile and to compare the conditions at the other two unprotected SMDS piles with the protected pile. Approximately 12 inches (0.3 m) of sand accumulated over a 20 month period at the scour mat protected pile. At the unprotected pile, approximately 13 inches (0.33 m) of sand was scoured away from this pile over a 20 month period.

In May 2006, four additional Seabed Scour Control Systems (SSCS) scour mats were installed around the southeast pile. These additional scour mats are of a modified design in web materials, manufacturing processes, and various frond lengths. The existing conditions of the first two scour mats were surveyed. Sediment scour was observed at each of the three piles. Portions of the nylon webbing on the existing mats were exposed above the seabed. The fronds appear to have separated longitudinally into many fronds of smaller width, though they appeared firmly attached to the mat webbing. Measurements were again taken (similar to monitoring in June 2005, described above). The measurements indicate a net accretion of 12 inches (0.3 m) at the southwest pile, and a net scour of 7 inches (0.17 m) at the previously unprotected southeast pile ([Report No. 4.1.1-8](#)).

Rock armor (large hard rock boulders) has also been proposed. A filter layer immobilizes the sand and one or more layers of rocks, capable of withstanding the energy of currents and waves, are used to stabilize the filter layer and protect the seafloor around the piles from erosive forces. The boulders would be large enough to deter removal by current conditions and wave effects and small enough for prevention of removal of stone fill material that is placed beneath them.

The rock armor and filter layer material would be placed on the seabed using clamshell bucket or a chute. By lowering the material into the water and placing the material on the bottom rather than dumping it, more control over the placement of the material can be achieved. Sediment suspended during the installation of the rock armor material is expected to be more than that associated with the use of scour mats. It is anticipated that the dominant sandy seafloor sediment would result in rapid settling of the suspended sediment material, which would limit the extent of the impact of suspended sediments.

This would result in total scour protection area of 2,064,964 ft² (47.41 acres or 191,841 m²) for all 130 wind turbine towers and 17,664 ft² (0.41 acre or 641 m²) for the 6 ESP pilings. Thus, rock armor scour protection would alter approximately 0.3 percent of the site of the proposed action. The rock armor and filter material would be placed at elevations that were similar to pre-installation sea-bed elevations. It is anticipated the rock armor would not appreciably change the local seafloor topography, as this design would promote deposition of a sand/silt matrix in the interstices of the boulder framework with the eventual burial of all the rock armor. Tidal currents may expose portions of the rock armor for short periods of time, until the bi-directional currents lead to establishment of a dynamic equilibrium, allowing the average condition of the scour-protected zone to be buried by sand.

The proposed rock armor designs are based on three predicted scour conditions resulting from wave and current action, water depth, and diameter of the piles. The scenarios considered include ([Report No. 4.1.1-6](#)):

- **Scenario 1A (16.75 ft diameter WTGs; water depths 12 to 15 ft [3.7 to 4.6 m]):**
Rock armor stones with a median weight of 125 lbs would extend 42 ft by 94 ft (12.8 by 28.7 m) from the WTG pile, four ft thick.

- **Scenario 1B (16.75 ft diameter WTG's & the ESP; water depths between 16 to 39 ft [4.8 to 11.8 m]):** Rock armor stones with a median weight of 50 lbs would extend 42 ft by 94 ft (12.8 by 28.7 m) from the WTG pile, three ft thick.
- **Scenario 2 (18 ft diameter WTG's; water depths between 39 and 56 ft [11.8 to 17.1 m]):** Rock armor stones with a median weight of 50 lbs would extend 45 ft by 88 ft (13.7 to 26.8 m) from the WTG pile, three feet thick.

The proposed rock armor design was reviewed against generally accepted methods along with the scour analysis parameters used for the modeled conditions to show that the design parameters in the Rock Armor Report were conservative when compared to observations from the SMDS and the hydrodynamic model predictions, and that the rock sizes would enable the scour protection to remain in place under the expected oceanographic conditions at the site of the proposed action ([Report No. 4.1.1-7](#)).

Scour protection would be installed around each foundation following the installation of the monopile. Some amount of scouring would take place around the pile prior to the scour mats or rock armoring being placed. Filter material, stones sized one-tenth the gradation and weight of the rock armor, would be placed on the bottom with a clam shell bucket to replace any scoured sediment and to help prevent the rock armor from sinking into the underlying material. In locations where monopiles are installed in sand waves and rock armoring is utilized, it is anticipated that the rock armoring would settle with the migration of the sand wave.

The impact to the seabed from sediment scour as a result of the pile foundation installation would be minor with the addition of the proposed scour controls.

Sand Waves

Sediment transport can be impacted by structures in a shallow marine environment as waves and current regimes create vortices that increase particle velocity at the seabed adjacent to a pile. This change in sediment transport at the seabed can result in scour around pilings. A site-specific study was completed to assess the effects of the WTGs on sediment transport and sand waves in Nantucket Sound.

The approach of the study followed those typically used to evaluate the effects of offshore structures. The key parameters in these analyses include the diffraction parameter, which indicates whether a wave would diffract behind a pile; and, the Keulagan-Carpenter (KC) number, which indicates whether flow around the pile would separate and shed vortices in the downstream direction. Since both parameters require wave length, analysis of one month (December, 2003) of wave data (wave height, wave period and water depth) was performed.

Diffraction effects were found to occur for 62 percent of the waves from the time series. However the largest diffraction occurred for waves with the smallest period with low induced bottom velocities. These waves cause insignificant sediment transport regardless of whether they diffract or not and so can be ignored. Larger waves, particularly ocean swells, are not affected by the presence of the piles ([Report No. 4.1.1-4](#)).

The calculation of the KC number, based on the wave data, found no value greater than 1.8, which is below the threshold for flow separation to occur. A potential flow analysis appropriate for this condition shows that the flow around the pile returns to within 89 percent of its undisturbed value within 1 pile diameter from the pile and to within 99 percent of its undisturbed value within 4 pile diameters. Using the same approach for the periodic tidal wave, a very long period shallow water wave, gave a large KC number over 5,000, indicating that vortex shedding would occur. The velocity defect created by this vortex street dissipates rapidly ([Report No. 4.1.1-4](#)).

Comparison to laboratory studies of multiple piles indicates that there is no anticipated wake interaction among the piles since interaction ceases when the piles are spaced greater than five pile diameters from each other and the spacing for this proposed action ranges from 120 to 190 pile diameters. There is no evidence that the piles would impact the migrating sand waves as a group and the impact to these migrating bedforms should be localized and minor, essentially associated with the area of scour protection at each pile. A diffraction effect occurred for waves with smaller periods that reduced sediment transport ability. Larger waves and ocean swells were not affected by the presence of a pile ([Report No. 4.1.1.4](#)).

The impact to the surficial geologic resource from the placement of piles is considered minor and would be reversible following decommissioning.

Potential impacts to the offshore cables from migrating sand waves and bedforms were evaluated. The evaluation considered the site-specific geophysical data collected for the area of the proposed action; existing data from other locations with migrating sand waves, and modeled migration estimates (see Section 5.3.1.3). It was concluded that with modeled bedform migration rates of 3.3 to 9.8 ft (1 to 3 m) per year, the potential for cable exposure on Horseshoe Shoal where migrating sand waves are located is possible within 6 to 18 years if no mitigation measures are undertaken ([Report No. 4.1.1-3](#)).

The results indicate that the seafloor may be impacted locally if the offshore cables, set approximately 6 ft (1.8 m) below the seabed, are exposed ([Report No. 4.1.1-3](#)). If the cable is exposed during sand wave migration, increased flow would occur above and below the cable, resulting in localized sediment scour. The applicant has proposed a periodic diver inspection and monitoring program to assess cable exposure and scour.

Because of the small area affected and the lack of interaction between WTGs, the potential impact to sandwaves and migrating bedforms is considered minor for the life of the proposed action and would be negligible following decommissioning.

Conclusion

Because of the small area affected and the lack of interaction between WTGs, the potential impact to sandwaves and migrating bedforms would be minor for the life of the proposed action and would be negligible following decommissioning. Mitigation being considered at this time includes sediment scour control and post-construction monitoring of sediment scour with periodic diver inspections and a monitoring program to assess cable exposure and scour developed by the design engineer. A more detailed discussion of mitigation is provided in Section 9.0.

5.3.1.2 Noise

Noise impacts generally fall into two categories: temporary impacts resulting from operation of construction equipment, and long-term or permanent impacts resulting from operation of the proposed action. Construction-related noise would result from offshore monopile pile driving and barge and ship engines. Onshore construction noise would be generated by HDD activities at Lewis Bay and installation of the cable system. Operational noise would be associated with the wind turbines themselves plus noise associated with the operation of maintenance vessels.

5.3.1.2.1 Construction/Decommissioning Impacts

Construction

Construction Impacts on Onshore Locations During Installation of Monopiles

The sound impacts during construction are associated with the installation of 130 16 to 18 ft (4.9 to 5.5 m) diameter monopiles (one for each WTG), installation of six smaller 4 ft (1.2 m) diameter piles for the ESP, and vessel traffic for transporting equipment, piles, and workers to the site. The jet plow embedment process for laying offshore cables with a cable barge produces no sound beyond typical vessel traffic in Nantucket Sound. The principal sound from construction would therefore be temporary pile driving of the WTG monopiles. Monopile installation for all of the WTGs is anticipated to require approximately 8 months from start to finish, plus any delays due to weather. It would take 4 to 6 hours to drive each monopile. The driving rate would be in the range of 2 to 36 impacts per minute. Measured sound data from installation of similar sized piles at the Utgrunden Project were used in the acoustic modeling. Noise levels of pile driving at the Utgrunden Project revealed L_{max} sound levels of 177.8 dB at 1,640 ft (500 m) (see Section 2.3.1 in [Report No. 4.1.2-1](#)). The sound levels from monopile driving would depend on the distance from the receiver to the particular point in the proposed action array and whether the receiver is upwind or downwind of the location where the monopile is being driven. (In the former case, the wind shadow effect substantially reduces sound levels).

Calculated pile driving sound levels for the onshore noise modeling locations are presented in [Table 5.3.1-1](#), along with the range of measured existing L_{eq} sound levels. The data in this table indicate that for the vast majority of locations, pile driving noise would be below the minimum measured ambient levels, even with onshore winds, which would result in the highest pile driving noise. The only two locations where pile driving noise could at times be equal to or exceed minimum measured ambient conditions are at Point Gammon and Cape Poge. The maximum calculated pile driving sound level at any location is 41 dBA whereas the lowest ambient level measured is 35 dBA.

Any audible pile driving would be limited to brief periods and at only some locations. As such, minor noise impacts are anticipated at onshore locations due to pile driving during construction.

Post Lease G&G Investigation

The post lease G&G investigation would involve vibracores and drilling of bore holes to acquire subsurface geological information on the sea bottom. The vibracores would be accomplished via a small gasoline motor and the drilling of cores would be accomplished via a truck mounted drill rig on a barge. Both of these activities would be very short term, and these devices generate sound levels that are much lower than sound levels associated with pile driving. Sound levels from a small gasoline motor would be comparable to that associated with a small motorized boat. Sound levels from a truck mounted drill rig would be comparable to those on a small ship or large boat. These types of sounds occur regularly in the area. Thus noise impacts are expected to be negligible with respect to G&G activity.

Construction Impacts on Onshore Locations During Horizontal Directional Drilling (HDD) and Onshore Cable Laying

Elevated noise levels would occur in association with the need to conduct HDD for the borehole containing the offshore transmission cable system from Lewis Bay to the transition vault on nearby land and noise impacts associated with overland laying of cable from the transition vault to the Barnstable Switching Station. The HDD involves the use of a drilling rig, mud pump and crane, powered by diesel engines. Onshore construction activities would be temporary, lasting 4 to 6 weeks, and would be audible to persons near the cable corridor. Sound levels would be similar to roadway construction equipment.

The exact temporary sound levels experienced by residents for the HDD and cable laying would depend on their distance from the construction activity. For example, a person standing 50 ft (15.2 m) from the equipment (HDD, excavator, backhoe) would hear sound levels (L_{eq}) in the range of 73 to 79 dBA, and at 200 ft (61 m) they would hear 61 to 67 dBA. Houses along New Hampshire Avenue where this construction would occur are generally 50 or more ft (15.2 or more meters) from the trench that would be dug. The nearest houses to the HDD area are Nos. 32 and 49 New Hampshire Avenue. The closest edge of the house at No. 32 New Hampshire Avenue is 16 ft (4.9 m) from the HDD pit and the closest edge of the house at No. 49 New Hampshire Avenue is 32 ft from the edge of the HDD pit. Noise barrier walls would be constructed at the edge of the HDD pit to shield these residences. The calculated L_{eq} sound level at the nearest edge of the house, assuming a second-floor window exists at that point, would be 68 dBA at No. 32 and 61 dBA at No. 49 New Hampshire Avenue.

To further facilitate the HDD operation, a temporary cofferdam would be constructed at the end of the boreholes. The cofferdam would be approximately 65 ft (19.8 m) wide and 45 ft (13.7 m) long and would be open at the seaward end to allow for manipulation of the HDD conduits. The cofferdam would be constructed using steel sheet piles driven from a barge-mounted crane. The noise effects would be temporary and the calculated maximum sound levels are 79 dBA at the two closest residences to the cofferdam, Nos. 32 and 49 New Hampshire Avenue. The installation of sheet steel for the cofferdam would utilize a low-noise vibratory method and would not use impact pile driving. Therefore underwater sound effects from the cofferdam installation would also be minimal and temporary.

Construction Impacts on Offshore Locations

Predicted maximum (L_{max}) pile driving noise levels at the Buoy G5 and Buoy G20 locations are presented in [Table 5.3.1-2](#). The lowest sound levels are associated with pile driving at the WTG location farthest away from the receiver, while highest sound levels are associated with pile driving at the WTG location closest to the receiver. The calculated construction levels are 31 dBA to 76 dBA when the receiver is downwind of the pile driving activity and 7 dBA to 49 dBA when the receiver is upwind of the activity. Existing average sound levels (L_{eq}) at sea in the vicinity of the proposed action are approximately 46 to 51 dBA. These existing levels represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind in light wind conditions. The range of calculated levels, which depend on location and wind conditions, is quite large. There would therefore be times when pile driving noise exceeds ambient conditions, and pile driving would be audible to boaters near the pile installation site. Other times, pile driving noise levels would be low, and likely inaudible. It should be noted that under high wind conditions or for boaters in motorized vessels, ambient levels would be much higher. Any construction noise impacts would be minor and temporary in nature.

Underwater Construction Impacts

The underwater sound effects of construction would be temporary and are associated with the installation of 130 16 to 18 ft (4.9 to 5.5 m) diameter monopiles (one for each WTG), installation of six smaller 4 ft (1.2 m) diameter piles for the ESP, vessel traffic for transporting equipment, piles, and workers to the site and vessel traffic associated with installation of offshore cables. According to divers experienced in jet plow installations, the jet plow itself produces no audible noises other than the sound of water exiting the nozzles, which is only audible when immediately adjacent to the nozzles. The principal sound from construction would therefore be temporary pile driving of the WTG monopiles using a drop hammer similar to an IHC S-600. Only one monopile would be driven at a time. The driving rate would be in the range of 2 to 36 impacts per minute. It is anticipated that the process of completing one string of WTGs (10 WTGs with associated inner-array cables and scour mats) would take up to approximately 1 month and installation of all 130 WTGs would occur over two construction seasons. Sound data from installation of similar sized piles at the Utgrunden Project were used in the acoustic modeling (see Section 2.3.1 in [Report No. 4.1.2-1](#)). Sound levels would depend on the distance from the underwater receiver to

the monopile being driven. For a detailed analysis on underwater construction noise and the effects to protected marine species and fish, please refer to Section 5.3.2.6 and Section 5.3.2.7, respectively.

Decommissioning

The decommissioning proposed action would not require pile driving activities, which cause the highest sound levels of any activities associated with the proposed action. Pile driving only takes place during the construction phase of the proposed action. Decommissioning would involve the use of similar vessels, cranes, jet plow, cutting and welding equipment and other tools that were involved in construction, but would not include any pile driving, blasting or activities which approach the noise level of pile driving. During decommissioning, the monopiles would be cut off at 15 ft (4.6 m) below the seabottom. As such, the noise impacts from decommissioning activities would appear to be less than the worst case impacts already presented for construction and would be minor.

Conclusion

In summary, the analysis revealed that noise impacts are expected to be minor as noise levels would remain below injury thresholds of all species evaluated for both construction and decommissioning. Further, mitigation measures being considered at this time include the use of underwater sound monitoring to confirm pile driving noise levels, the use of an NOAA Fisheries approved observer, and soft start of pile driving, which would be assessed further via consultation with the Federal agencies. A more detailed discussion of mitigation is provided in Section 9.0.

5.3.1.2.2 Operational Impacts

Above Water Operational and Maintenance Noise Impacts

Operational Impacts on Onshore Locations

A detailed noise modeling analysis of both operational noise was conducted. The modeling results were evaluated in conjunction with measured ambient conditions. Modeling receptors were chosen at the same three onshore locations as where ambient measurements were conducted, and at eight additional locations along the shore. The location of the modeling receptors are: Bass River Beach, Yarmouth; Point Gammon, Yarmouth; Lewis Bay, Yarmouth; Hyannisport, Barnstable; Hyannis Point, Barnstable; Wianno Beach, Barnstable; Oregon Beach, Barnstable; New Seabury, Mashpee; Oak Bluffs, Martha's Vineyard; Edgartown, Martha's Vineyard; and Cape Poge, Martha's Vineyard. These locations are listed in [Table 5.3.1-3](#). Ambient data for the eight additional locations were assigned from one of the three representative monitoring locations, where similar conditions were found to exist.

Industry standard methods and assumptions were utilized for the operational noise modeling analysis. This included: (1) geometric wave spreading (decrease of sound with distance); (2) absorption of sound by the atmosphere; and (3) excess anomalous attenuation (decrease of sound due to atmospheric turbulence, temperature gradients and ground characteristics). The sea surface was assumed to be a reflective surface and downwind conditions were included, essentially negating excess anomalous attenuation and resulting in a more conservative analysis. The assumptions in the construction noise analysis differed only in that calm to moderate winds were used to simulate conditions considered to be ideal for installation of the WTG piles.

Refraction of sound waves (re-direction due to changes in atmospheric conditions) can occur under certain meteorological conditions, and can cause sounds that would not normally be heard to be heard at large distances. Refraction of sound requires the presence of an atmospheric inversion (colder temperatures at the surface than aloft), which can occur under calm wind conditions. The presence of an

inversion causes the sound waves from a source to bend back toward the ground at locations further away from the source. During calm wind conditions wind turbine operation would not occur. As such, the effect of sound refraction would not be a factor during operation of the proposed action. Regardless of the fact that this condition can not occur during proposed action operation, the analysis nonetheless considered potential refraction of sound by assuming a temperature inversion would exist during operation.

Research has shown that under high wind conditions (20 mph and higher), changes in wind with height can slow down sound reduction with distance for low frequency sounds below 20 Hz. This slower wave spreading (cylindrical spreading), was included in the analyses. Higher frequency sounds are not affected by this condition. Lastly, only onshore winds were considered, since these would produce the highest sound levels (sound levels are reduced during upwind conditions).

Operational noise modeling was further divided into two parts; one for the WTG cut-in speed (8 mph at hub height) and one for WTG design speed (30 mph at hub height). Cut-in modeling represents conditions when ambient sound levels would be lowest, due to lighter winds, and design speed modeling represents maximum sound output from the WTGs. Detailed sound level data for the WTGs were obtained from recent tests conducted for a GE 3.6 MW unit operating near Barrax, Spain.

The noise modeling results for cut-in wind speed conditions at onshore locations are presented in [Table 5.3.1-4](#). Calculated levels are shown to be low, ranging from only 11.6 to 17.8 dBA. The calculated levels are also compared to the range of measured L_{eq} sound levels (41 to 63 dBA), and shown to be well below these levels. The frequency-specific modeling results (ESS, 2007 and Figures 16 through 37 in [Report No. 5.1.5-1](#)) reveal that low-frequency sound from the proposed action is below the threshold of human hearing and would be largely inaudible regardless of the baseline sound levels. For example, at Lewis Bay, Yarmouth, the calculated cut-in sound levels for the low frequency of 16 Hz is only 50 dB, while the hearing threshold (the level of sound needed at this frequency in order for it to be heard) is 92 dB. At 250 Hz, the calculated cut-in sound level is only 6 dB, while the hearing threshold is 14 dB. Calculated project sound by frequency falls to 0 dB beyond 250 Hz, and would also not be audible. A similar example is found for Edgartown, Martha's Vineyard, where the calculated cut-in sound level at 16 Hz is 49 dB, and at 250 Hz is only 2 dB. Accordingly, no noise impacts are anticipated at any onshore locations due to proposed action operation for either the cut-in or design wind speed conditions.

Calculated levels for the design wind speed condition (the maximum sound output from the WTGs) are also shown to be very low, and are presented in [Table 5.3.1-5](#). Proposed action sound levels are shown to range from 19.2 to 25.9 dBA at the onshore locations. A comparison of the calculated levels to measured existing ambient conditions (54 to 71 dBA) reveals that proposed action levels at the design wind speed would be well below ambient levels. Frequency specific modeling results indicate that low frequency sounds would be below the threshold of human hearing.

Considering the very low calculated proposed action noise levels, wind conditions, and the ambient conditions that have been measured, it is anticipated that the proposed action would be largely inaudible at onshore locations. Accordingly, negligible noise impacts are anticipated with proposed action operation under either the cut-in or design wind speed conditions.

Operational Impacts on Offshore Locations

The two noise modeling locations for the offshore analysis are the same locations as where ambient measurements were conducted (Buoys G5 and G20). Similar to the modeling for onshore locations, the offshore analysis considered both cut-in and design wind speeds. Calculated noise levels for the cut-in

and design conditions are presented in [Table 5.3.1-6](#) and compared to the measured ambient levels. Calculated levels (32 to 34 dBA) for the cut-in condition are shown to be well below measured ambient levels (46 to 51 dBA) at the Buoy locations. Calculated levels (42 to 45 dBA) for the design condition are shown to be well below measured ambient levels (60 to 65 dBA) at the Buoy locations. It is noted that the ambient levels presented are for non-motorized vessels, and ambient levels would be higher for those in motorized vessels. Accordingly, negligible noise impacts are anticipated at offshore locations.

Maintenance Impacts

Activities associated with maintenance, including crew boats, barges and small equipment (tools, utility generators, etc.) are similar to typical vessel usage of Nantucket Sound, and are not expected to measurably increase the ambient background noise levels. As such, the noise impacts from maintenance activities are expected to be minor.

Operational Noise on Underwater Locations

Calculated sound levels from operation of a WTG would only be 1.9 dB above baseline sound levels at the close in distance of 65.6 ft (20 m) from a monopile. Proposed action operation is anticipated to be inaudible to most marine life at this close-in distance. Accordingly, negligible impacts are anticipated to marine life due to proposed action operation.

Conclusion

Operational noise impacts are expected to be negligible for onshore locations, offshore locations, and underwater impacts because of the limited noise associated with the turbine operations and maintenance activities as described above.¹

5.3.1.3 Oceanographic Processes

Anticipated impacts on the physical oceanographic environment from installation of the WTGs, the inner-array cables, and the offshore transmission cable system would be minimal and localized. The nature and extent of these impacts and proposed mitigation measures are summarized below.

Minimal impacts in the form of sediment deposition and temporary increases in water column sediment concentrations would occur within the Massachusetts Coastal Zone as a result of jet plow embedment of the 115 kV offshore transmission cable system and the backfilling of the HDD cofferdam. The post lease G&G field investigations (refer to Section 2.7) would result in only temporary and localized turbidity as the result of drilling and vibracore activities. As described below, sediment deposition amounts are expected to be small. Increases in water column sediment concentrations are expected to be short lived and significantly lower than those that result from storm events or routine commercial trawling activities.

5.3.1.3.1 Construction/Decommissioning Impacts

Currents

There are no anticipated impacts to currents during construction/decommissioning of the WTG structures on Horseshoe Shoal other than the small and localized disruption of flow that occurs around the

¹ Project noise levels were also evaluated against the MassDEP noise policy for informational purposes (see section 3.0) for both onshore and offshore areas. Project noise levels were calculated to be well below the minimum measured ambient conditions at all locations. No increases in ambient noise levels would occur at onshore locations and minimal (e.g., 2 dBA or less) increases would occur at offshore locations. The Project would not produce pure tone noises. As such, the Project would be in compliance with the MassDEP noise policy, if it were applicable.

hull of moored vessels. Therefore, impacts on currents due to construction/decommissioning activity would be negligible.

Waves

There are no anticipated impacts expected on waves due to construction/decommissioning activities other than the small and localized reflection of waves that occurs around the hull of moored vessels. Therefore, the impacts on waves would be negligible during construction/decommissioning.

Salinity

There are no anticipated impacts from construction/decommissioning of the 130 WTGs, the ESP, or any of the cables on salinity. Construction/decommissioning activities would have negligible impacts on salinity.

Temperature

There are no anticipated impacts on water temperatures within Nantucket Sound or Lewis Bay from installation of the WTGs, the ESP or any of the cables. Therefore, impacts on temperature would be negligible during construction/decommissioning activities.

Sediment Transport

SSFATE modeling techniques were used to simulate water column sediment concentration and sediment deposition thickness and extent resulting from jet plow embedment of the offshore cable systems. The SSFATE model simulations were completed along a representative straight-line segment 4,200 ft (1,280 m) in length, presuming sand-sized sediment based on information from Vibracore VC01-L2, near the inlet to Lewis Bay. The results presented from the simulation can be considered typical and generally representative of the subsurface sediment types expected to be encountered along the offshore cable system routes, as those are also primarily sand-sized sediments. The modeling and results are considered to be representative of sediment conditions throughout the site of the proposed action.

The results of the model simulation indicate that sediment deposition ranges from zero to approximately 0.9 inches (23 mm) adjacent to the jet plow trench in sandy sediments. The majority of the sediment deposition is expected to remain within or immediately adjacent to the cable trench. The model simulation indicates that sediment deposition quickly tapers off to below 0.2 inches (5 mm) at approximately 100 ft (30.5 m) on either side of the cable trench in sandy sediments. These deposited sediments are anticipated to dissipate over time through natural tidal and storm-related sediment processes.

Special concern has been raised during the regulatory review process about the potential effects of the jetting operation on an eelgrass bed identified just west of Egg Island in Lewis Bay. In this area, the bottom sediments are relatively coarse. As a result, the sediments suspended by the jet plow are predicted to fall along the route with bottom deposition predicted to be in the range of 0.04 to 0.1 inches (1.0 to 3.0 mm) at the western edge of the eelgrass bed. The majority of the eelgrass bed is predicted to experience little or no deposition as a result of the jet plow embedment operations ([Report No. 4.1.1-2](#)).

In general, the deposition of sediments suspended by jet plow embedment operations was estimated to be minimal when compared to the active bed load sediment transport known to exist in Nantucket Sound (between 45 and 71 mg/L under natural tidal conditions). The modeling results show that the sediments suspended by the jet plow would generally fall along the route. In areas where the route is in a north-south orientation, which is perpendicular to the predominant east-west flow direction, the effects of the tides can be seen transporting the sediment slightly west or east of the route in an oscillating fashion. The

actual location of these oscillations (but not the shape) would change since they are determined by the relationship between the time of the tide and the jetting start time. Generally, the sediment deposition thickness is predicted to be in the range of 0.04 to 0.2 inches (1.0 to 5.0 mm), depending on location along the route and horizontal distance from the trench. In some isolated locations, deposition is predicted to be in the range of up to 0.4 inches (10 mm), with a few locations up to 0.8 inches (20 mm) along the 115 kV offshore transmission cable system and between 1.0 to 1.8 inches (35 to 45 mm) peak along isolated locations of each 33 kV inner-array cable routes. These higher deposition areas are predicted to occur when the tidal currents are in slack water conditions, which allow the deposition to be concentrated in small areas since current velocities do not disperse the sediment material. Relatively narrow bands between 0.02 and 0.04 inches (0.5 and 1 mm) thick are deposited on the fringes of the patterns. The model predicts the following peak deposition thicknesses in isolated locations along the four representative 33 kV inner-array cable routes modeled.

- **Southwest of the ESP:** 1.4 inches (35 mm)
- **Southeast of the ESP:** 1.0 inches (25 mm)
- **East of the ESP:** 1.1 inches (27 mm)
- **Northwest of the ESP:** 1.8 inches (45 mm)

Any effects from construction/decommissioning on sediment transport would be temporary and localized, and therefore overall, construction/decommissioning impacts on sediment transport in Nantucket Sound would be minor.

Water Depth/Bathymetry

Changes in seabed elevation around each WTG would be limited to localized scour around each WTG. The maximum estimated scour distance from a WTG is approximately 94 ft (28.7 m) (4.6 percent of the minimum distance between WTGs), with an associated estimated scour depth of approximately 14.7 ft (4.5 m). For the ESP, the predicted extent of scour was estimated to be 55 ft (16.8 m) with a predicted depth of 9.2 ft (2.8 m) for each of the six piles supporting the ESP. A slight depression, estimated to be between 0.5 and 2 ft (0.15 and 0.61 m) deep, is anticipated to result from installation of the inner-array cables and the offshore transmission cable system. This slight depression is expected to fill in over time through natural sediment resuspension, deposition, and consolidation. Although there is the potential for scour around each WTG and the ESP piles, the applicant has proposed scour mitigation measures and monitoring as described below, that would prevent substantial scour from occurring.

The recovery rate for jetting scars along the offshore cable routes on Horseshoe Shoal was estimated at between 0.2 and 38 days. It also determined that the presence of the jetting scar would not increase localized scour. In fact, it was estimated that the presence of the jetting scar would result in slightly decreased water flow over the scar, resulting in a decreased potential for sediment transport. These results are comparable to those for the two electric cables that have been installed by jet plowing between Cape Cod and Nantucket Island.

At the landfall in Lewis Bay, construction of the temporary cofferdam at the exit hole of the HDD to be used for cable installation under the Cape Cod Shoreline would include the dredging of sediments to a elevation of approximately -10 ft (-3 m) MLLW. After jet plow embedment of the offshore cable systems are completed, the dredged area would be restored with the original dredge material. If necessary, the dredged backfill material would be supplemented with imported clean sandy backfill material to restore preconstruction contours. Once the dredged area is restored, the sheet pile cofferdam would be removed from Lewis Bay.

The impacts to water depth/bathymetry from construction/decommissioning activities would be minor as the trenches created by the jet plow are anticipated to fill naturally over a short period of time, while suspended sediments from the jet plow are predicted to be a short-term localized event. At the landfall site the temporary cofferdam would mitigate any impacts to the surrounding area.

During decommissioning, the foundation components (transition piece, monopile and scour mats, and rock armor) would be removed. Sediments inside the monopile would be suctioned out to a depth of approximately 15 ft (5 m) below the existing seabottom in order to allow access for the cutting of the pile in preparation for its removal. The sediments would be pumped from the monopile and stored on a barge. Prior to the cutting and removal of the monopile, any adjacent scour protection (scour mats and rock armor) would be removed. After the removal of the monopile to a barge, the sediments would be returned to the excavated pile site using the vacuum pump and diver assisted hoses in order to minimize sediment disturbance and turbidity. The offshore cables would be disconnected and pulled out of the J-tubes on both the WTG and the ESP. The cables would then be cut below the seafloor. The cables would then be reeled in after being water jetted free of bottom sediments, creating a shallow linear depression that would only last a short while. This would result in a negligible impact.

Conclusion on Construction/Decommissioning Impacts

Overall, construction/decommissioning impacts on oceanographic processes would vary from negligible to minor, as they would result in only temporary and localized effects.

5.3.1.3.2 Operational Impact

Currents

The calculation of the Keulagan-Carpenter (KC) number based on the wave data found no value greater than 1.8, which is below the threshold for flow separation to occur. A potential flow analysis appropriate for this condition shows that the flow around the pile returns to within 89 percent of its undisturbed value within one pile diameter from the pile and to within 99 percent of its undisturbed value within four pile diameters.

Comparison to laboratory studies of multiple piles indicates that there is no anticipated wake interaction among the piles since interaction ceases when the piles are spaced greater than five pile diameters from each other and the spacing for this proposed action ranges from 120 to 190 pile diameters. Using a single pile zone of influence of five pile diameters long (if not significantly shorter [87 ft; 27 m]) and two diameters wide (35 ft; 11 m) or 3,014 ft² (280 m²), the total area for all 130 piles is 9 acres (0.0364 km²). This area can be compared to the total area of the WTG pile array on Horseshoe Shoal of 15,800 acres (64 km²) showing that only 0.057 percent of the area is potentially affected. In reality, only a very small portion of this area is really affected since all these impacts decrease quickly away from the pile. The large spacing between the WTGs and the small WTG pile diameter would prevent the effects of each WTG pile on current conditions from affecting adjacent piles. Therefore, the WTGs would not act as a pile group. Operational impacts on currents would be minor.

Waves

Due to the proposed spacing of the WTGs of 0.39 miles (0.63 km) from northwest to southeast, and 0.63 miles (1 km) from east to west, the proposed action would not be expected to have significant large-scale impacts on wave conditions. At the smaller scale, a pile's influence on wave propagation in the immediate vicinity of each WTG would depend on the ratio between the diameter of the pile and the wavelength of the incident wave. Piles with diameters less than one-tenth of the incident wavelength do not have an impact on waves, since the waves pass the pile without reflection or diffraction. Piles with

diameters greater than one-tenth of the incident wavelength do have an impact on incident waves in that the waves are reflected by the pile and diffracted around the pile. So, as wavelength increases, the effect the pile has on wave propagation decreases (USACE, 2003).

The proposed diameter of monopiles that would be used for WTGs is either 16.75 or 18 ft (5.1 or 5.5 m), depending on the water depth at the WTG location. Each of these pile diameters is greater than one-tenth of the average locally-generated ocean wavelengths. Thus, only small-scale reflection and diffraction of locally-generated and ocean waves would be expected to occur in the immediate vicinity of each WTG location.

A study on effects of the WTG pile array in Nantucket Sound determined that diffraction effects were found to occur for 62 percent of the waves from the time series. However, the longest diffraction occurred for waves with the smallest period with low induced bottom velocities. These waves cause insignificant sediment transport regardless of whether they diffract or not and so can be ignored. Larger waves, particularly ocean swells, are not affected by the presence of the piles.

Based on the WTG pile diameter and wave characteristics in the area, the piles are essentially invisible to the waves. Therefore, the presence of the WTGs would not affect wave conditions in the area and therefore operation impacts on waves would be negligible.

Salinity

The proposed action is anticipated to have no impacts to salinity in Nantucket Sound because there would be no intake or discharge of seawater associated with the operation of the proposed action, no new sources of freshwater due to the proposed action, nor any other mechanism by which salinity would be altered. Therefore, operational impacts on salinity in Nantucket Sound would be negligible.

Temperature

The offshore cable systems would generate a limited amount of heat immediately around the cables; however, the proposed action is anticipated to have no measurable impacts to water temperature in Nantucket Sound because the cables would be buried a minimum of 6 ft (1.8 m) below present bottom. This absorption of the generated heat into the sediments is essential for proper operation of the cables, and the temperature change at the sediment surface would be no greater than 0.19°F while the increase in water temperature immediately above the cables would be approximately 0.000006°F. There would be negligible operational impacts on water temperature within Nantucket Sound during operation.

Sediment Transport

Localized effects to sediment transport patterns may occur immediately around each WTG foundation base. However, it is expected that a localized sediment transport equilibrium condition would be reached shortly after construction of the proposed action given the cyclical nature of both the tidal regime and scour. Laboratory studies have shown that interaction among piles ceases when piles are spaced greater than five pile diameters from each other. The WTG array on the proposed site has spacing from 120 to 190 pile diameters. Although local sediment transport and scour would occur around individual piles, no cumulative or interactive effects of the pile array on currents or waves would occur and therefore no effects on large scale sediment transport would occur. The greatest diffraction (bending) of waves occurred for the smallest period waves which cause insignificant bottom velocities and cannot affect sediment transport.

Sand waves on Horseshoe Shoal have amplitudes of up to 12 ft (3.7 m) and wavelengths of up to 200 ft (60 m) ([Report No. 4.1.1-3](#)). More than 26 miles (42 km) of the total proposed 33 kV inner-array cable

route occurs in areas of active sand wave migration on Horseshoe Shoal. Assuming bedform migration rates of 3.3 to 9.8 ft/year (1 to 3 m/yr) and cable burial depths of 6 ft (1.8 m), it is possible that cable exposure could occur within 6 to 18 years after the burial if no mitigation measures are employed. Mitigation measures for offshore cable burial are described in Section 9.0.

There would be minor impacts on sediment transport due to operation of the proposed action, however, all impacts would be localized.

Water Depth/Bathymetry

A June 2005 underwater inspection was performed to visually inspect the scour mats around the southwest batter pile to allow comparison with the conditions at the other two unprotected SMDS piles. Results are discussed in Section 4.1.3.1.6. The divers performing the inspection observed that approximately 12 inches (0.3 m) of sand had accumulated over a 20 month period as a result of the presence of the scour mats. At the southeast pile, the divers' measurements revealed that approximately 13 inches (0.33 m) of sand has been scoured away from this pile over a 20 month period. Similar measurements were not obtained from the north pile. Based on these observations, the presence of the scour mats resulted in the accumulation of sand around an installed pile and therefore appears to be effective at preventing scour around installed piles as long as the scour mats remain intact and in place.

In keeping with the purpose of gathering additional data pertinent to the proposed action, four additional SSCS scour mats were installed around the southeast pile in May 2006 to test the efficacy of modifications to the web materials, manufacturing processes, and various frond lengths ([Report No. 4.1.1-8](#)). Measurements were again taken (similar to monitoring in June 2005, described above). The measurements indicate a net accretion of 12 inches (0.3 m) at the southwest pile, and a net scour of 7 inches (0.18 m) at the previously unprotected southeast pile, indicating that the existing mats are helping to prevent scour.

Based on the predicted scour conditions, three scenarios were developed to evaluate rock armor for scour protection around the WTGs, which are discussed in Section 4.1.3.1.6. The scenarios were developed based on the findings from the *Revised Scour Report* ([Report No. 4.1.1-5](#)), ranges of water depth, and the diameter of the WTG.

- **Scenario 1A** was developed to evaluate rock armor around the 16.75 ft (5.1 m) diameter of the WTGs located in water depths between 12 and 15 ft (3.7 and 4.6 m). Under Scenario 1A, rock armor would extend to a distance from the WTG pile of 94 ft (28.7 m) at the longest and 42 ft (12.8 m) at the narrowest parts of the ellipse. The rock armor stones would have a median weight of 125 lbs and the armor layer would be 4 ft (1.2 m) thick.
- **Scenario 1B** was developed to evaluate the rock armor around the 16.75 ft (5.1 m) diameter WTGs located in water depths between 16 and 39 ft (4.9 and 11.9 m). Under Scenario 1B, rock armor would extend a distance from the WTG pile of 94 ft (28.7 m) at the longest and 42 ft (12.8 m) at the narrowest parts of the ellipse. The rock armor stones would have a median weight of 50 lbs and the armor layer would be 3 ft (0.9 m) thick. The Scenario 1B conceptual design was also used for evaluating the rock armor requirements for the ESP.
- **Scenario 2** was developed to evaluate the rock armor around the 18 ft (5.5 m) diameter WTGs located in water depths between 39 and 56 ft (11.9 and 17.1 m). Under Scenario 2, rock armor would extend a distance from the WTG pile of 88 ft (26.8 m) at the longest and 45 ft (13.7 m) at the narrowest parts of the ellipse. The

rock armor stones would have a median weight of 50 lbs and the armor layer would be 3 ft (0.9 m) thick.

Under all the scenarios, the remaining predicted scour depth beneath the rock armor would be filled with a filter material to minimize the potential for the larger armor stone material to settle into the sediment below.

The rock armor and filter material would be placed so that the final elevations approximate pre-installation bottom contours to the extent practicable such that mounds of material would not be created. The estimated impact to the seabed from the presence of the rock armor for each WTG was multiplied by the number of WTGs in each scenario. The total estimated impact to the seabed from the rock armor for all the 130 WTGs and the ESP is approximately 47.8 acres. Operational impacts on water depth/bathymetry would be minor as final elevations associated with scour protection would approximate pre-installation bottom contours.

Conclusion on Operational Impacts

Overall, operational impacts on oceanographic processes would vary from negligible to minor and would result in only temporary and localized effects.

5.3.1.4 Impacts on Climate and Meteorology

5.3.1.4.1 Construction/Decommissioning Impacts

The post lease geological and geophysical sampling activities (see Section 2.0) would have negligible impacts on the climate and meteorology, while the construction and decommissioning of the proposed action would have minor impacts on climate and meteorology. Greenhouse Gas (GHG) (e.g., CO₂) emissions would result from use of geological and geophysical sampling (e.g., drilling) and construction equipment and the vessels used to transport the equipment. Decommissioning work would also involve the use of fossil fuel-fired equipment, as well as vessels to transport the equipment; and thus, the emissions of GHGs. The post lease geological and geophysical sampling activities and construction emissions would be temporary (approximately two years for construction and less for decommissioning) prior to the operation of the proposed action, while the decommissioning activities would also be temporary (approximately two years) after the shutdown of the proposed action.

Conclusion on Construction Impacts

Based on the limited amount of CO₂ emissions that would result from the G&G investigations and construction and decommissioning work, climate and metrological impacts would be minor.

5.3.1.4.2 Operational Impacts

The turning of the WTG rotors, which react to the wind rather than create or modify it, would not affect the wind speed and/or wind direction in the waters of Nantucket Sound. The WTGs operate due to the force of the passing wind on the blades. After passing through the area of the proposed action there is some additional turbulence in the wind stream as a result of the wind's passage through the WTGs. At a distance of several rotor diameters beyond the proposed action, site winds return to laminar flow similar to that prior to encountering the site of the proposed action. Conditions such as the formation or dissipation of fog would not be affected by the WTGs operation because fog is formed during specific psychrometric (atmospheric temperature and moisture) conditions.

As discussed in Section 4.1.4.5, nearby onshore seasonal average mixing heights (4,662 ft) are substantially above the top of the rotor swept zone (440 ft). It is unlikely that the WTGs would entrain air above the mixing height to the layer below the mixing height.

During the operation of the proposed action, the only anticipated emissions of GHGs would be from the vessels used to transport the maintenance workers and any equipment necessary for possible offshore cable repair activities (see Section 2.4). These emissions would be during the life of the proposed action and the vessels and equipment would undergo regular maintenance, which would assist in minimizing the amount of GHG emissions.

Benefit Analysis for Climate

Operation of the proposed action would result in the potential to provide benefits in terms of lowering emissions of greenhouse gases and ozone precursors attributed to power production in the New England area. Emissions of CO₂ from fossil fuel combustion in New England have increased by 10 percent over the period between 1990 and 2004 (based on data from http://www.epa.gov/climatechange/emissions/state_energyco2inv.html). The total CO₂ emissions from fossil fuel combustion in 2004 were 190.8 million tons. Electric power generation contributed 24 percent to the total. The largest contributor was transportation with 40 percent of the total. The annual rate of CO₂ emissions from fossil fuel combustion in Massachusetts have increased by 4 percent over the period between 1990 and 2004.

The total generating capacity in the New England power system in the year 2004 was 30,940 MW (ISO New England, 2005). Of this total, southeastern Massachusetts has a capacity of 3,362 MW, or about 10 percent of the total New England capacity. The ISO New England Inc. (ISO-NE) predicts that the net energy need for New England will increase from 134,085 gigawatt hours (GWh) in 2005 to 152,505 GWh in 2014, a rate of about 1.4 percent per year. The peak summer and winter loads are expected to increase at a rate of 1.5 percent per year (ISO-NE, 2005). The annual growth rate in summer and winter peak loads for southeastern Massachusetts is projected to be 1.7 and 1.5 percent, respectively.

The proposed action would generate 1,600 GWh of power annually. The ISO-NE has calculated marginal emission rates for CO₂ (ISO-NE, 2004). The marginal emission rates provide an estimate of the additional emissions that would result from increased power consumption during periods of higher energy demands. For CO₂ the annual average marginal emission rate is 1,102 lb/MWh. Thus if the amount of energy produced by the proposed action would have to be produced by fossil-fuel powered plants instead, it would result in about 0.88 million tons of CO₂ emitted per year. The projected increase in energy needs in New England between 2005 and 2014 would result in an increase of about 84 tons per year of CO₂ if the power were to be produced by fossil-fuel power plants. The potential reduction in the growth of CO₂ emissions due to operation of proposed action would be about 1 percent of the total projected increase. Thus the proposed action would have the potential to very slightly reduce the growth in CO₂ emissions in the New England area.

Conclusion on Operational Impacts

The operation of the wind turbines would have negligible impacts on climate and meteorology; however, the maintenance activities associated with the proposed action, and any potential cable repair activities, would have a minor impact due to GHG emissions from the vessels transporting the maintenance workers and equipment necessary for cable repairs. Operation of the proposed action would potentially have some beneficial effects in terms of greenhouse gas emissions from power production in the region as discussed above because it would somewhat reduce the reliance on the use of fossil fuels. These benefits would outweigh the very small emissions resulting from operation of the proposed action, so the net impacts would be positive.

5.3.1.5 Impacts on Air Quality

Introduction

This section discusses applicable regulatory requirements and potential air quality impacts associated with the proposed action. It describes the proposed action compliance with the CAA during post lease geological and geophysical sampling activities, construction/decommissioning and operation. The information contained in this section was obtained from review of existing data available for the area of the proposed action.

Regulatory Analysis

The 40 CFR Part 55 – OCS Air Regulations, was promulgated by USEPA in 1992 in order to apply Section 328(a)(1) of the CAA to OCS sources of air pollution located outside of the Western Gulf of Mexico. At the time of promulgation, the regulations were intended to apply to oil and gas development, production, and extraction facilities. The regulations did not contemplate projects involving alternative energy resources or non-extractive sources of energy. However, some activities associated with the proposed action are considered an OCS source, as defined in the regulations. Thus these activities are subject to the same requirements as those applicable to the nearest onshore area, the “Corresponding Onshore Area,” and USEPA Region One would conduct a consistency review and incorporate the relevant state rules (as described at 40 CFR Parts 55.12, 55.14, and 55.15).

The EPAct amended the OCS Lands Act of 1953 (OCSLA) (43 U.S.C. 1331 et seq.) to grant authority to the DOI to manage alternative energy projects on the OCS. As a result of the EPAct, the proposed action’s construction activities became subject to Section 328 of the CAA (42 U.S.C. 7627) relating to air emissions from OCS sources for activities regulated or approved under the OCSLA.

Section 328 (a)(4)(c) of the CAA defines an OCS source to include any equipment, activity, or facility: (1) which emits, or has the potential to emit, any air pollutant, (2) is regulated or authorized under the OCSLA, and (3) is located on the OCS or in or on waters above the OCS. This definition also includes emissions from any vessel servicing or associated with an OCS source, including emissions while at the OCS source or en route to or from the OCS source within 25 miles of the OCS source. The proposed action has three distinct time periods during which OCS sources and the vessels servicing them would emit, or have the potential to emit, air pollutants: preconstruction G&G data gathering stage, the two-year construction period and the decommissioning period.

USEPA considers vessels to be exempt from the definition of an OCS source unless they are attached to the ocean bottom or are en route to a structure or facility defined as an OCS source. The OCS sources for the proposed action would be the vibracore boat and diesel powered boring equipment, the jack-up barges and the diesel powered cranes or hydraulic rams on those jack-up barges that are directly attached to the ocean bottom using jack-up legs or spud piles and the support vessels servicing these OCS sources while en route to or from the OCS source within 25 miles of the OCS source. [Figure 5.3.1-3](#) shows the 25 mile area around the proposed action. The following equipment and activities are subject to permitting by USEPA as OCS sources:

1. During the post lease geological and geophysical sampling, gathering stage, the equipment associated with the seafloor boring program (vibracore boat and diesel powered boring equipment) would be considered to be OCS sources.
2. During the two-year construction period, OCS sources include the following activities: pile installation, installation of scour protection, offshore cable laying, installation of the ESP, and installation of the WTGs. OCS sources include the

following vessels: crane barges (if attached to the ocean bottom), and attendant barges (if attached to the ocean bottom). Finally, OCS sources include the following equipment: hydraulic rams and diesel powered cranes.

3. During decommissioning, the removal of the WTGs, piles and scour protection would require the use of jack-up barges that would be attached to the ocean bottom, diesel powered cranes to handle the piles, diesel powered dredgers for the removal of rock armoring, and diesel powered hydrologic dredgers to remove material from inside the monopile prior to cutting of monopile under the surface of the sea floor, and then to replace the dredged material back into the hole. These barges and cranes and dredging equipment would be considered OCS sources.
4. During construction and during decommissioning, emissions from crew boats, tugs and support vessels en route to or from these OCS sources identified in items 1 through 3 would also be regulated by the USEPA permit when they are within 25 miles of the respective OCS source.

During the 20-year operational period, there would be no emission sources attached to the ocean bottom or en route to a structure or facility defined as an OCS source. Thus there would be no operating facilities that are OCS sources. The WTGs and the ESP would not have the potential to generate air pollutants during operations and thus are not considered to be OCS sources.

Emissions during post lease geological and geophysical sampling activities, construction, operations, and decommissioning in the waters and on land designated as non-attainment areas regulated by Massachusetts and Rhode Island would also be reviewed to determine whether they meet the requirements set forth in the USEPA's General Conformity Regulations as codified in Section 176(c) of the CAA. This section prohibits Federally funded entities from taking actions in nonattainment or maintenance areas which do not conform to the SIP for the attainment and maintenance of the NAAQS. The purpose of conformity is to:

- (1) ensure Federal activities do not interfere with the budgets in the SIPs;
- (2) ensure actions do not cause or contribute to new violations; and
- (3) ensure attainment and maintenance of the NAAQS.

The regulations provide that conformity determinations are required when the total of applicable direct and indirect emissions exceed specified *de minimis* levels. Both Massachusetts and Rhode Island are located in an ozone transport region and were designated "moderate non-attainment" for 8-hour ozone on June 15, 2004 by the USEPA. According to 40 CFR 93.153, the applicable *de minimis* level for triggering a Conformity Review in a moderate non-attainment area inside an ozone transport region is 100 tons per year for NO_x and 50 tons per year of VOC. Based on preliminary emission estimates, a General Conformity analysis would be required in Massachusetts and Rhode Island.

5.3.1.5.1 Construction/Decommissioning Impacts

Air quality impacts due to post lease geological and geophysical sampling activities, including a marine shallow hazards survey and a supplemental geotechnical program (see Section 2.7.1), would occur offshore and would be conducted prior to construction. Construction air quality impacts would result from offshore and onshore (onshore) activities. The offshore activities are anticipated to take approximately 2 years to be completed and the onshore activities are anticipated to take 1 year to complete. Offshore activities would consist of pile installation, scour protection installation, offshore cable laying, turbine installation, and ESP installation. [Table 5.3.1-7](#) shows the potential emissions by

major activity: preconstruction, construction, operations, and decommissioning, and [Table 5.3.1-8](#) shows the potential emissions by location. Potential emissions of CO, SO₂, PM₁₀/PM_{2.5}, NO_x, VOC, CO₂, and HAPs range from a minimum of 7.6, 2.5, 0.6, 19.6, 0.8, 919.0, and 0.0 lb/hr, respectively, during preconstruction activities to a maximum of 214.8, 130.2, 29.4, 984.7, 30.5, 46,905, and 0.4 lb/hr, respectively, during decommissioning activities. Most of the potential emissions will occur within OCS areas and will be regulated by the EPA. The applicant has submitted an NOI to EPA for authorization for the above referenced emissions. EPA will review the NOI and determine whether air modeling is required, and coordinate the establishment of an appropriate air quality modeling protocol as necessary.

Onshore construction activities would rely on substantially less powered equipment than that involved with the offshore construction phase. The onshore work can be broken down into three general categories: HDD, duct bank construction, cable pulling and termination. The HDD at the landfall would take between 2 and 4 weeks with emissions resulting primarily from the diesel powered drilling rig. The duct bank would be excavated, constructed and backfilled using a diesel powered bulldozer and excavator. Diesel trucks would deliver duct bank materials to the onshore work site. It is expected that the duct bank would take 5 months to complete. Once the duct bank is constructed, the onshore cable would be pulled to its connection with the Barnstable Switching Station, again using diesel powered equipment. Cable pulling, splicing and termination would also take approximately 5 months to complete. Emissions of fugitive dust from onshore cable construction would occur from time to time depending on the area of exposed soils, the moisture content of those soils and the magnitude and direction of ground level winds. Fugitive dust emissions would be minimized by limiting the amount of exposed soils at a given work area and by spraying water for dust control when weather conditions warrant it.

Decommissioning activities are anticipated to take approximately 2 years and include the removal of the piles, the scour protection, and the underwater cable and the decommissioning of the turbine, ESP, and meteorological tower. [Table 5.3.1-8](#) shows that approximately 39 percent of the decommissioning emissions will potentially occur in waters regulated by Rhode Island, approximately 39 percent will occur in OCS areas regulated by the EPA, approximately 15 percent will occur in waters regulated by Massachusetts, and an additional approximately 7 percent will occur in OCS waters but are not emission sources regulated by a permit.

The activities associated with post lease geological and geophysical sampling, construction and decommissioning of the proposed action would result in air emissions over Nantucket Sound due to the use of fossil fuel fired mobile sources (e.g., ships, cranes and other powered construction equipment). The proposed action would need to comply with all Federal and State general conformity requirements during these activities. Furthermore, the proposed action would be required to apply all mitigation measures imposed by any Federal or State regulations and permit conditions to minimize the air quality impact of these activities.

Visibility Impacts

Reduced visibility in the local area and the Class I areas (e.g., Arcadia, Presidential Range-Dry River, Lye Brook, and Great Gulf) in the region is a concern for the public and regulatory agencies. In the *Particle Pollution Report, Current Understanding of Air Quality and Emissions through 2003* (USEPA, 2004), the USEPA states “In the East, reduced visibility is mainly attributable to sulfates, organic carbon, and nitrates. Poor summertime visibility is primarily the result of high sulfate concentrations, combined with high humidity. Sulfates, which dominate the composition of these visibility-impairing particles, have been found to contribute even more to light extinction than they do to fine particle concentrations.” The post lease geological and geophysical sampling, construction and decommissioning activities would have emissions of SO_x and NO_x, which directly contribute to the formation of sulfates and nitrates in the

atmosphere, and PM, of which a percentage would be organic carbon. Therefore, these activities have the potential to impact the local and long range (i.e., Class I areas) visibility.

The local and long range (>50 km) visibility impacts due to the post lease geological and geophysical sampling, construction and decommissioning activities and the mobile sources used during these activities would be temporary. Thus, the “pollutant loading” in a certain area due to these activities would be minimized. However, diesel exhaust plumes may be visible from vantage points somewhere around the area of the proposed action for an extended period of time. Overall impacts on visibility would be negligible.

Emissions Impacts

The activities associated with post lease geological and geophysical sampling, construction and decommissioning of the offshore and onshore cables would result in air emissions due to the use of fossil fuel fired mobile sources (e.g., trucks, ships, cranes and other powered construction equipment). In addition, the construction of the onshore cable would generate fugitive particulate emissions resulting from land alteration activities (e.g., clearing, excavation, backfilling and grading, etc.). Other construction activities, such as welding, cleaning and degreasing, painting, etc. may also result in air emissions.

Regulated by the State and Federal agencies depending on the location of the emissions, the offshore emissions would be required to comply with all regulations and mitigation requirements enforced by these agencies. As a result of complying with these various regulations, the potential emissions due to the offshore post lease geological and geophysical sampling, construction and decommissioning activities should be minimized to the extent possible. The onshore construction and decommissioning activities would be regulated by the local and State agencies and the proposed action would be required to comply with all permit limits and mitigation measures imposed on these activities. In summary, emission impacts would be minor.

Public Health Impacts

The proposed action would result in temporary and low levels of fossil fuel emissions associated with equipment used in the offshore post lease geological and geophysical sampling, construction and decommissioning activities for the proposed action. These emissions would comply with the appropriate air regulations to ensure the health and safety of the onshore area. Onshore construction and decommissioning activities would be regulated by the local and State agencies, which would also ensure that the emissions are sufficiently controlled to protect the public health. In summary, public health impacts would be negligible.

Conclusion

Overall the post lease geological and geophysical sampling, construction and decommissioning air quality impacts are expected to be negligible to minor as these impacts would be for the most part temporary in nature and localized. The proposed action would be subject to various regulations, which may require mitigation measures to reduce the emissions from the post lease geological and geophysical sampling, construction and decommissioning activities. The proposed action would be required to comply with all of the local, State, and Federal regulations. Mitigation being considered at this time includes the use of water sprays on exposed soils when weather conditions are likely to raise dust. A more detailed discussion of mitigation is provided in Section 9.0.

5.3.1.5.2 Operational Impacts

The actual wind turbines in the site of the proposed action would not have any emissions when in operation. However, maintenance work for each turbine has been anticipated to be 5 days per year. Two of these days would be scheduled maintenance work and 3 days are estimated for emergency maintenance work. Emergency maintenance work would be such work as cable repair activities in the event that a cable is damaged. The scheduled maintenance work would be planned for the summer months when weather conditions are more favorable. Emissions from the vessels used to transport the work crews and emissions from any welding, cleaning and degreasing, painting, etc. may also result during these maintenance work periods.

The maintenance work emissions that are anticipated would be minor and could be emitted anywhere within the 25 square miles (65 km²) proposed action site depending on the turbines being serviced. The vessels used to transport the work crews would be subject to regular maintenance to enhance fuel economy and to minimize their emissions. Furthermore, the vessels would be required to apply all mitigation measures imposed by any Federal or State regulations and permit conditions to minimize the air quality impact of these activities. Finally, it should be noted that the proposed action would result in a new clean source of electricity thus reducing a considerable quantity of local emissions that would occur if a fossil fuel facility were constructed instead of the proposed action (Refer to Section 3.3.6.4, the No-Action Alternative, for a cost benefit analysis that evaluates the likely environmental consequences that would occur if the proposed action were not constructed).

Visibility Impacts

Emissions from the maintenance activities would contribute to visibility degradation. However, because the maintenance activities are dispersed throughout a 25 square miles (65 km²) area, it is unlikely that the maintenance activities would significantly contribute to visibility degradation. Moreover, regular maintenance of the vessels and compliance with all of the operating requirements imposed on the vessels by the Federal and State agencies should minimize the amount of PM and other visibility degrading pollutants emitted by the vessels during maintenance activities. Overall, visibility impacts would be negligible.

Emissions Impacts

Maintenance activities during normal operations of the proposed action would occur within the offshore proposed action. Vessels used to transport the maintenance workers would have emissions from the port of departure to the offshore proposed action and within the site of the proposed action. Maintenance activities and vessel emissions would be regulated by Federal and State agencies and would be required to comply with all of the permit conditions imposed by these agencies. The permit conditions would ensure that the emissions from the maintenance activities and vessels would be minimized to ensure local air quality impacts are minor.

Public Health Impacts

The proposed action operation would not generate fossil fuel emissions. However, maintenance of the facility would result in temporary and low levels of fossil fuel emissions (SO_x and NO_x) associated with maintenance vessels. These emissions would comply with the appropriate air regulations to ensure the health and safety of the onshore area. Onshore construction and decommissioning activities would be regulated by the local and State agencies, which would also ensure that the emissions are sufficiently controlled to protect the public health. Overall, public health impacts would be negligible.

Benefit Analysis for Air Quality

Operation of the proposed action would have the potential to provide benefits in terms of lowering emissions ozone precursors attributed to power production in the New England area. The total generating capacity in the New England power system in the year 2004 was 30,940 MW (ISO New England, 2005). Of this total, southeastern Massachusetts has a capacity of 3,362 MW, or about 10 percent of the total New England capacity. The ISO-NE predicts that the net energy need for New England will increase from 134,085 GWh in 2005 to 152,505 GWh in 2014, a rate of about 1.4 percent per year. The peak summer and winter loads are expected to increase at a rate of 1.5 percent per year (ISO-NE, 2005). The annual growth rate in summer and winter peak loads for southeastern Massachusetts is projected to be 1.7 and 1.5 percent, respectively.

The proposed action would generate 1,600 GWh of power annually. The ISO-NE has calculated marginal emission rates for nitrogen oxides (NO_x) and sulfur dioxide (SO₂) (ISO-NE, 2004). The marginal emission rates provide an estimate of the additional emissions that would result from increased power consumption during periods of higher energy demands. Massachusetts and Rhode Island are classified moderate non-attainment area for ozone. The proposed action has the potential of reducing emissions of NO_x, which is an ozone precursor. The proposed action could slightly reduce the need for added capacity for fossil-fuel generating plants in the New England area. In addition, during periods of peak demands associated with spells of hot weather in the summertime, the proposed action could supply power that would otherwise have to be produced by fossil-fuel plants that generate NO_x and other air pollutants. Warm spells are usually associated with high ozone levels and thus air quality impacts would be mitigated somewhat. The marginal emission rate for NO_x for on-peak hours in the ozone season (May through September) is 0.48 lb/MWh. If we assume that the proposed action output would be 182.6 MW, typical of an average day, the potential amount of NO_x reductions would be about 1 ton/day. In the year 2002 inventory for Massachusetts, the total NO_x emissions for all sources on a summer day is 771.8 tons/day. The amount of potential reduction would thus be very slight.

Conclusion

The proposed action would have no emissions during operations except for maintenance activities and the vessels used to transport the maintenance workers. Maintenance activities could occur anywhere within the 25 square miles (65 km²) proposed action. Therefore, it is anticipated that the operational impacts from the proposed action would be minor as the vessels used during the maintenance activities would be required to comply with all of the Federal and State permit requirements to minimize the potential emissions impact. The proposed action would have the potential of providing some beneficial effects in terms of air quality and climate change in the region as discussed above because it would reduce somewhat the reliance on fossil fuels for power production. These benefits would outweigh the very small emissions resulting from operation of the proposed action, so the net impacts could be positive.

5.3.1.6 Water Quality

Introduction

Projects involving a discharge of dredged or fill material to a waterbody or wetland require a permit from the USACE under Section 404 of the CWA (33 U.S.C. 1344); and a 401 WQC from MassDEP under the Federal CWA (33 USC 1341; Massachusetts CWA; MGL Chapter 21§§26-53; and 314 CMR 4.00 and 9.00). The Federal CWA allows States the authority to review projects that must obtain a Federal license or permit and that result in a discharge to state waters. Please refer to Section 5.1.1 for discussion on vessel withdrawal and discharge as well as discussion of grey and black water, trash and debris, etc.

This proposed action would be subject to both Section 401 and Section 404 due to the volume of sediment to be dredged for the HDD offshore exit point and for the discharge of dredged or fill material back to Lewis Bay to backfill the cofferdam location. Section 401 and 404 jurisdiction extends to the 3.5 miles (5.6 km) State territorial limit. The only proposed action activity proposed within this 3.5 miles (5.5 km) limit is installation of a portion of the electric transmission cable interconnection between the ESP and the Barnstable Switching Station. Within the marine portion of the cable route, the proposed method of cable installation is via hydraulic jet plow, considered a non-jurisdictional activity under Sections 401 and 404 (MassDEP and the USACE, 2002). In the nearshore area at the proposed offshore transmission cable system landfall, the cable system is proposed to be placed in a conduit to be installed using HDD installation techniques. As discussed in detail below, HDD would require the dredging of an offshore exit point pit and the placement of a temporary cofferdam within Lewis Bay to facilitate the HDD operation. The dredged sediments from within the cofferdam pit would be temporarily removed from waters of the U.S. and replaced upon completion of the offshore transmission cable system installation.

Dredging of the offshore exit point pit, placement of a temporary cofferdam, installation of the conduit by HDD, cable installation via hydraulic jet plow, and construction of the WTGs and ESP are subject to the jurisdiction of Section 10 of the Rivers and Harbors Act of 1899 (U.S.C. 403) since these represent activities involving the placement of structures in Waters of the U.S. Installation of the offshore cable systems within the 3.5-mile (5.6-km) limit would also require permits under the Massachusetts WPA and local wetland bylaws. Each of these programs involves consideration of water quality issues.

The WTGs and the ESP do not require the use of water for any part of their operations. Neither the WTGs nor the ESP require the use of water to complete scheduled maintenance activities on the proposed action's equipment. Temporary living accommodations would also be provided on the ESP. These would only be intended for use during emergency periods when crews cannot be removed due to weather or sea state issues. These accommodations would utilize waste storage holding tanks for domestic waste that would be pumped to the service vessel for proper disposal. All equipment would be contained within an enclosed weather-protected service area. Runoff of rainwater from the WTGs and ESP would also not affect water quality. All oil and grease bearing components would be covered and contained such that storm water would not come into contact with oil and grease during periods of rainfall.

5.3.1.6.1 Construction/Decommissioning Impacts

Suspended Sediments/Dredge

The offshore cables would be installed using low impact hydraulic jet plow equipment, and disturbance associated with submarine foundation structures would be minimized through use of a monopile system (see Section 2.3). Potential marine water quality impacts would be limited to temporary and localized sediment disturbance along the offshore cable corridors and at monopile locations from construction vessel anchoring, anchor line sweep, and installation of the scour protection, foundation and cables. The temporary disturbance would typically last for a few hours after operations have ceased at the specific locations. Chemical analysis results indicate that constituents of concern were present in sediment samples from Lewis Bay and Nantucket Sound and were determined to be at concentrations below the levels that would cause either chronic or long-term biological impacts and should pose little or no risk to water quality or aquatic life.

Lewis Bay

The transition of the interconnecting 115 kV offshore transmission cable system from water to land would be accomplished through the use of HDD methodology in order to minimize disturbance within the intertidal zone and near shore area. The HDD borehole length between the entry point, which would be

on New Hampshire Avenue near its intersection with Shore Road, and the exit point pit in Lewis Bay would be approximately 200 ft (61 m). Four 18 inch (45.7 cm) High Density Polyethylene (HDPE) conduit pipes (one for each of the three-conductors in the 115 kV offshore transmission cables) would be installed via HDD between the vaults and the pit. To further facilitate the HDD operation, a temporary cofferdam would be constructed at the end of the boreholes located within Lewis Bay approximately 90 ft (27.4 m) seaward of the landfall location. The cofferdam would be approximately 65 ft (19.8 m) wide and 45 ft (13.7 m) long and would be open at the seaward end to allow for manipulation of the HDD conduits. The area enclosed by the cofferdam would be approximately 2,925 ft² (0.067 acre or 271.7 square miles) and would involve the removal of approximately 840 yd³ (642 m³) of material. The cofferdam would be backfilled after completion of the cable installation.

The dredged material would be removed using mechanical dredging equipment (i.e., clam-shell bucket). The dredged material would be temporarily placed on a barge for storage. The dredged area of the cofferdam would be backfilled with the dredged material. If necessary, the dredged material backfill material would be supplemented with imported clean sandy backfill material to restore preconstruction contours. No removal of sediment outside of the cofferdam would be required.

To minimize the release of the bentonite drilling fluid into Lewis Bay during HDD, freshwater would be used as a drilling fluid to the extent practicable prior to the drill bit or the reamer emerging in the pre-excavated pit. This would be accomplished by pumping the bentonite slurry out of the hole, and replacing it with freshwater as the drill bit nears the pre-excavated pit. It is possible that some minor residual volume of bentonite slurry may be released into the pre-excavated pit. The depth of the pit and the temporary cofferdam perimeter are expected to contain any bentonite slurry that may be released. Prior to drill exit and while the potential for bentonite release exists, diver teams would install a water-filled temporary dam around the exit point to act as an underwater "silt fence." This dam would contain the bentonite fluid as it escapes and sinks to the bottom of the pre-excavated pit to allow easy clean-up using high-capacity vacuum systems.

In Lewis Bay, elevated suspended sediment concentration levels would remain considerably longer, as a result of weak tidal currents. Suspended sediment concentrations of 10 mg/L are generally predicted to remain for less than 24 hours after the jet plow has passed a given point along the route ([Report No. 4.1.1-2](#)). However, near the Yarmouth landfall concentrations of 10 mg/L are predicted to remain for up to 2 days after the jet plow passes as a result of very weak currents and fine bottom sediments. In places along and immediately adjacent to the offshore transmission cable system route (near the Yarmouth Landfall and south of Egg Island), suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 5 hours ([Report No. 4.1.1-2](#)).

In the area of the eelgrass bed south of Egg Island, suspended sediment concentrations are predicted to be in the range of 50 to 500 mg/L, depending on proximity to the cable route. Suspended sediment concentrations of 10 mg/L are predicted to remain for approximately 9 to 18 hours after the jet plow has passed this point on the route. At the western end of the eelgrass bed, suspended sediment concentrations of 100 mg/L are predicted to remain for up to 6 hours. The eastern portion of the bed may experience maximum concentration levels of less than 50 mg/L ([Report No. 4.1.1-2](#)).

Horseshoe Shoal

The installation of WTG foundations, inner-array and the offshore transmission cable system routes would physically displace sediment at specific locations through sediment suspension, transport, and deposition. In sandy sediments, such as those in the area of the proposed action, the majority of disturbed sediments are expected to settle and refill cable trenches and areas immediately surrounding these trenches shortly after installation. A small depression may remain over the cables after installation,

depending on localized sediment depositional processes. As with other projects involving submarine cable embedment in the seabed using jet plow technology, the majority of disturbed sediments are expected to settle and refill cable trenches and areas immediately surrounding these trenches shortly after installation (Connecticut Light & Power Company, 2002; Bohlen, pers. comm., 2002).

The scour mats are placed on the seabed by a crane or davit onboard the support vessel. Final positioning is performed with the assistance of divers. After the mat is placed on the bottom, divers use a hydraulic spigot gun fitted with an anchor drive spigot to drive the anchors into the seabed. Sediment suspended during the installation of the mats is expected to be minimal and expected to result from mat placement on the bottom and actions of the divers. The mats are removed by divers and a support vessel in a similar manner to installation, and are expected to result in greater amounts of suspended sediments than levels associated with the original installation of the mats. However, the sandy nature of the bottom material over most of the site of the proposed action would result in rapid settling of the suspended sediment material, which would limit the extent of the impact of suspended sediments.

The rock armor and filter layer material would be placed on the seabed using clamshell bucket or a chute. By lowering the material into the water and placing the material on the bottom rather than dumping it, more control over the placement of the material can be achieved. Sediment suspended during the installation of the rock armor material is expected to be more than that associated with the use of scour mats. However, the sandy nature of the bottom material over most of the site of the proposed action would result in rapid settling of the suspended sediment material, which would limit the extent of the impact of suspended sediments. In those locations where rock armoring has been used for scour protection, it would remain in place following the proposed action's decommissioning.

The SSFATE model also predicts that, in sandy sediments, suspended sediment concentrations from the jet plow are estimated to occur in a limited area in close proximity to the cable trench and exist for short durations of minutes to less than one hour at any fixed location ([Report No. 4.1.1-2](#)). In addition, the amount of suspended sediment injected into the water column from jet plow embedment is estimated to be approximately 0.36 yd³ (0.28 m³) for every linear foot of cable installed, which is much less than that introduced into the water column from commercial trawling operations (1.32 yd³ [1.01 m³] per foot of trawling) (Churchill, 1998).

It is important to note that the suspended sediment concentration levels are short lived due to the tides flushing the plume away from the jetting equipment and the sediments rapidly settling out of the water column. Within Nantucket Sound, suspended sediment concentrations away from the offshore cable route of 10 mg/L are predicted to largely remain for approximately 3 hours after the jet plow has passed a given point along the route. In places along and immediately adjacent to the cable route, suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 2 to 3 hours.

For the four representative inner-array cable routes modeled ([Report No. 4.1.1-2](#)), suspended sediment concentrations away from the cable route of 10 mg/L are predicted to largely remain between less than 3 and 12 hours, with one area being up to 18 hours, after the jet plow has passed a given point along the route. In places along and immediately adjacent to the cable route, suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 2 to 6 hours, where as the active bed load sediment transport known to exist in Nantucket Sound is approximately 45 to 71 mg/L. ([Report No. 4.1.1-2](#)). The longer time durations associated with construction related turbidity occur in areas where the inner-array cable alignments run in an east-west direction, which is in the same direction as tidal currents in the area (see [Table 5.3.1-9](#)).

The volume and extent of sediment disturbance as well as the biological impacts associated with the jet plow are less than those associated with both one tidal cycle and one commercial trawling event. In

addition, it is important to note that use of the jet plow is an isolated event whereas commercial trawling takes place routinely over large areas during the fishing season and two tidal cycles generally occur each and every day. The near bottom suspended sediment concentrations associated with the jet plow are within the range of natural variability resulting from tidal currents, waves, storms, trawling, and vessel propulsion, and as a result are lower compared to concentration associated with other natural and man-made occurrences in Nantucket Sound (Cape Wind, 2003). Potential impacts to surface water resources would be minimized to the greatest extent practicable through the use of appropriate cable installation techniques, and by limiting the area of seabed disturbance. Therefore, minor short-term and negligible long-term impacts are anticipated.

In addition to the water quality impacts discussed, the post lease G&G field investigations (Refer to Section 2.7) would require drilling and vibracore activities to assess geological conditions on the sea floor. Impacts associated with this would include temporary and localized turbidity, which would have a minor impact on water quality.

Inland Waters

Once the offshore transmission cable system makes landfall, the transmission cable system would be transitioned to the onshore transmission cable system in two below-grade transition vaults. The transition vaults would be located at the land boreholes with the dimensions of approximately 7 ft (2.1 m) wide by 34 ft (10.4 m) long by 7.6 ft (2.3 m) high (see [Figure 2.3.7-1](#)). The transmission cable system transition vault would be installed within the pavement using conventional excavation equipment (e.g., backhoe). This work would result in no impacts to wetland resource areas. Work may be required within the 100 ft (30.5 m) Buffer Zone of Wetland 6 in Yarmouth. No work is proposed in wetland jurisdictional areas in Barnstable.

The proposed transmission cable would not result in changes to surface or groundwater hydrology. Portions of the proposed cable route would be located near public water supply wells and within Zone I and II wellhead protection areas. Based on conversations with MassDEP staff regarding the proposed installation of subsurface utilities along the proposed cable route (MassDEP, 2002b; MassDEP, 2003), MassDEP would typically prefer that the utilities were installed outside of the Zone I areas. However, the MassDEP staff stated that they would allow the installation of utilities along existing roadways as long as alternative routes have been evaluated and the areas affected were minimized to the extent practicable. It is also important to note that the cable installation within Zone I areas would be installed using conventional open trench excavation and installation techniques, and that the transmission cables would not contain any fluids, petroleum, oils, or lubricants. The trenchless technology proposed for the Route 6 area would not be located within a Zone I area. The MassDEP Drinking Water Program staff indicated that the MassDEP would allow the installation of the proposed transmission cables within the Zone I area (MassDEP, 2002b; MassDEP, 2003).

The proposed action would not result in the addition of impervious surface areas, nor would it change the infiltration of surface water. The MassDEP regulations (310 CMR 22.21(2)(a) and (b)) outline the restrictions for the siting of various land uses within the delineated Zone II area. None of these restrictions would affect the proposed action along the proposed route. Based on these findings, it does not appear that the MassDEP Zone I and Zone II regulations would affect the proposed action along the proposed route.

Two known culverts are located along the proposed route on Higgins Crowell Road, at Wetland 1 and Wetland 2. During final design, it would be determined whether the ductbanks and transmission cable system s would pass above or beneath these culverts. No impacts to the culverts or adjacent waterways or wetlands are proposed.

The proposed action would not alter any freshwater wetlands or regulated culverts that would trigger Section 401 review. However, the proposed action would result in minor impacts to paved Riverfront Area and Buffer Zones, as regulated under the Massachusetts WPA and would, therefore, require an approval from the town Conservation Commission via an Order of Conditions. Work within Riverfront Area and the 100 ft (30.5 m) Buffer Zone is limited to temporary construction on paved roadway surfaces for the installation of the proposed transmission cable system route.

Proposed work in Yarmouth would result in temporary alteration of locally-regulated Lake and Pond Recharge Areas. In addition, the Yarmouth Wetlands Protection Regulations establish a 35 ft (10.7 m) Vegetated Buffer, 50 ft (15.2 m) No-Structure Zone, and 100 ft (30.5 m) Buffer Zone to certain resource areas, including any Bank or Vegetated Wetland. Direct impacts to these resource areas would be avoided by installing the transmission cable system beneath existing paved roadways and onshore portions of the NSTAR Electric ROW.

Conclusion

Overall, the construction and decommissioning impacts on water quality are expected to be minor, as disturbance to marine sediments would be only temporary and localized. Mitigation measures considered at this time include silt fences and other erosion control. A more detailed discussion of mitigation is provided in Section 9.0.

5.3.1.6.2 Operational Impacts

Operation of the proposed action and cable system is not anticipated to impact wetland resource areas.

There was some concern regarding frond deterioration from the scour mats and its impact on water quality. The fronds are stitched to the webbing material in a manner that prevents them from dislodging. Degradation could result from exposure to ultraviolet radiation; however, this is not possible in this situation because the fronds are installed on the sea-bottom where direct exposure to sunlight for extended periods of time does not occur. Frond degradation, as a result of excessive heat, is not possible because temperatures in excess of 100°F are required for such thermal degradation to take place. As previously stated, year long temperature readings at the SMDS did not record temperatures over 72°F. During a June 2005 observation, no fronds were missing from the webbing material. During a May 2006 investigation of the fronds, they were observed to have separated longitudinally into many fronds of smaller widths; however, the fronds appeared to have remained firmly attached to the webbing material. Therefore, there is a very low probability that fronds would dislodge and impacts to water quality would be minor.

Risk Characterization for Oil or Fuel and WTG Fluid Spills

The only components of the proposed action that would come into regular contact with seawater and would be subject to potential interactions between water, encrusting organisms, and sediment are the welded steel monopile foundations. The transition piece of the WTGs, which would be located on top of the monopile at the water line/splash zone, would be coated with a product equal or similar to Interzone® 954. The portions of the structural steel and steel surfaces not directly exposed to seawater, such as the tower (above the transition piece), would be coated with an epoxy-polyamide. In addition, cathodic protection using sacrificial anodes made of pure aluminum would be employed on the piles. The limited area of contact between the coated transition piece and seawater, and the protective anodes on the monopile, would minimize the potential for undesirable interactions between water, encrusting organisms, and sediment. The selected coating is not anticipated to degrade substantially or leach materials into the water column over the life of the proposed action, as evidenced by its wide spread use in marine

applications (i.e., hulls, bridge structures, etc.). Therefore, no measurable change in these interactions is expected after proposed action installation.

The WTGs would contain lesser amounts of the following materials in the nacelle or hub: bearing lubrication (Mobil SCH 632), gear lubrication & cooling (Optimal Synthetic A320), break and hydraulic fluid (Mobil DTE 25), transmission fluid (ATF 66), gear lubrication and heat dissipation (water/glycol). Total storage of these materials at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). The WTGs have been carefully configured to contain any potential fluid leakage and to prevent overboard discharges. During service or maintenance of the WTGs, the possibility of small leaks could occur during oil changes of hydraulic pump units or the gearbox oil conditioning system. During WTG operation small leaks could occur as a result of broken gear oil hoses/pipes, and/or broken coolant hoses/pipes. Gear oil leaks would be contained within the hub and main bed frame and/or tower as described above. Coolant leaks could occur on a number of locations within the nacelle fiberglass covers.

Analyses were performed to estimate the trajectories of oil spills and calculate probable estimates of area coverage and minimum travel time. The study used two models: HYDROMAP to calculate currents, and OILMAP to calculate oil spill trajectories and resulting oiled areas and travel times.

The OILMAP model was used to simulate spill trajectories and determine probabilities of areas being oiled and oil travel times for an instantaneous release of 40,000 gallons (150,000 L) of electrical insulating oil at the ESP site in Nantucket Sound. This scenario (instantaneous release of entire tank contents) is highly unlikely and therefore conservative ([Report No. 4.1.3-1](#)).

The model results indicate that oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 to 30 percent). The likelihood of a spill impacting Nantucket is consistently small (less than 10 percent), while the chance of a spill impacting a shoreline somewhere within Nantucket Sound and the immediate surrounding areas is greater than 90 percent. Typically, the central and western areas of the Cape Cod coast and the east and northeast coasts of Martha's Vineyard are most vulnerable to a spill. The shortest time to reach shore for each of the scenarios ranges from 4.8 to 11.3 hours.

Some calculations were made that showed at 10 hours the percent evaporated ranged from less than one percent to slightly over 2 percent for the range of winds (5 to 20 knots [2.6 to 10.3 m/s]) typically seen in Nantucket Sound. After 24 hours, approximately 3 to 6 percent of oil had evaporated. In light wind conditions (less than 10 knots), greater than 90 percent of the oil remained on the surface. Less than 50 percent of oil remained on the water surface after 24 hours when winds exceeded 10 knots (5.1 m/s).

In addition to the oil spill trajectory modeling, an analysis has been performed of the probability that an oil spill might occur at the site of the proposed action ([Report No. 5.2.1-1](#)). The analysis involved the determination of the probability of the theoretical occurrence of an instantaneous release of 40,000 gallons of electric insulating oil and 2,000 gallons of diesel and other oils from the ESP² and up to 200 gallons of turbine and other lubricating oils from each of the 130 WTGs (for a total worst case of 68,000 gallons of oil). The analysis involved two major components: (1) determining the probability that any spill might occur from the ESP and WTGs; and (2) analyzing the range of spill sizes (and associated

² The applicant formerly had proposed use of emergency diesel generators on the ESP, which involved the storage of up to 2000 gallons of diesel and other oils. The emergency generators have since been replaced by battery backup. While [Report 5.2.1-1](#) includes the diesel fuel in the spill trajectory and risk analyses, the DEIS does not include an analysis of the environmental impacts of a diesel fuel spill from the ESP.

probabilities) that might be expected if a spill was to occur from the ESP and WTGs. The analysis involved a four-step process:

- (1) Evaluate and describe the events that might cause damage to the ESP and/or WTGs;
- (2) Estimate or qualitatively analyze the probability of each of these events occurring;
- (3) Estimate or qualitatively analyze the probability that for each of these events that damage occurs to the ESP and/or WTGs; and
- (4) Estimate or qualitatively analyze the probability for each of these events to cause damage sufficient to cause an oil spill from the ESP and/or WTGs.

The analysis shows that the highest possibility of an oil spill occurring in the area in and around Nantucket Sound is related to vessels transiting the area, regardless of the presence of the proposed action structures and related work vessels. Over the course of 30 years, transiting vessels alone may result in 21 spills in and around Nantucket Sound. These spills are unrelated to the presence of the facility and would occur whether or not the facility was in place. The presence of the facility may very slightly increase the risk of spills from vessels colliding with one of the proposed action structures. When the presence of the proposed action components is combined with transiting vessels, the possibility for a spill over the 30 year period increases slightly to 22.443 spills. The oil spill probability analysis shows that only 7 percent of all spills expected in Nantucket Sound during a 30 year period could be attributed to the addition of the proposed action facility. It is possible that 2 spills attributable to the proposed action itself could occur during the same 30 year period. Of these spills, there is a 90 percent chance that they would involve 50 gallons or less, and a 1 percent chance they would involve volumes of 10,000 gallons. The probability of a spill in the same 30 year period involving the entire 68,000 gallons of oil contained within the 130 WTGs and the ESP is less than one in a million ([Report No. 5.2.1-1](#)).

Conclusion

Based on the temporary and localized impacts to water quality, and the very small probability of a major oil spill, the proposed action's operational impacts on water quality are expected to be negligible.

5.3.1.7 Electric and Magnetic Fields (EMF)

This section assesses impacts of the proposed action on EMFs. The information contained in this section was obtained from review of existing data available for the area of the proposed action, EMF monitoring and modeling, and review of the scientific literature on EMF.

Research has been conducted for over 20 years in the United States and around the world to examine whether the use of electricity and the associated exposure to electric and magnetic fields poses a health risk. In 1992, the U.S. Congress authorized the Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF-RAPID) in the EPA Act (PL 102-486). The National Institute of Environmental Health Sciences (NIEHS), National Institute of Health (NIH) and the DOE were designated to direct and manage a program of research and analysis aimed at providing scientific evidence to clarify the potential for health risks from exposure to EMF (NIEHS, 1999).

Over the course of this program, the DOE and NIEHS managed more than 100 cellular and animal studies, exposure assessment, and engineering studies. No additional epidemiology studies were conducted; however, analysis of studies already conducted was an important part of the assessments (EMF-RAPID Program Report, 2002). In 1998, the NIEHS completed the review of a comprehensive body of scientific research on the potential health effect of EMF. The NIEHS organized several technical symposia meetings and a Working Group meeting to review EMF research. The Working Group was

made up of scientists representing a wide range of disciplines including engineering, epidemiology, cellular biology, medicine, toxicology, statistics and pathology to review and evaluate the RAPID program research and other research. The results of the Working Group's evaluation were published in the report *Assessment of Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields* (August 1998).

In June 1999 the NIEHS submitted the report, *NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*, to Congress. In part, the report concluded the following:

The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults.... In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although some sporadic findings of biological effects have been reported. No indication of increased leukemia in animals has been observed.... Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done in cells fail to support a causal relationship between ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings.

NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. However, virtually all of the population in the United States uses electricity, and therefore, is routinely exposed to power frequency EMF. As a result passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulatory community on way in which to reduce exposure. NIEHS also suggested that the power industry continue the current practice of siting power lines to reduce exposure and encourage technologies that lower exposures from neighborhood distribution lines provided they do not increase other risks such as those from fire or accidental electrocution. The NIEHS does not believe that other cancers or non-cancer outcomes provide sufficient evidence of a risk to currently warrant concern (NIEHS, 1999, 9-10).

Human Health Effects Associated with EMF

The likelihood for power line EMF to cause adverse health impacts in humans has been reviewed by many and various scientific groups. Hazard is identified by a standard process that considers data from epidemiologic, laboratory, and biophysical studies. Several epidemiologic studies have reported a small degree of association between measures of EMF and several diseases, e.g., childhood leukemia. Other studies have failed to find an association. A causal basis for the EMF associations is not supported by laboratory and biophysical evidence, and the actual basis remains unexplained. Nonetheless, in 2002, the International Agency for Research on Cancer (IARC) (IARC, 2002) designated EMF as a class 2B carcinogen ("possibly carcinogenic"), based on "consistent statistical associations of high-level residential magnetic fields with a doubling of the risk of childhood leukemia." Also, in 2002, the California Department of Health Services (CADHS, 2002) issued a report concluding that: "EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease, and miscarriage."

Despite considerable research directed toward the topic, the direct health risks result from exposure to EMF has not been established. The epidemiologic association reported between EMF and some diseases have been the subject of continued statistical analysis (Greenland et al., 2000; Ahlbom et al., 2000; Wartenberg, 2001). When Greenland et al. (2000) pooled their epidemiology studies of childhood leukemia, they found evidence of increased risk at low magnetic flux densities, but not at the upper-end of the magnetic fields range used in the study, to which a small proportion of United States residents are exposed. The authors estimated a relative risk of 1.7 (95 percent confidence interval [CI], 1.2 to 2.3) for exposures above 3 mG, and a population attributable fraction of 3 percent (95 percent CI, -2 percent to +8 percent) for exposures above 0.5 mG. Another pooled analysis by Ahlbom et al. (2000) produced similar results for a 4 mG cutpoint. The possibility that the EMF associations are due to bias or confounders, however, has not been ruled out (Hatch et al., 2000; Ahlbom et al., 2001; Savitz, 2003).

Extensive investigations of animals exposed at much higher levels of EMF (up to 50,000 mG) have not demonstrated adverse health effects (Mandeville et al., 1997; McCormick et al., 1998 and 1999; Boorman et al., 1999 and 2000). The elevated levels of EMF exposure in occupational settings likewise do not show a consistent pattern of increased risk (Kelsh and Sahl, 1997; Kheifets et al., 1999; Sahl et al., 2002). Laboratory studies of cells and tissues do not support the hypothesis that EMF exposure at ambient levels is a significant risk factor for human disease (NIEHS, 1999). The failure to observe biological effects from EMF exposure may be due to the fact that, mechanistically, effects of EMF on biology are very weak (Valberg et al., 1997). Cells and organs function properly in spite of many sources of intrinsic chemical “noise” (e.g., stochastic, temperature, concentration, mechanical, and electrical noise), which exceed the effects caused by EMF by a large factor (Weaver et al., 2000).

If power line EMF initiates or modulates physiological dysfunction or onset of disease in humans or animals, then a mechanism by which EMF alters molecules, chemical reactions, cell membranes, or biological structures in a functionally significant manner should exist. Mechanistic models begin with the recognition that EMF is a physical, not chemical, agent as illustrated in the following causal chain:



A necessary condition for EMF impact on human or ecosystem biology is that the EMF-induced changes must exceed chemical changes from natural or background influences. Changes in biology are coupled to EMF through changes in forces on charged structures, which in turn, must be coupled to metabolically important chemical processes (reaction or transport rates). The size and direction of the electric field predicts the size and direction of force on electric charges. Likewise, the magnetic field predicts force on moving charges. Thus, any EMF bioeffects must solely and ultimately be the result of forces. There are no other actions of EMF. The possibility of a biological effect depends on whether EMF forces can significantly modify biological processes having electrically responsive elements (for example, ions, charged proteins, neural electric currents, magnetic molecules (free radicals), and magnetic particles).

The EMF impacts can be evaluated by asking how the forces and energies conveyed by EMF compare to forces and energies endogenous to biological systems. Energies and forces exerted by typical 60 Hz EMF are well below those present in biological systems. That is, normal living cells operate under conditions of energy and force “noise” such that 60 Hz EMF effects would be lost in this background. Aside from specialized sensory systems, fundamental force and energy considerations preclude disruption of biology by weak EMF. Mechanisms by which EMF might alter biologic function are found to be small compared to the endogenous energies and forces characteristic of the living system (Valberg et al., 1997). [Table 5.3.1-10](#) shows that in terms of energy or force on the whole-body scale or on the molecular scale, the effect of “large” EMF is many orders of magnitude below the typical forces and energies that accompany life processes. For example, the energy of a 60 Hz EMF photon is vastly less than that of

ionizing radiation, and EMF is too weak to alter molecular structures. The level of the electric field *per se* could be increased to levels where it accelerates individual free electrons to electron-volt energies, exceeding those needed to break a chemical bond (as for example, in corona discharge). However, electric-field levels required for this type of molecular damage is far greater than what any organism would be exposed to with power line EMF. Likewise the force required to distort the shape of complex biological molecules, for example DNA or enzymes, is far larger than what the electric component of EMF can provide. The magnetic component of EMF can potentially rotate magnetic particles (which would act like compass needles) or single-molecule magnetic moments (e.g., free radicals) as described in the following section.

The failure to observe laboratory effects from EMF exposure (NIEHS, 1999) is likely due to the fact that typical power line EMF does not affect biology in a manner detectable above the many sources of noise in biological systems, and this inability to detect EMF effects in bioassay systems suggests that EMF itself does not play a causal role in the epidemiologic associations. In summary, a large number of blue-ribbon panels and public health review groups have examined the issue of the public's exposure to power line EMF. The overall conclusion of these groups is that available data do not establish a cause-and-effect relationship between exposure to typical environmental levels of EMF and elevated risk of disease.

Ecological Health and Exposure Effects Associated with EMF

Both terrestrial (e.g., birds and honeybees) and marine animals (e.g., finfish, eels, sharks, and sea turtles) likely use the earth's DC magnetic field for orientation, navigation and migration (Kirschvink, 1997; Kirschvink et al., 2001; Lohmann and Johnsen, 2000; Phillips et al., 2001; Ritz et al., 2000; Wiltschko et al., 2002). The mechanism underlying this magnetic sense is primarily limited to slowly-varying fields, and is not expected to respond to rapidly-varying (e.g., 60 Hz) AC fields. Aside from orientation and navigation, other potential effects of low-frequency electric and magnetic fields on ecological systems have been investigated, but the findings on ecological effects have been equivocal (NRC, 1997; Levin and Ernst 1997; Pagnac et al., 1998), and there is no consistent evidence to establish an adverse-effect level. In fact, the RAPID research program mentioned above was carried out on laboratory animals, and the lack of consistent findings for EMF effects in those species also supports this conclusion.

Weak electric fields can be detected by certain fish (rays, sharks) for use in orientation and prey location. For example, sharks are capable of responding to extremely weak, slowly-changing electric fields in sea water. The shark's electric sense organ (*ampullae* of Lorenzini) is complex, containing a large number (~10,000) of receptor cells, in which small interactions are integrated to generate a change which stands out against noise (Adair, 2001; Adair et al., 1998).

Data on the Nysted Offshore Wind Farm (Nysted) Project have documented some effects from offshore cable routes on fish behavior indicating avoidance of the cable as well as attraction, depending on species. However, the observed phenomena were not significantly correlated with the assumed strength of the EMF (Danish Energy Authority, 2006).

The specifications of the proposed cable systems require the cable to be shielded. Since electric field lines start and stop on charges, this shielding would effectively block the electric field produced by the conductors. Therefore, no electric field impacts are expected for the offshore cables. Magnetic fields on the other hand cannot be easily shielded because the magnetic field lines do not stop on objects they form continuous loops around conductors carrying currents.

The physics of power line EMF interactions with matter are universal, and the constituents of non-human living organisms share many similarities with human cells and tissues. Hence, the following parallels can be drawn between the potential for EMF health effects in humans and the potential for ecological effects in non-human species:

- Due to similar electrical properties (conductivity, permittivity, polarizability) of human and animal tissues, similar electrical interactions can be expected. Some differences may arise due to geometrical and size factors.
- Due to the universal structure and properties of cell membranes, the threshold field strengths for biophysical (thermal and non-thermal) effects on cell membranes can be expected to be high both for human and non-human species.
- Animals and species with special sense organs (i.e., endogenous magnetic particles, ampullae of Lorenzini) may require special consideration of possible EMF effects on behavior.

With regard to potential impacts of the EMF from submarine cables on living organisms, the following summary supports an absence of impacts (ICNIRP, 2000; NAS, 1993; VNTSC, 1994):

- Power line EMF has not been reported to disrupt land-based, freshwater, or marine organism behavior, orientation, or migration.
- Special sense organs, such as a “compass-needle” type of receptor for steady magnetic fields, are known to exist for some animals (Kirschvink et al., 2001)³, but such a receptor would not be affected by power line, 60 Hz magnetic fields, which alternate in direction, and average to zero over 1/60th of a second (Adair, 1994; Valberg et al., 1997).⁴
- The actual magnitude of typical 60 Hz magnetic fields in the vicinity of the submarine cables is, in most locations, many fold below that of the steady geomagnetic field (~ 500 mG).
- The very low energy content of 60 Hz EMF means that the amount of thermal energy absorbed by nearby sea creatures is extremely small.
- The volume of ocean or on-land habitat with any measurable EMF levels is a tiny fraction of overall available habitat.

In summary, the primary consideration is for organisms that may have magnetic sense organs. The current opinion as to how animals use the earth’s magnetic field for magnetic orientation is that such sensing is due to a “compass needle” mechanism. Although magnetite particles are plausible geomagnetic field sensors (Adair, 1994; Kirschvink et al., 1992 and 2001), functional biogenic ferromagnetic material has been established only in a limited number of organisms (for example,

³ In the abstract of his 2001 article, Dr. Kirschvink states that: “All magnetic field sensitivity in living organisms, including elasmobranch fishes, is the result of a highly evolved, finely-tuned sensory system based on single-domain, ferromagnetic crystals.”

⁴ As illustrated in Table A, the potential effects of EMF on any organism can be evaluated in the context of fundamental physics and chemistry. Such an analyses power line EMF mechanisms has been reported in a series of articles by Dr. Robert Adair, professor of physics at Yale University. Dr. Adair showed that the effective biological EMF “signal” (relative to biological “noise”) is not of sufficient strength to alter biological processes. Dr. Adair considered a wide variety of possible interactions of EMF with biological systems, and he concluded that typical EMF field strengths are “much smaller than the smallest fields that have been known to affect chemistry.”

magnetotactic bacteria) (Blakemore, 1982). The “compass needle” mechanism would not be expected to respond to power line magnetic fields which rapidly change in size and direction, and have a time-average magnitude of zero. Even for an optimized hypothetical biological sensor, the minimum 60 Hz magnetic flux density detectable by microscopic particles in marine organisms would have to exceed 50 mG (Adair, 1994; Polk, 1994). However, no one has demonstrated an effect on animal orientation by AC fields. Moreover, any expected levels above the 60 Hz magnetic field occurs only directly over the 115 kV offshore transmission cable system on the sea floor and in the immediate vicinity of the ESP within 10 ft of five convergent heavily loaded inner-array (33 kV) cables. In all other locations, the 60 Hz magnetic fields are below this value.

Based on the body of scientific literature examined there are no anticipated adverse impacts to the marine environment from the 60 Hz magnetic fields associated with the operation of the proposed action.

5.3.1.7.1 Construction/Decommissioning Impacts

No significant electric or magnetic fields are anticipated during construction other than possible small fields associated very close to construction equipment. As a result electric and magnetic fields impacts from construction/decommissioning are expected to be negligible.

5.3.1.7.2 Operational Impacts

Electric and Magnetic Fields at Landfall Area

Electric Fields

Calculated existing electric field levels in and adjacent to the streets along the onshore route range between 0.01 and 0.09 kV/m. Because the electric field of the proposed underground 115 kV cables would be effectively contained within the body of each cable by its grounded metallic shield, the addition of the transmission cable system would not change these electric field levels.

Magnetic Fields

At the transition vault located at the end of New Hampshire Avenue, the HDD conduits would converge to a more compact configuration in order to facilitate the transition from offshore transmission cable to duct type cable. The calculated peak magnetic flux density at an elevation of 3.3 ft (1 m) above grade at the vault is 11.3 mG for the 168 MW output and 30.8 mG for the 464 MW output.

The calculated peak magnetic flux densities produced by the proposed underground 115 kV cable in the streets is 7 mG at an annual average output of 168 MW, and 20 mG at maximum output of 454 MW. The field level falls off fairly rapidly with distance from the center of the duct bank.

The net magnetic flux density produced by the combination of the existing overhead and new underground cable system is a complex function of the relative geometry and loading of the overhead and underground circuits. The net magnetic flux density depends on the following:

- The relative position of the lines with respect to each other (i.e., whether the overhead and underground lines are on the same or opposite sides of the street);
- The phasing of the overhead conductors, which may vary along the route; and
- The north-south location along the route, since the loading on the overhead lines generally decreases along the line as it travels south toward the landfall location due to lessening loads.

Mathematical models were run for several representative laterals across the street at different points along the route. The resultant peak field strength, with the overhead lines at peak load, ranged between 8 and 36 mG with the proposed action at average output, and between 19 and 36 mG with the proposed action at maximum 454 MW output.

With the proposed action generating at either 168 MW or 454 MW, the magnitude and profile of the resultant magnetic fields on either side of the road are unchanged from a distance of approximately 20 to 30 ft (6.1 to 9.1 m) from the edge of pavement and beyond. Therefore, the magnetic flux densities experienced by residential or other properties along this section of the route would be the same as experienced with the existing overhead distribution lines. Likewise, the resultant magnetic fields on the side of the road closest to the Marguerite E. Small School are unchanged from those experienced under current peak loading on the existing overhead distribution lines as shown in [Report No. 4.1.7-1](#).

Electric and Magnetic Fields at NSTAR Electric ROW

Electric Fields

The electric field would be effectively contained within the body of each new underground 115 kV cable by its grounded metallic shield and therefore, no external electric field would be produced. As a result, upon completion of the new underground transmission cable system the electric fields within the ROW are anticipated to be approximately the same as the existing condition, which is due to the presence of the overhead 115 kV lines.

Magnetic Fields

To connect to the Barnstable Switching Station, 115 kV underground transmission cable system would be installed in the NSTAR Electric ROW. Calculations were performed to determine the net magnetic field due to this duct bank and the overhead 115 kV lines (with load flows as predicted by NSTAR Electric). At an average proposed action output of 168 MW, this resulted in 127 mG directly under the lines, a localized peak of 23 mG directly over the duct bank, 56 mG at the north edge of the ROW, and 12 mG at the south edge of the ROW. At the maximum proposed action output of 454 MW, these values become, respectively, 127 mG, 49 mG, 56 mG, and 12 mG, which are a small change from the 168 MW case. These results indicate that the predominant fields within the ROW are those generated by the existing overhead lines, whose loading under this interconnection option is not changed by the addition of the proposed action. The predicted impact of adding the underground transmission cable system is a negligible change from existing conditions within the ROW and no change in field strength at the ROW edges would occur.

[Report No. 4.1.7-1](#) provides additional detail regarding the measurement of existing magnetic fields and calculations to predict future expected field levels for the onshore portion of the proposed action and for the 115 kV offshore transmission cable system.

Electric and Magnetic Fields in Marine Environment

No existing sources of power frequency fields are present in the offshore area of the proposed action. Projections were developed using the “ENVIRO” computer program to determine the magnetic flux density expected from both the 33 kV inner-array cables and the 115 kV offshore transmission cable system. Calculations were performed with the proposed action generating at a maximum delivered output of 454 MW and at the annual average output of 168 MW. Anticipated magnetic flux density was determined for the area directly above the cables (buried 6 ft [1.8 m] below the surface) at the sea floor and at varying water depths above the sea floor. In the horizontal plane, magnetic flux density was

calculated approximately 20 ft (6.1 m) on either side of the offshore, at which point the magnetic flux densities had significantly decreased due to distance.

The magnetic flux density associated with the 33 kV inner-array cables is proportional to its electrical current and would, therefore, vary widely depending on the location of the cable segment in relation to the turbine string, and on the power output of the turbines. To account for this variation, calculations were performed for the most lightly loaded cable segment, which would be located at the end of a string and carry the output of only one WTG, and for a “homerun” cable segment, located between the closest turbine on a string and the ESP, carrying the output of 10 WTGs, the maximum number of WTGs on a cable string.

In the immediate vicinity of the ESP, the homerun cables become more closely spaced. Within approximately 20 to 30 ft (6.1 to 9.1 m) of the ESP, the cables begin to rise up in the subsurface trench such that they would be buried approximately 2 ft (0.61 m) deep under the scour control mats prior to rising vertically from the sea floor to the ESP in J-tube conduits secured to the ESP support structure. While this design has not been finalized, some reasonably conservative assumptions can be made to serve as a basis for magnetic field calculations at this singular location. It was assumed that a maximum of five 33 kV inner-array cables would be grouped on a single riser, spaced 6.5 inch (16.5 cm) (one cable diameter) apart, edge to edge. Magnetic flux density was then calculated at varying distances from the surface of the cables.

Calculations for the 115 kV offshore transmission cable system were performed which represent the two methods of installation proposed. The first method is appropriate to the majority of the submarine route, where the cable would be laid 6 ft (1.8 m) below the sea floor in two trenches with two cables per trench. The second method is for the transition to landfall where each of the four 115 kV offshore transmission cable system would be routed in its own 18 inch (45.7 cm) diameter HDPE conduit, installed using HDD construction techniques.

As with the onshore cable, no electric field calculations were performed because the electric field of the 33 kV and 115 kV offshore cables would be effectively contained within the body of each cable (i.e., shielded) by its grounded metallic shield.

Any fields produced by the generating equipment in the nacelle of the WTGs would be greatly attenuated at sea level (MLLW is 246 ft [75 m] below the nacelle). Fields produced by the electrical equipment within the ESP can be expected to be comparable to or less than those found in conventional land based substations. The principal sources of magnetic fields in a substation are the exposed high voltage buses (the magnetic field of a transformer is largely contained within the transformer). In the compact gas-insulated design proposed for the ESP, the bus bars are more closely spaced than in an outdoor air insulated substation, so the magnetic flux density is expected to be less. Moreover, any fields experienced on the ESP would be attenuated at sea level (MLLW is 39 ft [12 m] below the ESP deck). Lastly, because the ESP electrical equipment is effectively contained in a grounded metal enclosure, no external electric field is produced. Because of these considerations, the focus of the analysis was on the magnetic flux densities associated with the offshore cables, rather than on the fields generated by the electrical equipment.

Electric Fields

The proposed offshore cables would contain grounded metallic shielding that effectively blocks any electric field generated by the operating cable system. Since the electric field would be completely contained within those shields, there is no perceptible electric field created by the cable system.

Magnetic Fields

The 115 kV offshore transmission cable system would consist of four 3-conductor cables configured as two circuits of two cable sets each. Each circuit would carry half the electrical output of the proposed action at any given moment. Throughout most of the submarine route (all but the HDD), the cables would be laid 6 ft (1.8 m) below the sea floor in two trenches, with two cable sets per trench. The trenches would be spaced approximately 20 ft (6.1 m) apart horizontally.

Calculations were performed to predict the magnetic flux density above the trenches on the sea floor, and at varying water depths above the trenches. The calculations predicted peak magnetic flux densities on the sea floor directly above each cable trench. The field strength decreases rapidly moving horizontally on the sea floor away from the trench. At elevations of 10, 20 and 30 ft (3, 6.1 and 9.1 m) above the sea floor the field strength also decreases as a function of vertical distance. The calculated peak value at the sea floor is (3 mG) and the corresponding field levels above the cable trenches are 0.4 mG at 10 ft, 0.2 mG at 20 ft, and less than 0.1 mG at 30 ft (see [Table 5.3.1-11](#)).

The 33 kV inner-array cables would also consist of 3-conductor solid dielectric cables. The cables would be arranged in strings, each of which would connect approximately 7 to 10 WTGs radially to a 33 kV circuit breaker on the ESP. Some strings may be bifurcated. The electrical current in the cable segments within each string would vary depending on location within the string: cable segments closer to the ESP would carry the output of more WTGs. Three different cable sizes would be used to accommodate this variation. The cables would be buried approximately 6 ft (1.8 m) below the sea floor, one per trench.

Calculations were performed to predict the magnetic flux density over the inner-array cables on the sea floor, and at varying water depths above them. The results are similar to what was found for the 115 kV offshore transmission system cables. Predicted peak magnetic flux densities on the sea floor, directly above the cable, decrease rapidly with distance from the cable and with vertical distance above the sea floor. Magnetic flux density around a cable is proportional to its electrical current, and therefore, the field strength would vary widely depending on the location of the cable segment within a string of turbines and on the output of the turbines. Accordingly, calculations were performed for the most lightly loaded cable segment located at the end of a string and carrying the output of only one WTG, and for a homerun cable segment located between the closest turbine on a string and the ESP (carrying the output of 10 WTGs). The calculated peak value at the sea floor is 28 mG and field levels at the cable trenches are 4 mG at 10 ft, 2 mG at 20 ft, and 1 mG at 30 ft (see [Table 5.3.1-12](#)).

Calculations were also performed to predict the magnetic flux density generated by the 33 kV inner-array cables in the immediate vicinity of the ESP, where they converge. The calculations conservatively assumed five homerun cables, each carrying the maximum load of 10 WTGs separated by one cable diameter. Magnetic flux densities were calculated at a distance of 2 ft (0.61 m) from the cables, which would represent the maximum exposure to marine organisms on the surface of the scour protection. Magnetic flux densities were also calculated at a distance of 10 ft (3 m) from the cables, which would be the closest reasonable approach of a boater to the cables at the point where they rise vertically out of the water up to the ESP. In fact, most responsible sailors or boaters would maintain a much greater distance from this structure. Because the cross-bracing on the ESP support structure would block vessels from passing under the ESP, this was considered the maximum exposure possible for the public at this singular location. While maintenance and construction workers may be briefly exposed to higher levels, such as when in direct contact with the J-tube conduits or in the cable spreading room on the ESP, their exposure would be comparable to that experienced by workers in conventional substations and generating stations. The calculated peak values directly in line with the cables at the 2 ft (0.61 m) and 10 ft (3 m) distance are

473 mG and 51 mG respectively. The calculated values a short distance to the side of the cables are 26 mG at the 2 ft distance and 18 mG at the 10 ft distance (see [Table 5.3.1-13](#)).

[Report No. 4.1.7-1](#) presents additional detail regarding calculations performed to predict future expected magnetic flux densities for the marine portion of the proposed action.

With respect to the cable's landfall, the transition to landfall would change the configuration so that each of the four sets of cables is routed in an 18 inch (45.7 cm) diameter HDPE conduit, installed by HDD. It is expected that the conduits would be spaced 10.5 ft (3.2 m) apart at their seaward end. Peak magnetic flux densities calculated for this configuration directly above the offshore cables at the sea floor, at MLLW and at MHW are 29.2 mG, 18.8 mG, and 11.5 mG respectively (see [Table 5.3.1-14](#)).

EMF Exposure in the Marine Environment

For all of the proposed offshore circuits, the high-voltage conductors are enclosed in a shielded cable, and no external electric field is produced. Therefore, the proposed action would not produce or add to any electric-field exposures in either near shore or offshore waters.

Aside from the exposure to maintenance and other workers, the only possible magnetic field exposure scenarios for humans involve boaters in the proximity of the ESP or divers on the sea floor in the vicinity of the buried offshore cables or in the vicinity of cables that rise from the sea floor to the ESP. Potential exposures for marine organisms would be the same as for divers. The maximum levels of exposure occur over a narrow area along the cables, and decrease rapidly within a few feet of such locations as shown in [Table 5.3.1-15](#). Magnetic flux densities directly over the offshore cables at peak load and in the vicinity of the ESP drop off rapidly with lateral and vertical distance from the cable and with distance from the ESP. Given the small area occupied by the offshore cables and ESP, and because divers or mobile marine species would likely not spend a large amount of time directly over the cables, exposure to magnetic fields would be minimal.

Marine species that may frequent the area around the ESP would be mobile, and therefore, their exposure would be dependent on the amount of time they were in the vicinity of the ESP. Marine benthos such as bi-valves and worms may spend more time in the vicinity of the buried offshore cables and therefore experience more exposure. These organisms are also mobile and have the ability to move horizontally and vertically within the sub bottom sediments. Overall, only a very small fraction of the available habitat would have potential exposure to the higher fields in the vicinity of the ESP.

A recent report on EMFs generated by offshore windfarm cables found that burial of the cable was generally ineffective in "dampening" the magnetic field, but that burial does provide some mitigation for the possible impacts of the strongest magnetic field and induced electric fields that exist within millimeters of the cable (Centre for Marine and Coastal Studies, 2003). The study also found that increased permeability or conductivity of the soils around cable reduced the induced electric field.

There are no anticipated EMF impacts associated with the construction staging/laydown activities at Quonset Rhode Island because it is an existing facility and there would be no or minimal changes to the existing electric infrastructure.

Conclusion

As electric and magnetic field levels would be small, and the exposure to humans and marine life limited largely due to the depth of cable burial, impacts on humans and marine life from electric and magnetic fields during operation of the proposed action would be negligible.

5.3.2 Biological Resources

5.3.2.1 Terrestrial Vegetation

5.3.2.1.1 Construction/Decommissioning Impacts

The terrestrial resources impacted from this proposed action would be located along the onshore transmission cable system starting near the landfall location in Yarmouth and heading to Barnstable Switching Station. The proposed onshore transmission cable system route runs north from the landfall at New Hampshire Avenue in Yarmouth for approximately four miles (6.4 km) within roadway and road shoulder along Berry Avenue, Higgins Crowell Road, and Willow Street, and then the route leaves the roadways for approximately two miles (3.2 km), heading west and then south along the existing NSTAR Electric ROW to the Barnstable Switching Station. The NSTAR Electric ROW is actively managed in accordance with NSTAR's routine vegetation management program.

The proposed onshore transmission cable route within the NSTAR Electric ROW would consist of an excavated trench a minimum of eight ft (2.4 m) wide and approximately 36 manholes. The manhole covers would be flush with the surface of the ground. For terrestrial work, traditional construction equipment such as backhoes and cable trucks would be utilized. The excavation would be backfilled to the original grade, with topsoil replaced on the surface, and the area would be seeded with an erosion control seed mixture for stabilization. The total width of workspace disturbance would be approximately 25 ft (7.6 m), including construction access, laydown areas, and the eight ft (2.4 m) wide trench. This work would require the temporary disturbance of approximately 5.8 acres/252,648 ft² (23,471.6 m²) of vegetation within the maintained ROW. The existing Barnstable Switching Station property can accommodate the addition of the proposed transmission cable with no additional land required.

Decommissioning of the onshore transmission cable system components would involve leaving in place the conduits, ductbanks and underground vaults beneath the roadways and the existing NSTAR Electric ROW but disconnecting and removing the underground conduit system. The onshore transmission cable system would be reeled and the reels would be transported to the staging area for further handling. The decommissioning of the onshore transmission cable system would be much shorter in duration than the installation because less work would occur since the conduit and vaults are being left in place. The vegetation impacts from the decommissioning activities would be reduced compared to construction since the entire route would not be disturbed, only the areas at the vaults or where reel up occurs.

Spills during equipment refueling, hydraulic line leaks or ruptures, or sloppy application of lubricants and greases could result in contamination of soils. The applicant would construct and operate the proposed action with an approved SPCC Plan, which should serve to minimize the potential adverse effects of such unintentional releases on the environment, including vegetation and vegetated habitats.

Impacts on Terrestrial Flora

The proposed action was designed to avoid impacts to previously undisturbed landscapes. The proposed transmission cable system route from the landfall location to the Barnstable Switching Station includes work within existing paved roadways and the existing maintained NSTAR Electric ROW. Although no disturbance of natural woodlands is planned, there may be some minor tree removal (if needed) along the ROW and road shoulders of the proposed transmission cable system. By planning the proposed action to use existing disturbed and managed areas, the proposed action would not result in extensive vegetation removal, especially of woody species, and would not directly impact freshwater wetlands.

To limit possible impacts to the surrounding landscape the following protocol would be used to facilitate revegetation along the undeveloped portions of the disturbed ROW. Sedimentation and erosion control devices would be installed as needed in uplands and near wetland areas along the edge of the construction ROW to prevent sediment flow into adjacent waterbodies and wetlands. Erosion and sediment control devices would be installed following vegetative clearing operations, but prior to grading and trenching in order to insure proper installation.

Although it is unlikely that there would be any trees taller than 15 ft (4.6 m) in the ROW, any trees 15 ft (4.6 m) in height or greater would be cleared and stockpiled for later wildlife habitat use. The understory vegetation and topsoil would then be stripped and stored along the trench. After the transmission line installation, topsoil would be re-spread, since separate topsoil stockpiling and replacement is important for successful vegetation re-establishment. The topsoil would be replaced as quickly as possible to minimize drying soils, germinating seeds, leaching nutrients, and declining microorganisms.

After the topsoil is re-spread, any trees that were cleared before would be placed evenly across the construction ROW (horizontally). The logs provide an effective erosion barrier and act as sediment traps. The logs provide habitat for pioneer animals such as insects and later, small mammals. The logs would also add organic material to the soil as they decompose.

Finally, the construction ROW would be seeded to ensure soil stabilization. A typical seed mix used for ROW revegetation might be composed of the following species: Creeping Red Fescue (*Festuca rubra*), Annual Rye-grass (*Lolium multiflorum*), Timothy (*Phleum pratense*), White Clover (*Trifolium repens*), Little Bluestem (*Schizachyrium scoparium*), Red Top (*Agrostis alba*), and Side-oats Gramma-grass (*Bouteloua curtipendula*). It is an appropriate seed mix for road cuts, pipelines, detention basin side slopes, and areas requiring temporary cover during the ecological restoration process. The mix would be applied by hydro-seeding or by mechanical spreader at a rate of 35 lbs per acre. The soil would be raked to create grooves and provide a seedbed. After applying the seed, the soil would be lightly raked over and organic fertilizer (Neptune's Harvest Fish/Seaweed Fertilizer Blend 2-3-1 at a rate of 20 gallons mix per acre or equivalent) would be applied. A slow release and low nitrogen organic fertilizer is being used since the site of the proposed action is within a Significant Natural Resource Area for the presence of public water supply wellhead protection area. If seeding is by mechanical spreader, the construction ROW would be covered with a light mulching of certified weed free straw to conserve moisture and to aid in slope stabilization.

Following soil stabilization, pre-existing seeds within the re-spread topsoil would begin to sprout. The shrub and tree roots remaining in the disturbed but untrenched areas of the ROW are expected to further enhance revegetation of the ROW within two growing seasons. Based on the applicant's previous project experience on Cape Cod, scrub oak would resprout and grow to two to three ft (0.61 to 0.91 m) after one full growing season.

According to the NHESP, the proposed terrestrial cable route intersects mapped areas of habitat for the Plymouth Gentian (*Sabatia kennedyana*) a species of special concern. These mapped areas are: PH 88, EH178, PH 40, EH 680, and EH 188. Because these locations occur along the roadway portion of the onshore cable route, with construction occurring in the roadway or road shoulder, the impact to the Plymouth Gentian would be negligible. The proposed terrestrial route intersects PH 88 and EH 178 in the existing utility ROW portion of the route. The area where this occurs is in the buffer zone for Wetland 6 (see [Figure 4.2.1-1](#)). Plymouth Gentian is list as an obligate wetland plant for Region 1 according to the USDA plants database (NRCS, 2007). Because the proposed route is in the buffer zone of Wetland 6 and not in Wetland 6, the Plymouth Gentian is unlikely to occur in the work areas along the proposed route.

Through the proper implementation of construction BMPs, the potential for indirect impact to the Plymouth Gentian would be negligible.

During decommissioning, impacts to the terrestrial flora would be greatly reduced compared to the installation impacts by limiting the activity to reel locations and not excavating the entire onshore transmission route. The erosion controls and revegetation procedures that are discussed in the construction impact sections would also be employed during the decommissioning phase of the proposed action to reestablish disturbed areas created during the proposed action's decommissioning. It is possible that there could be some tree removal in the reel up locations to create a safe working environment. Since this would represent a small fraction of the proposed route, these impacts are considered negligible to minor.

Conclusion

During construction and decommissioning, impacts to the terrestrial flora are expected to range from negligible to minor as these impacts would be temporary in nature, and localized. During decommissioning there could be some tree removal in the reel up locations to create a safe working environment. This represents a small fraction of the route and these impacts would be negligible to minor in nature. The impact to the Plymouth Gentian should be negligible. With the Plymouth Gentian being an obligate wetland plant and the proposed route being located in the buffer zone of a wetland and not in the wetland, there should be no Plymouth Gentian in the direct path of the proposed route, and implementation of construction BMPs would further help to ensure impacts would be negligible.

5.3.2.1.2 Operational Impacts

During the proposed action's operations, regular vegetation maintenance would be performed along the proposed route along the NSTAR ROW. The vegetation maintenance schedule and procedures would be the same vegetation management plan that is currently employed along the ROW. The vegetation management along the roadway portions of the proposed route would also follow the current vegetation management being employed along the roads of the proposed route. In the event that repairs are needed and the cable system needs to be excavated, it is anticipated that the impact would be similar to the installation impacts, although the duration of the impact would be shorter and the disturbance localized to the repair location. The erosion controls and revegetation procedures that are discussed in the construction impact sections would also be employed during any repair needed along the terrestrial route.

Conclusion

The operations of the proposed action are expected to have negligible to minor impact on terrestrial flora, largely because of the already developed and cleared or maintained characteristic of the route. Impacts from repairs would be similar to the installation impacts, although the duration and extent of the impact would be shorter and smaller and would be considered negligible to minor depending on the repair location and the time of year. A discussion of mitigation is provided in Section 9.0.

5.3.2.2 Coastal and Intertidal Vegetation

5.3.2.2.1 Construction/Decommissioning Impacts

Once the offshore transmission cable system makes landfall at the proposed location, the transmission cable system would be transitioned to the onshore transmission cable system in two below-grade transition vaults. The transition vaults would be located at the land boreholes with the dimensions of approximately seven ft (2.1 m) wide by 34 ft (10.4 m) long by 7.6 ft (2.3 m) deep (see [Figure 2.3.7-1](#)). The transmission cable system transition vaults would be installed within the pavement using conventional excavation equipment (e.g., backhoe).

In an attempt to minimize the release of the bentonite drilling fluid into Lewis Bay during HDD operations, freshwater would be used as a drilling fluid to the extent practicable prior to the drill bit or the reamer emerging in the pre-excavated pit. This would be accomplished by pumping the bentonite slurry out of the hole, and replacing it with freshwater as the drill bit nears the pre-excavated pit. It is possible that some minor residual volume of bentonite slurry may be released into the pre-excavated pit. The depth of the pit and the temporary cofferdam perimeter are expected to contain any bentonite slurry that may be released. Prior to drill exit and while the potential for bentonite release exists, diver teams would install a water-filled temporary dam around the exit point to act as an underwater “silt fence.” This dam would contain the bentonite fluid as it escapes and sinks to the bottom of the pre-excavated pit to allow easy clean-up using high-capacity vacuum systems.

Cable jetting operations would result in the creation of elevated suspended sediment concentrations that could reduce photosynthetic activity in seagrass beds. If the suspended sediment concentrations are high enough for long periods of time, sediment deposition could result in smothering of eelgrass beds. As discussed below, the applicant has undertaken studies of this potential occurrence and taken measures to minimize adverse impacts.

While sedimentation from the trenching process could affect nearby seagrass beds, direct disturbance impacts have been minimized by routing the offshore cables outside of known locations of seagrass. Anchors associated with the jetting vessel positioning would result in localized disturbance to seagrass, if they are deployed within areas of seagrass. Anchor cable sweep would increase the disturbance of seagrass from any anchoring occurring within the seagrass beds.

Impacts on Coastal Flora

Since the landfall location is devoid of vegetation (made up of intertidal sand and mud flats and concrete) and the transmission cable route immediately heads under an existing paved road, the impact to any coastal flora would be negligible. Inside the proposed action’s buffer zone, there are residential properties directly east and west with associated yards with riprap and concrete walls towards the water. There are no known significant populations of coast flora at the landfall location. A salt marsh is located approximately 200 ft (61 m) west of the landfall location, but would remain unaffected by the proposed action due to the distance from the cable landfall and use of HDD technology for transmission cable installation.

Impacts on Seagrass Beds

In order to address special concerns about the potential effects of the jetting operation on an eelgrass bed identified just west of Egg Island in Lewis Bay, simulations of sediment transport and deposition from jet plow embedment of the offshore transmission cable system and the inner-array cables were performed. These simulations, which used two models (HYDROMAP to calculate currents and SSFATE to calculate suspended sediments in the water column and bottom deposition from the jet plow operations), estimated the suspended sediment concentrations and deposition that could result from jet plow embedment of the cables. The full analysis is included in [Report No. 4.1.1-2](#) and summarized below.

In the area of the eelgrass bed in Lewis Bay, the bottom sediments are relatively coarse. As a result, the sediments suspended by the jet plow are predicted to fall along the route with bottom deposition predicted to be in the range of 1.0 to 3.0 mm (0.04 to 0.1 in) at the western edge of the eelgrass bed. The majority of the eelgrass bed is predicted to experience little or no deposition as a result of the jet plow embedment operations. Suspended sediment concentrations in this area are predicted to be in the range of 50 to 500 mg/L, depending on proximity to the cable route. Suspended sediment concentrations of 10

mg/L are predicted to remain for approximately 9 to 18 hours after the jet plow has passed this point on the route. At the western end of the eelgrass bed, suspended sediment concentrations of 100 mg/L are predicted to remain for up to four hours. Concentrations at that level are not predicted to occur at the bed's eastern end, which experiences maximum concentration levels less than 50 mg/L ([Report No. 4.1.1-2](#)).

Eelgrass beds typically experience some level of sedimentation under natural conditions as a result of tidal currents, waves, and storms. As a result, eelgrass has morphological, physiological, and reproductive means of dealing with exposure to a certain amount of deposited sediments. Regrowth of seagrasses such as eelgrass can occur if sediment deposition only results in a light covering of sediment material and if the rhizome system is not damaged (Duarte, 1997). Since the majority of the eelgrass bed is expected to experience little or no deposition as a result of jet plow operations, it is anticipated that the natural means of seagrass adaptation to changing sedimentation conditions would allow the eelgrass bed to withstand the short-term jet plow operations that would pass by the eelgrass bed ([Report No. 4.1.1-2](#)). In addition, the short duration of exposure to elevated total suspended solids (TSS) levels would have negligible effects on photosynthesis and there should be no indirect impacts to the eelgrass beds.

Macroalgae is less tolerant of suspended and deposited sediments since areas of hard substrate to which the algae attach are typically areas of minimal sediments. However, as with the eelgrass, the duration of anticipated elevated suspended sediment concentrations is unlikely to measurably reduce photosynthesis and there should be negligible indirect impacts to areas of macroalgae. Hard substrates that become covered with sediment up to 0.12 inch (3 mm), may not allow for settlement and attachment of macroalgae, if the hard substrates remain buried during the reproductive period. However, it is likely that wind and tidal induced currents may remove deposited sediments, since the Horseshoe Shoal area is shallow and experiences both tidal and wave induced currents.

While the majority of the potential SAV observed in the Horseshoe Shoal area was macroalgae consisting of red macro-algae (*Grinnellia americana*, *Dasya pedicellata* and *Gracillaria tikvahiae*), and green macro-algae (*Codium fragile*, *Ulva lactuca*), some eelgrass was observed. It is possible that some of the small clumps of eelgrass located at the northern end of the western SAV area, per the OSI 2003 and 2005 surveys in the Horseshoe Shoal area, could be disrupted by the cable jetting since an exact survey of eelgrass locations relative to the specific cable routes has not been performed. However, since the cable installation process involves disturbance of only a small percentage of the overall site of the proposed action in the western portion of Horseshoe Shoal, the majority of the small clumps of eelgrass should experience little to no direct impact from the installation and overall impacts on eelgrass would be minor.

Installation of WTG monopiles or ESP piles could result in the permanent loss of marine vegetation at the pile location. Jack up or spud barges could also result in very small, localized loss of vegetation within the footprint of the pads or spuds. However, most of the monopiles occur in areas of no or very sparse macroalgae or seagrass, so direct impacts are unlikely. The dispersed and infrequent loss or alteration of small patches of macroalgae or seagrass would only result in minor affects on these species, and recovery of the area would occur over time.

During decommissioning, the offshore cables would be disconnected and pulled out of the J-tubes on both the WTGs and the ESP, and the cables would be cut below the seafloor. The cables would then be reeled in after being water jetted free of the bottom sand. The jetting to remove the cables would have the same affects as the jetting during cable installation, resulting in direct loss of vegetation within the trench area, and minor indirect sedimentation affects nearby, due to the predominance of coarse sediments which limits sediment resuspension, transport, and deposition.

In association with the construction process, particularly cable jetting, construction vessels would be held in position using a series of large anchors with thousands of feet of anchor cable deployed. While the applicant has committed to using mid-line buoys to help suspend a portion of the cable off the seafloor, there would be areas where the cable sweeps across the seafloor surface as the jetting barge moves. This could have the affect of a wire cheese cutter slicing the top layer of sediment, resulting in disturbance to rooted plants such as seagrass or severing the holdfasts of attached macroalgae which would turn it into drift algae. Since much of the macroalgae experiences seasonal die-back, the anchor cable removal of patches of algae would result in minor changes in the biomass of the algae present along the cable routes at levels well below the natural die-back. Since the presence of seagrass and macroalgae is predominantly only in a portion of the western part of Horseshoe Shoal, only a limited number of the inner-array cables would be constructed where this vegetation occurs.

Conclusion

The construction and decommissioning impacts on coastal flora are expected to range from negligible to minor, considering there is no significant coastal flora located at the landfall location or seagrass within close proximity to the undersea work area. The largest source of potential impact is associated with anchor cable sweep during jetting of inner-array cables in the western portion of Horseshoe Shoal.

5.3.2.2.2 Operational Impacts

The impacts of the buried transmission cable in the coastal and intertidal environment during the operation phase of the proposed action should be negligible, but in the likelihood that the cable needs to be repaired, it is anticipated that the impact would be similar to the installation impacts, although the duration of the impact would be shorter. The nature of the impacts would also be dependent on where the cable repair was needed, since the marine vegetation varies throughout the site of the proposed action. For example, between Horseshoe Shoal and Lewis Bay, there are no areas of seagrass or macroalgae. The probability of a repair being needed, and for it to be required within an area of vegetation, is low. As a result, impacts on marine vegetation during the operational phase if repairs are needed would be negligible.

Conclusion

The day-to-day operational impacts on coastal and intertidal flora are expected to be negligible as the cable is buried and there is no expectation that it would need to be uncovered for normal maintenance, so no seafloor disturbance should occur. Impacts from repairs would be similar to the installation impacts, although the duration of the impact would be shorter and would be considered negligible to minor depending on the repair location and the time of year. The WTGs and ESP maintenance activities would primarily be above water and not involve seafloor disturbance. If the scour protection needs maintenance, there would be disturbance of any macroalgae that has colonized the area, resulting in the minor loss of biomass that was artificially generated due to the installation of the monopiles and scour protection in the first place.

5.3.2.3 Terrestrial and Coastal Faunas Other Than Birds

This section discusses impacts to those animals occurring along the land portion of the cable route as well as bats. There are species that are common to the area that have the potential to be affected by construction/decommissioning and operation of the proposed action. In addition, certain species, such as bats, may spend a majority of their time over land, but do have the potential to occur within the vicinity of the turbines on Horseshoe Shoal.

5.3.2.3.1 Construction/Decommissioning Impacts

Installing the transmission cable within existing roadways serves to greatly reduce the potential impacts to local reptile and amphibian populations as many of the local populations of these species have adjusted the migratory patterns to avoid the roadways as well as the fact that roadways do not serve as habitat for these species.

Small mammals, reptiles, amphibians and invertebrates that utilize onshore areas adjacent to Long Pond may experience limited displacement or mortality during construction, and some foraging opportunities for waterfowl and other wildlife may be lost for a season or two along the disturbed area until vegetation becomes reestablished. However, this represents a small fraction of the maintained ROW habitat available to these species, and these impacts would be negligible.

The Eastern Box Turtle has been known to be found in this general area of Cape Cod along the roadway portion of the landfall route. The roadway itself would not be used for breeding, foraging, or nesting. The roadway may be crossed by the Eastern Box Turtle when migrating from breeding, foraging, or nesting areas, but the temporary affects of construction are limited compared to daily traffic. Overall, the construction impacts on the Eastern Box Turtle would be negligible. Since decommissioning only involves work at reel in locations, potential decommissioning impacts would be even less than during construction.

The impacts to state listed T&E invertebrates would be minimized by installing and decommissioning the onshore transmission cable system during times when these threatened species are limited to the wetlands, that is, seasonal periods outside of summer months. This would be accomplished by installing the cable system when damselfly and dragonfly species are in there egg or aquatic nymph phases of their lifecycles and through the use of proper construction BMPs to prevent any sediment from entering wetlands. Using these BMPs, the construction impacts on the threatened or endanger damselfly and dragonfly species would be negligible. The damselfly and dragonfly egg or aquatic nymph, phase of life is also the Water-willow Stem Borers egg or larval phase of life. The Water-willow Stem Borer is a moth that is only found in southeastern Massachusetts. According to the NHESP fact sheet on the Water-willow Stem Borer, the only plant species used by the Water-willow Stem Borer is swamp loosestrife (*Decodon verticillatus*). Swamp loosestrife is listed as an obligate wetland plant for Region 1 according to the USDA plants database. With the proposed route only being in the buffer zone of wetlands, rather than directly crossing freshwater wetlands, no Swamp loosestrife would be directly damaged by the construction activities and with proper construction BMPs, the potential for indirect impact on the Water-willow Stem Borer would be negligible.

Short-term displacement and avoidance of active construction areas would have a localized and minor affect on wildlife present along the ROW route by causing them to temporarily abandon feeding, breeding, and resting activities. Most wildlife species are anticipated to move into similar nearby habitat areas until construction is completed and the disturbed areas become revegetated. In addition, small mammals, such as voles, may suffer some mortality due to trenching activities. However, the noise and vibration of construction machinery may cause some individuals to leave the construction workspace in front of the trenching activity, thereby avoiding mortality.

Spills during equipment refueling, hydraulic line leaks or ruptures, or sloppy application of lubricants and greases could result in contamination of soils. The applicant would construct and operate the proposed action with an approved SPCC Plan, which should serve to minimize the potential adverse affects of such unintentional releases on the environment, including wildlife.

During the construction installation phase and decommissioning in the ROW, the local terrestrial wildlife may be disturbed by construction activity and noise. The construction activity would most likely cause some wildlife to alter their travel patterns but this would be limited to small-localized areas. This impact would be relatively short in nature and be limited to small-localized areas. During the roadway installation, the noise could also disturb some of the wildlife. However, due to the installation being under the current roadway, much of the wildlife inhabiting the surrounding landscape should be accustomed to noise produced by traffic and should be familiar with avoiding the road. Thus noise impact to wildlife would be minor.

Significant bat foraging locations or migratory corridors are not anticipated to be impacted by construction or decommissioning of the WTG structures. Construction of the WTGs would not result in the loss of roosting habitat. Construction and decommissioning activities including the transport of large equipment, increased vessel traffic, monopile driving, or cable trenching are anticipated to have negligible to minor impacts to bat habitat as bats are not expected to frequent the area of the proposed action.

Onshore activities associated with installation of the transmission cable system would occur in existing ROWs (road or transmission line) within a developed region, and would therefore not result in loss of habitat. Use of onshore locations for the staging of offshore construction and decommissioning equipment would occur at existing developed locations that experience similar uses. Therefore, onshore activities associated with construction or decommissioning of the proposed action are not expected to result in loss of bat habitat.

There is a potential for collisions of bats with WTGs under construction, or construction equipment, if bats' migratory movements were to occur within the area of the proposed action. More information is needed to assess bat occurrence and flight behavior over areas of Nantucket Sound, as well as the mechanisms that result in collisions, including potential bat attraction to tall structures as potential roost habitat, or noise interferences with bat acoustical detection. However, bat occurrence greater than five miles offshore is anticipated to mainly be limited to migratory or dispersal periods due to the lack of suitable habitat offshore. Additionally, bat migratory or dispersal movements across the Sound are expected to be sporadic. There are no known bat migration corridors through the site of the proposed action and bats are not expected to frequent the area of the proposed action. Therefore, the risk of collision during construction or decommissioning activities is anticipated to result in negligible to minor impacts to bats.

Conclusion

The construction and decommissioning impacts on terrestrial and coastal faunas other than birds are expected to be negligible to minor. Short-term displacement and avoidance of active construction areas and noise disturbances are expected to have a minor impact on wildlife present along the ROW. The decommissioning activity should have a negligible impact to the wildlife along the proposed route, with the affected locations representing a small fraction of the habitat available to these species.

5.3.2.3.2 Operational Impacts

By landscapes along the proposed cable route not changing in land management or land use, the resources available to the fauna using terrestrial route should not be significantly different from the current condition. In the event that repairs are needed and the cable system needs to be excavated, it is anticipated that the impact would be similar to the installation impacts, although the duration of the impact would be shorter. This would again cause some localized displacement of wildlife in the repair area work zone. This would also disturb any wildlife habitat that has established itself on top on the buried utility cable system. However, this would represent a small fraction of the proposed route.

Onshore wind projects have emerged as a potentially significant source of mortality for migrating bats based on the results of recent studies (Johnson and Strickland, 2004; Kerns and Kerlinger, 2004; Arnett et al., 2005; Curry and Kerlinger 2007; Kunz et al., 2007). These studies have raised numerous concerns regarding the potential for collision mortality associated with wind turbines to impact bat populations (Williams, 2003). However, the concerns lie primarily with wind farms on forested ridgelines in the eastern United States, where documented bat fatality rates have been considerably higher (bats/turbine/year) than at western and mid-western wind farms (Johnson et al., 2003; Williams, 2003; Arnett et al., 2005). Mortality at western and mid-western facilities is much lower, with documented fatality rates ranging from only 0.07 to 2.32 fatalities/turbine/year while those from some eastern facilities ranging from 30 to 40 fatalities/turbine/year (Erickson et al., 2001; GAO 2005). Emerging evidence from one facility on the prairies of Alberta, however, indicate that bat mortality in those open habitats can be comparable to that observed along the forested ridgelines of the central Appalachian Mountains (unpublished data presented by Robert Barclay, University of Calgary, Alberta, at the North American Symposium on Bat Research, October 2005).

Several hypotheses regarding bats' vulnerability to collision with wind turbines have been proposed, but none have been adequately tested to date. Bats may be attracted to wind turbines due to curiosity about motion or noise, acoustic interference produced by turbines, or potential roost habitat on the turbines themselves. Insects may also concentrate around turbines due to lighting or the heat of the nacelles, which could in turn attract bats to turbines. Landscape features such as topography, forest edges, roads, or watercourses may serve as corridors for migrating or foraging bats, funneling them towards wind turbines located near these features (Arnett et al., 2005). Some bats that fly close to turbines may not actually collide with turbines but may become trapped in the blade-tip vortices, and may be injured or killed by decompression as the blades rotate downward (Kunz et al., 2007). Specific weather conditions may attribute to bat collisions with wind turbines. Low cloud cover or thermal inversions following the approach of fronts may influence bats to fly at lower altitudes when migrating (Kunz et al., 2007).

Cryan and Brown (2007) determined that certain weather factors are associated with the arrival of migratory hoary bats at an island migration stop-over location in the Pacific. Low wind speeds, low moon illumination, overcast conditions, and low barometric pressure were associated with bat arrivals and departures. Island arrivals were most associated with passing storm fronts in autumn (Cryan and Brown, 2007). High intensity lights emitted from a lighthouse on the island was believed to influence the presence of migratory bats at this location. However, aviation lighting on wind turbines has not been shown to influence bat fatalities at existing wind farms (Cryan and Brown, 2007). The study supports the conventional belief that bats use vision to navigate during long-distance migration, and that bats may orient themselves toward visual landscape features during migration.

A few consistent patterns have emerged from mortality studies of bats at onshore operating wind energy facilities regarding the timing of mortality and the species most commonly found. The timing of fatalities documented at existing wind facilities and other structures suggests that fall migrating bats are at the highest risk, while risk during the summer feeding and pup-rearing period is low (Johnson and Strickland, 2004; Johnson et al., 2003; Whitaker and Hamilton, 1998; Cryan and Brown, 2007). Additionally, only certain species of bats may be at risk. Of the 45 species of bats that occur in the United States, only 6 have been found during mortality searches (Erickson et al., 2001). The species most commonly found during mortality searches are the migratory tree bats (eastern red bat, hoary bat, and silver-haired bat) and the Eastern pipistrelle. Although bat collision mortality has been documented during inclement weather (Johnson et al., 2003), collisions occur most frequently on nights with wind speeds of less than 9 to 13 mph (4 to 6 m/s) (Arnett et al., 2005; Kunz et al., 2007).

Because the exact mechanisms that cause high collision rates among migratory bats at onshore projects are understudied, the process of accurately characterizing potential impacts of an offshore wind farm is difficult. Bats are known to migrate or disperse over-water and they are known to inhabit and stop-over at migratory locations on Martha's Vineyard in Nantucket Sound. Radar surveys conducted in the area of the proposed action in the absence of thermal imaging confirmation to differentiate between bird and bat targets cannot be used to assess bat use of the area of the proposed action. Therefore, there is limited information available to characterize bat frequency and flight behaviors within the area of the proposed action. However, due to the relatively low food availability and a lack of roosting structures offshore, the abundance of bats over the ocean is conventionally believed to be far less than the abundance of bats among onshore habitats.

Mortality data from onshore wind farms indicate that bat collision mortality is expected to occur mainly on nights with calm winds during migratory periods. Species at risk of collision with operating WTG structures mainly include long-distance migratory species. Non-migratory bats are expected to make infrequent crossings of the Sound during dispersal periods, and would therefore be at a very low risk of collision. Long-distance migratory bat species may be at a greater risk of collision due to the observed mortality at existing onshore facilities, however, bat use of Nantucket Sound is poorly understood and basing potential impacts of an offshore wind farm on existing data from onshore facilities may not be appropriate. There are likely differences between bat flight behaviors over water verses over forested landscapes or other open landscapes such as agricultural fields. The actual mechanisms that result in bat collisions as well as bat occurrence and flight behavior within the area of the proposed action require further investigation.

Bats may be among species of terrestrial animals impacted by artificial sources of EMF produced by the onshore transmission cable system. EMF may directly deter bats from an exposed area. Studies show that due to the thermal effects of EMF exposure, bat foraging activity was significantly reduced in habitats exposed to EMF (>2 v/m) when compared to similar habitats with no EMF levels (Nicholls and Racey, 2007). However, the addition of the onshore transmission cable system would not change electric field levels. The electric field within the existing NSTAR Electric ROW would be effectively contained within the body of each underground onshore transmission cable system by a grounded metallic shield. No external electric field would be produced. Upon completion of the onshore transmission cable system the electric fields within the existing NSTAR Electric ROW are expected to be approximately the same as the existing condition, due primarily to the presence of the existing overhead 115 kV lines. Therefore, impacts associated with EMF to bats are anticipated to be negligible.

Conclusion

The day-to-day operational impacts on terrestrial and coastal faunas other than birds are expected to be negligible. Impacts from repairs would be similar to the installation impacts, although the duration of the impact would be shorter and would be considered negligible to minor depending on the repair location and the time of year.

Because bat habitat does not occur within the area of the proposed action, the development of the proposed action is not expected to result in loss of habitat. There are no known migration corridors over Nantucket Sound; therefore, bats are expected to occur infrequently and sporadically within the area of the proposed action during migratory or dispersal periods. Therefore, the presence and operation of the turbines are not expected to present a major barrier to the flight paths of bats. Impacts are expected to be limited to occasional collision mortality associated with bats migrating or dispersing through the area of the proposed action. The proposed action is anticipated to result in minor adverse impacts to migratory bats, and is expected to be negligible for non-migratory bats.

5.3.2.4 Avifauna

Potential impacts to avian species can result from the development and operation of an offshore wind farm. Construction and decommissioning activities can result in disturbances associated with increased human presence or boat traffic, the operation or presence of large construction equipment, displacement due to habitat loss or modification, as well as the risk of collision with WTGs under construction or large equipment. Such impacts can result in changes to foraging or flight behavior resulting in increases in energy expenditure, decreased breeding success, or increased mortality. Operation of a wind facility can result in more long-term disturbances including habitat loss, disturbances associated with EMF from the offshore cables or onshore transmission cable system, or barriers to flight movement due to the presence of operating turbines. Additional disturbances associated with operation of a facility include increased vessel traffic or human presence during routine maintenance activities associated with monopile collapse or cable repair, impacts associated with oil spills, as well as the risk of collision with operating turbines.

Potential project impacts are largely species specific depending on each species use of the area of the proposed action as well as the particular flight or foraging behaviors of a species within the area of the proposed action. The following sections summarize the results of 2002 to 2006 boat, aerial, and radar bird surveys, and describe the potential proposed action impacts, and the magnitude of these impacts that could occur during the construction and decommissioning, and operational phases.

5.3.2.4.1 Construction and Decommissioning Activities

Terrestrial Birds

Raptors (hawks, owls, eagles, falcons, etc.)

There are a multitude of raptor species that occur during the breeding and wintering seasons in the region. A range of species also occur along the Atlantic Coast during spring and fall migration. The potential proposed action impacts to raptors during construction and decommissioning of the proposed action include loss or modification of habitat, impacts associated with EMF from the onshore transmission cable system, the risk of collision mortality. Impacts associated with these sources of disturbance are anticipated to be negligible as most species of raptor do not regularly occur 5 miles (8 km) out to sea. However, exceptions include a few species that are known to cross large expanses of ocean during migration and other raptors species that could get blown offshore during migration. Additionally, osprey may forage in Lewis Bay, the proposed cable landfall location.

Raptor Observations in Nantucket Sound

Raptors observed during surveys consisted of a total of eight ospreys seen during boat surveys in Nantucket Sound on August 15 and 22, 2002, and September 12, 2003 ([Report Nos. 4.2.4-5 and 4.2.4-10](#)). All individuals observed were seen less than one mile offshore south of Falmouth. The ospreys observed were foraging at heights less than 50 ft (15 m). No other raptor species were observed during the 125 aerial surveys or 89 boat surveys of Nantucket Sound conducted between 2002 and 2006.

Raptor Observations at Existing Wind Facilities

Relatively few observations of raptors at existing offshore facilities have been reported. Raptor observations in the vicinity of the Kalmar Sound facility in Sweden during Spring 1999 to 2003 and Fall 2000 to 2003 reported 150 individuals consisting of species of osprey, eagle, harrier, falcon, *buteo*, and *accipiter*. Raptors that flew through the area generally flew at high altitudes 492 to 656 ft (150 to 200 m), above the rotor zone of the Kalmar Sound facility. Migrant raptors that were observed near the project mainly passed between the facility and the shoreline (Pettersson, 2005); however the majority of raptors were observed closer to shore. At the Horns Rev Offshore Wind Farm (Horns Rev) facility in Denmark,

raptor observations near the facility consisted of eight total individuals including species of accipiter and falcon, during survey periods from August 2002 to November 2003, and March through May 2004. A few birds were observed as migrants, however, Eurasian sparrowhawk (*Accipiter nisus*) were observed perching on turbine foundation structures (Christensen et al., 2003).

At land-based facilities located in close proximity to nesting or foraging habitat, high collision mortality of raptors has been reported. White-tailed eagles have experienced high mortality at an island-based facility on Smola off of the northwest Norwegian coast (Bird Life Intl., 2006). The island was designated as an Important Bird Area due to a high density of the nesting eagles. Altamont Pass in California is notorious for its high raptor collision mortality mainly due to turbines located in the vicinity of optimal foraging habitat and the model of turbines that occur there. Raptor mortality in the United States, outside of California, has been documented to be very low. For example, mortality rates found at onshore wind developments outside of Altamont Pass have documented 0 to 0.07 fatalities/turbine/year from 2000-2004 (GAO, 2005). As of 2002, there were seven reported raptor fatalities which occurred in North America outside of California (Kerlinger and Curry, 2002) and few have been reported from onshore facilities since then. The factors that explain why raptor mortality outside of California has been notably lower include: significantly lower raptor use of existing area of the proposed actions; the lack of topographical features that funnel migrants toward existing facilities; the deployment of larger turbines with slower moving blades that may be more easily avoided by raptors; and the now standard use of tubular towers that eliminate perching sites below the spinning blades.

Potential impacts during construction and decommissioning activities include loss of habitat or habitat modification, and the risk of collision with construction equipment or WTGs undergoing construction.

Onshore activities associated with installation of the transmission cable system would occur in existing ROWs (road and transmission line) within a developed region, and would, therefore, not result in loss of habitat or other disturbances to raptors. Near-shore construction and decommissioning activities may result in the temporary loss or modification of foraging habitat for osprey. Cable trenching would occur in Lewis Bay where osprey may forage. Increases in human presence and vessel activity during construction and decommissioning may temporarily displace foraging osprey. Cable trenching would result in sediment plumes that may temporarily displace prey fish. However, sediment suspended by trenching during cable installation is expected to be localized (20 mm/liter within 1,500 ft [457 m] from the trench) and is expected to quickly resettle (within minutes or up to a few hours). Jet plow embedment would allow for simultaneous plowing and cable-laying to minimize impacts. Therefore impacts to foraging osprey during cable laying are anticipated to be temporary and negligible.

Offshore construction and decommissioning may result in the potential for collision with WTG structures under construction or construction equipment. However, because raptors are mainly diurnal, and have exhibited high turbine avoidance behaviors at wind farms that do not occur in high raptor use areas, and because they are not expected to regularly occur within the area of the proposed action, the risk of collision during construction and decommissioning is low. The risk of collision mortality during construction and decommissioning activities are expected to have negligible impacts to raptors.

Passerines

A substantial portion of the land bird population of North America consists of neotropical and regional migrant passerines. A number of local or migrant passerine species occur in the area of Nantucket Sound at varying times of the year. While it's a conventional belief that coastal areas concentrate migrant songbirds during active migratory flights and during stopover events, little information exists on the actual numbers of night migrants in the air along the Atlantic Coast. While

relatively few species routinely use open water, marine habitat, large numbers of songbirds could occur in and over the area of the proposed action during both nighttime and daytime migration. Migrants may be blown offshore depending on the prevailing wind direction during nighttime movements along the coast. Some neotropical migrant species, specifically those of the family Parulidae (wood warblers), may make substantial water crossings during nocturnal migration (Richardson, 1978). Although a number of terrestrial ornithological radar studies have been conducted to determine the characteristics of nocturnal migration, there is little information available that thoroughly quantifies nocturnal migration over the ocean.

Potential impacts to migratory songbirds during construction and decommissioning of the proposed action include risk of collision with WTGs undergoing construction, and onshore activities associated with installation of the underground transmission line, which would occur in roads and in an existing ROW. The majority of flight heights are well above the rotor zone, and impacts associated with collision mortality during offshore construction and decommissioning are anticipated to be minor.

Onshore activities associated with installation of the transmission line would occur in roads and an existing ROW, and would therefore, not result in any permanent loss of habitat. Construction would cause the temporary displacement of birds that breed or forage in the immediate secondary vegetation or edge habitats present in uplands and wetlands on ROW. During the breeding season, this could include such species as Eastern towhee (*Pipilo erythrophthalmus*), song sparrow (*Melospiza melodia*) and field sparrow (*Spizella pusilla*) within the ROW, and species such as blue-winged (*Vermivora pinus*), prairie (*Dendroica discolor*), and chestnut-sided (*Dendroica pensylvanica*) warblers, and Baltimore oriole (*Icterus galbula*) along the edge of the ROW (King, 2003). Since secondary vegetation will be quickly restored, any impacts due to displacement will be temporary and minor.

Coastal Birds

A number of shorebirds, including piping plover (federally-threatened) and red knot (federally-listed as a species of conservation concern), as well as wading bird species such as herons and bitterns, are known to either breed, stage, or winter along the mainland and island shores of Nantucket Sound and surrounding areas. Wetlands and inter-tidal areas around the bay provide important habitat for a multitude of shorebirds and wading birds, including migratory species that commonly occur along the Atlantic coast.

Construction and decommissioning activities can result in impacts to coastal bird species as a result of disturbances associated with increased human presence or boat traffic, the operation or presence of large construction equipment, displacement due to habitat loss or modification, as well as the risk of collision with WTGs under construction or the risk of collision with large equipment. Such impacts can result in changes to foraging or flight behavior resulting in increases in energy expenditure, decreased breeding success, or increased mortality. Operation of a wind facility can result in more long-term disturbances including habitat loss, or barriers to flight movement due to the presence of operating turbines. Additional disturbances associated with operation of a facility include increased vessel traffic or human presence during routine maintenance activities associated with cable repair in Lewis Bay, impacts associated with oil spills, as well as the risk of collision with operating turbines.

Detailed analysis for species of conservation concern including piping plover and red knot have been provided in [Appendix C](#) and Section 5.3.2.9.

Shorebird Observations in Nantucket Sound

Few shorebirds were observed within the study area during aerial and boat surveys conducted by the applicant and MAS from 2002 to 2006. This may be due to the fact that aerial and boat surveys focused effort on shoal areas within Nantucket Sound instead of the shorelines of the mainland and islands of Nantucket Sound where the majority of local or stopping-over shorebird species aggregate for foraging. Few observations may also represent the limitations to aerial and boat surveys. Low flying, small, light-colored birds may not be easily detected from altitudes of 246 ft (75 m) or greater during aerial surveys. Alternately, high flying birds may go undetected during boat surveys conducted at the surface of the water. Shorebirds species migrating over the Nysted and Horns Rev wind farm in Denmark would have gone undetected by an observer had the radar not detected a flock flying over 984 ft (300 m) (Petersen et al., 2006). Surveys were limited to daytime periods of good visibility, therefore there is no data to describe shorebird occurrence in the study area at night or during periods of inclement weather.

Shorebird observations in the study area were limited to: one American oystercatcher ([Report No. 4.2.4-8](#)); one red knot in a mixed species flock with six other unidentified sandpipers observed flying low over the water near Cape Poge, Martha's Vineyard; and 20 dunlins observed on Muskeget Island ([Report No. 4.2.4-9](#)).

Potential impacts associated with construction and decommissioning activities may include habitat loss or modification, disturbances associated with human presence, the activity of construction equipment, and increased boat traffic, as well as the risk of collision with turbines under construction or large construction equipment.

Habitat Loss or Modification

The effects of habitat loss or modification can result in increases in energy expenditure as birds access alternate foraging habitats, which may ultimately result in decreases in nesting success or survival. HSS does not provide habitat for foraging shorebirds or wading birds, therefore, impacts would be limited to the proposed landfall of the transmission cable. The shoreline where the offshore transmission cable system would make landfall is developed and primarily consists of concrete and stone with minimal sandy areas. This area is not likely to provide important habitat for shorebirds or wading birds. Impacts associated with habitat loss or modification for shorebirds or wading birds at Great Island are expected to be negligible because the shoreline would be drilled under for installation of the cabling.

Specific construction techniques, including horizontal drilling and jet plow embedment, would minimize the impacts to the inter-tidal community within the vicinity of the landfall site. Sediment suspended by trenching during cable installation is expected to be localized (20 mm/liter within 1,500 ft [457 m] from the trench) and is expected to quickly resettle (within minutes or up to a few hours). The laying of offshore transmission system cables in Lewis Bay and near the inlet of the bay are not expected to cause significant changes to the inter-tidal habitat structure or prey availability. The increase in suspended solids and the relocation of sandy sediments would be temporary and would result in no substantial changes in the coastal areas of interior Lewis Bay, or the beaches on either side of the inlet.

Because of the inherent dynamic nature of the inter-tidal zone, disturbances created during construction and decommissioning are not expected to cause lasting or particularly harmful effects. Small mortality events of infaunal organisms are likely to occur, but effects on local inter-tidal assemblages would be negligible. Disturbance of the sea floor within Lewis Bay may provide for opportunistic colonization by disturbance tolerant benthos after construction, and similarly after decommissioning activities; however, these changes are not expected to influence inter-tidal areas. Impacts associated with changes in inter-tidal habitat during installation of the offshore transmission cable system in Lewis Bay are anticipated to result in negligible impacts to coastal bird habitat.

Human Disturbance (human presence, vessel activity, noise created by construction equipment)

Red knot and piping plover are among species of shorebird that are sensitive to human disturbances, particularly during critical nesting or pre-migratory staging periods. Substantial disturbances may flush foraging shorebirds, resulting in increases in energy expenditure, decreased breeding success, and potentially decreased survival. Piping plover may abandon nests as a result of disturbance (USFWS, 1996). Red knot are among species known to be particularly sensitive to relatively high levels of vessel activity (Peters and Otis, 2007). Piping plover are known to nest on Great Island, the beach that occurs in closest proximity to the proposed offshore transmission system cable. Additional shorebird and wading bird species may occur at this beach. However, the island occurs in a developed area which experiences high human activity. The buried cables at their closest point would occur approximately 820 ft (250 m) from Kalmar Point/Dunbar Beach and approximately 1,210 ft (369 m) from Great Island. There would be an 820 ft (250 m) buffer or greater between cable construction activities and the beach area; therefore, increases in boat activity as well as the operation of loud construction equipment offshore would not result in significant impacts to shorebirds or wading birds. Human activity associated with performing the HDDs and pulling the cables through the installed conduits would involve minor and temporary disturbances, similar to other people walking and being present along the shoreline. A tracking system, consisting of a wire to power the drill head may be placed across the beach; however, this disturbance would be equal to a person walking across the beach. Due to the buffer between the beach and offshore construction activities, disturbances associated with construction and decommissioning would be minimal and temporary.

Risk of Collision

Risk of collision is based on the frequency of occurrence through the area of the proposed action, visibility conditions during encounters with structures, and the flight behaviors of birds during crossings of the area of the proposed action. Shorebirds and wading birds typically remain onshore except during migration although they occasionally cross water bodies such as bays to access foraging or high-tide roosting locations. As the site of the proposed action is located over five miles (8 km) offshore, coastal birds may only occur within the area of the proposed action during migration movements. Migrants may occur over areas of Nantucket Sound, however, there are no known shorebird or wading bird migration corridors that occur over HSS. During construction or decommissioning, shorebirds or wading birds may be at risk of collision with WTGs under construction or large construction equipment, particularly species that migrate at night or during periods of low visibility.

There is data that suggest refraction caused by lighting mounted on tall structures during periods of fog and rain can disorient birds traveling at night (Huppopp et al., 2006). Lighting on tall structures is believed to be associated with high collision rates of nocturnal songbird migrants. The effects of lighting on nighttime migrating shorebirds and wading birds are not well studied. Shorebirds and wading birds represent a relatively small fraction of collisions documented with tall, lit structures (Huppopp et al., 2006); however, the effects of refraction to lighting during periods of rain or fog may contribute to increased collision risk.

Petersen et al. (2006) observed a substantial decrease in the volume of migrating birds during weather periods of elevated collision risk. Fewer waterbirds migrated during periods of low visibility and strong headwinds (Petersen et al., 2006). Due to limitations of boat and aerial surveys, there is no coastal bird data available for nighttime migration or inclement weather conditions within the area of the proposed action. However, shorebird species have been documented at flights greater than 1.2 miles (2,000 m), well above the proposed rotor zone during nighttime migration movements (Richardson, 1978b). Shorebirds that migrate both day and night have been documented at heights as high as 2.8 to 3.7 miles (4,500 to 6,000 m) (Sibley, 2001). Shorebird species are known to migrate at altitudes from just above

the surface of the water to 3.7 miles (6,000 m), depending on the altitude where favorable wind conditions exist (Sibley, 2001).

Many species are known to depart beaches for migration during rising tides, throughout the day, but mainly in the late afternoon or early evening (Sibley, 2001). Other observations indicate shorebirds may depart for migration mainly on sunny days, in the few hours before twilight (Harrington, 2001). Inclement weather may deter the departure of migrants as many shorebird species move inland during coastal storms to nearby agricultural fields (Sibley, 2001). Due to the generally high altitude of migrating shorebirds and the low risk of occurrence of shorebirds or wading birds in the site of the proposed action during periods of inclement weather, the risk of collision is low. Nighttime construction activities for the proposed action would occur and lighting would be used to illuminate structures under construction, however, construction activities would be limited on those nights with the greatest risk of collision during inclement weather. The risk of collision or shorebirds is low due to the generally high altitude of migrants and the low chance of occurrence in the area of the proposed action during periods of reduced visibility. Depending on the species affected, impacts associated with collision during construction are anticipated to be minor. Although the risk of collision is anticipated to be low for coastal bird species, any level of collision mortality for species of conservation concern, such as the federally-threatened piping plover, would represent a more substantial impact. The risk of collision of piping plover is discussed in detail in [Appendix C](#) and a more detailed description of risk of collision to coastal birds in general is provided in Section 5.3.2.4.2. Impacts associated with collision during construction and decommissioning activities are anticipated to be minor for coastal non T&E bird species.

Marine Birds

The potential impacts to marine birds due to the proposed action vary among taxonomic groups of birds depending on use of the site of the proposed action, flight behavior within the site of the proposed action (particularly flight altitude), and the duration of time spent in the site of the proposed action.

Construction and decommissioning activities can result in disturbances associated with increased human presence or boat traffic, the operation or presence of large construction equipment, displacement due to habitat loss or modification, as well as the risk of collision with WTGs under construction or large equipment. Such impacts can result in changes to foraging or flight behavior resulting in increases in energy expenditure, decreased breeding success, or increased mortality.

The following sections summarize marine bird uses of Nantucket Sound, and describe the potential proposed action impacts to marine birds according to taxonomic group during the construction and decommissioning phases, and finally, attempts to gauge the magnitude of impacts to marine bird populations.

Marine Bird Observations in Nantucket Sound

Observations of marine birds during aerial and boat surveys conducted by the applicant and MAS documented that the diversity and numbers of birds found in the area of the proposed action is a small subset of those found in other parts of Nantucket Sound (See [Table 4.2.4-2](#) and Section 4.2.4.3 for more detailed study results). Of all the types of marine birds those most often seen on Nantucket Sound include terns and sea ducks.

The majority of tern observations in Nantucket Sound occurred outside of the Shoal study areas. Terns were generally concentrated around the mainland and island coasts of the Sound, particularly Monomoy Island during the late-August and early-September staging period. During this period HSS likely had the lowest level of activity out of any similar habitat surveyed in the Sound.

In general, throughout Nantucket Sound, the numbers of marine birds are highest in the months from October through April. These high numbers are related primarily to the occurrence of wintering sea ducks, mainly common eider, scoters, and long-tailed ducks. Aerial survey data collected by the applicant and MAS from 2002 to 2006 were used to calculate average densities of sea ducks for the season from October 8 through April 23. High densities of sea ducks (>1000 birds per km²) were documented within and on the edge of the area of the proposed action boundary (Report No. 4.2.4-2). This would indicate that in recent winters, sea ducks are using HSS for foraging. Based on winter aerial survey data, the average numbers of eiders detected during surveys were between 60 and 280 (see Tables 4.2.4-15 and 4.2.4-16). Scoters were regularly detected in HSS during winter surveys, often in large flocks (>500 individuals) (see Tables 4.2.4-19 and 4.2.4-20). However, sea ducks were observed to be less abundant in HSS than other parts of Nantucket Sound. The total number of individuals observed in HSS (25,125) comprised 6.8 percent of the total sea ducks observed during aerial surveys, which is substantially lower than the 13 percent expected if the birds had been evenly distributed across the study area.

Terns, skimmers, and gulls

Nantucket Sound is known breeding and foraging habitat to a number of terns including common tern (Special Concern), least tern (Special Concern), and roseate tern (Endangered). A detailed description of impacts to roseate terns is provided in Appendix C. Tern species nest on South Monomoy and Minimoy Islands. A few other species of tern seldom occur in the bay including black (*Chlidonias niger*), arctic, royal (*Sterna maxima*), and Forster's (*Sterna forsteri*) terns. Black skimmers (*Rhynchops niger*), a relative to terns, are known to nest on South Monomoy (USFWS, 2005). Several species of gull are common and numerous in Nantucket Sound during various periods of the year including great black-backed gull, herring gull, ring-billed gull, laughing gull, and Bonaparte's gull. Gulls breed within areas of the Sound, however, their nests in vicinity of protected tern breeding locations are sometimes destroyed for predatory species control.

Terns forage over shallow areas, reefs, and sand spits within the Sound where their prey, primarily sand lance, is available. As gulls are opportunists they take advantage of a variety of food sources, however, over the Sound, their foraging behaviors are similar to terns. During migration, large percentages of the North American populations of roseate, common, and least terns many occur in areas of the Sound.

Habitat Loss or Modification

There is no available tern or gull breeding habitat within or in close proximity to the proposed action boundary, and the transmission cable and proposed landfall would not cross breeding locations. Therefore, the effects of habitat loss or modification would be limited to foraging areas in proximity to the WTGs and submarine cable.

Construction, operation, and decommissioning activities could directly deter terns or gulls or their prey from the area of the proposed action resulting in the temporary or permanent loss of habitat. A decrease in food availability can result in decreased breeding success or increased mortality (Safina et al., 1988). However, baseline surveys conducted in Nantucket Sound documented minimal tern use of the area of the proposed action in relation to other locations in the Sound. Most terns were observed traveling, fewer were seen actively foraging. Terns and gulls are known to regularly forage near recreational fishing boats, ships, and other man-made structures. Terns and gulls are among species of birds that have been observed in the vicinity of operating turbines at European offshore facilities (Everaert and Stienen, 2006; Petersen et al., 2006; Pettersson, 2005). Visual data collected at the Nysted and Horns Rev facility in Denmark indicate that the majority of terns generally avoided the direct wind farm area but increased their use of the 1.2 miles (2 km) zone surrounding the facility (Petersen et al.,

2006). One study documented habituation of gulls to turbines that were constructed on a jetty where the gulls were observed feeding, apparently undisturbed near the turbines (Kerlinger and Curry, 2002). Terns and gulls would be expected to habituate to the presence of the proposed turbines similar to how they have demonstrated habituation to a variety of man-made structures, including other turbines. These birds would likely continue to forage and travel in the vicinity of construction activities and operating WTGs, assuming that their food sources were not displaced.

Vibrations from pile-driving could startle and temporarily displace prey fish from the area of the proposed action. Increases in turbidity from cable trenching could temporarily impede fish foraging and navigation in disturbed areas (Jarvis, 2005). Construction activities could affect fish and benthic communities up to 328 ft (100 m) from the activity (Nedwell et al., 2004 *as cited by* Gill 2005). However, impacts to foraging habitat are anticipated to be minimal as construction activities would be temporary and localized within the area of the proposed action. A jack-up barge (approximately 172 ft² [15.9 m²]) with a crane would be used to install the monopiles. There would be a total of two pile driving rams used to fix the 130 monopile structures into the seabed and it is unlikely that both rams would be used simultaneously. The hollow monopiles are expected to trap the majority of sediment displaced during pile driving. Sediment suspended by trenching during offshore cable installation is expected to be localized (20 milligrams/liter within 1,500 ft [457 m] from the trench) and is expected to quickly resettle (Report No. 4.1.1-2). Jet plow embedment would allow for simultaneous plowing and cable-laying to minimize impacts. As a result of disturbances to sediment during trenching and pile driving, small benthic organisms would be stirred up and prey fish may be attracted to the area to forage. This in turn could attract terns and gulls to forage.

As the area of the proposed action is not a significant foraging location or traveling corridor, and because of the small footprint of the actual development area, minimal habitat loss is anticipated during proposed action construction and operation activities. Impacts associated with displacement of prey fish during construction are anticipated to be minimal and temporary. The natural benthic substrate and prey fish communities would be essentially maintained after a short recovery period, therefore, adverse impacts associated with loss of habitat or modification are not anticipated. The impacts associated with decommissioning are anticipated to be similar to or less than construction activities because pile driving would not be required (Jarvis, 2005).

Human Disturbances

Increases in human presence and vessel traffic could result in impacts to terns and gulls during the construction, and decommissioning phases of the proposed action. A large vessel(s) would be used to transport and install the monopiles, towers, nacelles, hubs, and blades during construction and decommissioning. The vessel would be loaded in Quonset, Rhode Island, and would be anchored near the monopiles that are undergoing construction. During installation and decommissioning of the WTGs, the large vessel would make several trips from Quonset to the area of the proposed action. Additionally, small vessels from Falmouth, Massachusetts, and a maintenance support vessel from New Bedford would make regular trips to HSS during the construction period.

During high surf conditions, workers may be transported by helicopter to the platform on the ESP. There may also be occasional helicopter landings at the ESP in association with some regular maintenance activities. An increase in recreational fishing may occur around the WTGs if fish populations aggregate around foundations. The arrival of vessels and helicopters could temporarily displace terns or gulls from localized areas within the larger area of the proposed action. This type of disturbance already occurs to some extent within and adjacent to the area of the proposed action due to existing levels of vessel activity.

Terns and gulls appear to be less sensitive to human disturbances than other species of birds, and are also thought to be attracted to some areas of human activity (Borberg et al., 2005; Drewitt and Langston, 2006; Sadoti et al., 2005a). Terns are known to habituate to some levels of human presence and disturbance. Terns are regularly observed traveling and foraging in the vicinity of vessels and other man-made structures. At the Nysted and Horns Rev facilities in Denmark, gulls were abundant in the construction area likely as a result of increased vessel activity (Petersen et al., 2006). An increase in the presence of terns and gulls observed in areas around the Horns Rev offshore facility in Denmark was believed to be associated with increased boat activity for maintenance activities (Petersen et al., 2006). Therefore, terns and gulls are expected to continue their traveling and foraging activities despite the presence of increased boat traffic and the few anticipated helicopter landings in HSS. Terns and gulls would be expected to return to the area after the departure of the vessels.

Terns and gulls are expected to be among those species of bird that would habituate to the presence of increased boat traffic associated with construction and decommissioning activities. Therefore disturbances associated with increases in human presence and vessel activity are anticipated to have minor impacts on terns.

Risk of Collision

The potential exists for terns and gulls to collide with WTGs under construction, and large construction equipment. The results of available mortality studies indicate that the majority of avian collisions with man-made structures take place at night during periods of inclement weather (Kerlinger, 2000). Birds that fly within proximity to construction equipment or within the rotor zone of the turbines would be at greatest risk of collision. Risk of collision is expected to result in minor impacts to gull species based on the stable populations of species that are most abundant in the area (risk of collision is discussed in more detail in Section 5.3.2.4.2). Impacts to terns associated with collision during construction are anticipated to be moderate (risk of collision is discussed in more detail in Section 5.3.2.4.2). Although the risk of collision during construction is anticipated to be low for tern species, any level of collision mortality for species of conservation concern, such as the endangered roseate tern, or for common or least terns (both species of special concern) would represent a more substantial impact. A discussion of the risk of collision specific to roseate terns is provided in [Appendix C](#). Risk of collision for tern species during the construction phase is anticipated to result in moderate impacts.

Pelagic Species (shearwaters, petrels, gannets, auks)

Oceanic or pelagic species such as shearwaters, gannets, storm-petrels, and auks typically spend most of their lives well offshore, particularly during the non-nesting season. However, storm events and strong, consistent on-shore winds can push these offshore species into coastal areas and occasional seasonal influxes of these species might occur during migration. Potential proposed action impacts are limited to risk of collision during operation of the proposed action (See Section 5.3.2.4.2). Due to the infrequent occurrence of pelagic species anticipated during the construction phase, risk of collision is anticipated to be low. Therefore, impacts associated with collision risk are expected to be minor.

Waterfowl and Non-Pelagic Water Birds

There are a number of sea duck, waterfowl, and diving species that occur within Nantucket Sound, particularly during the winter months. Species such as scoter, eider, and long-tailed duck over-winter in large flocks in the region. A number of common and red-throated loon (*Gavia stellata*), as well as grebes, geese, brant, and dabbling ducks are also local to the bay during various times of the year. Double-crested cormorant are abundant in the site of the proposed action through the breeding season and late-fall. Great cormorant occur in the area mainly in the winter months.

Habitat Modification

Habitat modification during construction and decommissioning could displace sea duck and waterfowl. Displacement can lead to over-crowding and competition at alternative foraging sites and can ultimately result in increased mortality of more vulnerable species (Maclean et al., 2006). Optimal foraging locations are generally restricted to waters no deeper than 164 ft (50 m) deep, however, they are typically less than 31 ft (10 m) deep (USFWS, 2001b; Robertson and Savard, 2002). This is due to the energetic costs of diving to access resources. Sea ducks, including long-tailed duck, scoter, and eider, which forage on sedentary benthic invertebrates, are among species most sensitive to loss of habitat due to offshore wind development. A study at the Tuno Knob facility, in Denmark failed to find any evidence that the distribution of common eiders was affected by the presence of the turbines themselves, but was correlated to changes in bivalve distributions (Guillemette and Larsen, 2002). The impact of habitat modification on sea ducks would be dependent on the location of the turbines in relation to suitable feeding areas.

The area of the proposed action is characterized by water depths of 8 to 60 ft (2.4 to 18.3 m), and the average depth is less than 20 ft (6 m). The dominant substrate is medium and fine sand. Benthic macroinvertebrate sampling indicated the HSS benthic community included a variety of organisms such as crustaceans, clams, snails, and worms. Mussel habitat, such as boulders and ledges, are not a notable component of the area of the proposed action. Common eider diet consists mainly of mollusks and crustaceans (Palmer, 1976) and they prefer blue mussels (*Mytilus edulis*) which are typically attached to rocky substrates. Scoter diet consists of mollusks (Bordage and Savard, 1995; Brown and Fredrickson, 1997; Savard et al., 1998), such as Arctic wedge clam (*Mesodesma arctatus*) and Atlantic razor clam (*Siliqua costata*), found in sandy substrates along coastlines (Stott and Olson, 1973). The benthic community provides suitable foraging habitat for scoters and marginal foraging habitat for eiders. Long-tailed duck forage for crustaceans including amphipods and isopods, bivalves, gastropods, fish and fish eggs (Robertson and Savard, 2002). Other waterbirds such as cormorants may prey on small fish in the area of the proposed action.

Surveys conducted in the Nantucket Sound study area indicate that in recent years, sea ducks such as scoter and eider forage in the area of the proposed action during the winter. However, the abundance of sea duck in the area of the proposed action was low compared to other locations surveyed in the Sound, indicating abundant alternative foraging habitat outside of the area of the proposed action ([Report Nos. 4.2.4-2, 4.2.4-12, 4.2.4-13](#)). Long-tailed ducks are thought to forage during the day south of Nantucket Island, on Nantucket Shoals (NS), and then commute in the evening to roost overnight in Nantucket Sound. Because much of the long-tailed duck population of Nantucket Sound is assumed to forage in NS, substantial loss of foraging habitat is not an anticipated impact for long-tailed duck.

During construction, increases in turbidity from cable trenching could temporarily impede foraging, as well as displace prey fish for foraging cormorant. Vibrations from pile driving could displace prey fish as well. Construction activities could affect fish and benthic communities up to 328 ft (100 m) from the activity (Nedwell et al., 2004 *as cited by* Gill, 2005). However, impacts to foraging habitat are anticipated to be minimal as construction activities would be temporary and localized within the area of the proposed action. A jack-up barge (approximately 172 ft² [15.9 m²]) with a crane would be used to install the monopiles. There would be a total of two pile driving rams used to fix the 130 monopile structures into the seabed and it is unlikely that both rams would be used simultaneously. The hollow monopiles are expected to trap the majority of sediment displaced during pile driving. Sediment suspended by trenching during cable installation is expected to be localized (20 milligrams/liter within 1,500 ft [457 m] from the trench) and is expected to quickly resettle (within minutes or up to a few hours). Jet plow embedment would allow for simultaneous plowing and cable-laying to minimize impacts. As a result of disturbances to sediment during trenching and pile driving, small benthic organisms may be

injured or killed. However, such benthic impacts would be minor and there are expected to be minimal impacts to the prey base due to construction of the proposed action.

Due to the small footprint of the actual development area in relationship to the overall habitat available in Nantucket Sound, and due to the relatively low abundance of sea duck and other waterfowl species in the area of the proposed action, minimal habitat loss is anticipated during proposed action construction, decommissioning, and operation activities. Impacts associated with displacement of prey fish during construction are anticipated to be minimal and temporary. The natural benthic substrate and prey fish communities would be essentially maintained after a short recovery period, therefore, adverse impacts associated with loss of habitat or modification are not anticipated. The impacts associated with decommissioning are anticipated to be similar to or less than construction activities because pile driving would not be required (Jarvis, 2005). Therefore, impacts associated with loss of habitat or habitat modification during proposed action construction, and decommissioning, are anticipated to be minor.

Human Disturbances

Disturbances such as increased human presence and vessel activity during proposed action construction and decommissioning associated with the operation of loud construction equipment may result in impacts to sea ducks and waterfowl. If these disturbances are substantial, they may displace sea duck and waterfowl. The level of disturbance is based on the proposed action design and proximity to roosting, feeding and breeding habitat (Exo et al., 2003). Divers including loons and scoters are particularly sensitive and could be disturbed during construction and decommissioning activities due to their strong reaction to boats (Maclean et al., 2006).

Noise and vibrations associated with construction activities such as drilling and piling and cable laying can impact the acoustic systems of benthic species within 328 ft (100 m) of the source and can cause some mobile species to avoid the area (Nedwell et al., 2004 *as cited by* Gill, 2005). Underwater noises are known to deter foraging waterfowl from the area (Gill, 2005). As pile driving and cable laying would be temporary and limited to small areas directly under construction, these disturbances are expected to result in minimal impacts to foraging birds (see previous section for a description for impacts associated with habitat modification).

Observations at existing offshore facilities indicate that increased vessel activity during the construction and decommissioning could result in disturbances to sea duck or waterfowl foraging in the vicinity of the area of the proposed action. The area surrounding the proposed development experiences regular vessel activity, therefore, increased human presence or vessel activity is not anticipated to present a substantial increase in disturbances. Results from other facilities indicate that divers and other sea ducks may be displaced by approaching vessels, however, they return after the vessel departs. Therefore, human disturbances are not expected to result in long-term or adverse impacts to foraging sea duck or waterfowl. Minor adverse impacts are anticipated to result from human disturbances associated with construction, decommissioning of the proposed action.

Risk of Collision

The potential exists for migrating or dispersing birds to collide with WTGs under construction and with large construction equipment. The risk of collision depends on use of the area of the proposed action, visibility during crossings of the area of the proposed action, and flight behaviors exhibited during encounters with turbines. In general risk of collision during construction/decommissioning is expected to be negligible as impacts associated with collision are primarily related to operation of the wind turbines (See Section 5.3.2.4.2).

Conclusions on Construction/Decommissioning Impacts

Based on research cited and information discussed herein, with respect to affects resulting from habitat modification, human disturbance, and risk of collision, the overall construction and decommissioning impacts to non T&E avifauna would be minor.

5.3.2.4.2 Operational Impacts

Terrestrial Birds

Raptors (hawks, owls, eagles, falcons, etc.)

The potential impacts to raptors associated with operation of the proposed action include loss or modification of habitat, a barrier effect due to the presence and operation of the WTGs, and risk of collision with the operating WTGs, and impacts associated with EMF from the onshore transmission cable system,

Osprey, in outstanding situations have been known to forage as far offshore as 0.6 to 3.2 miles (0.6 to 5 km) (Poole et al., 2002), however, they would not be expected to forage in HSS which is approximately 5 miles (8 km) offshore. No other raptor species would be expected to forage in the vicinity of the proposed action (Buehler, 2000). Therefore, no loss of habitat is expected to occur in HSS. Habitat loss associated with the presence of the offshore transmission cables system within Lewis Bay is anticipated to be negligible for raptors, since the buried cable does not represent a permanent alteration of habitat. During operation, the cable itself would result in minimal influences on the benthos, and therefore impacts to raptor foraging locations would be negligible.

There is a potential that the presence of WTG structures or ESP could result in habitat modification in the form of perching opportunities for migrant raptors. A Eurasian species of raptor at the Horns Rev facility was occasionally observed perching on turbine foundation safety railings (Christensen et al., 2003). However, specific design features have been incorporated to discourage avian perching on the ESP and WTG structures. The above water foundations, WTGs, and the ESP would be equipped with stainless wire and vision restriction perch deterrent devices. Each turbine foundation would have a deck which would be covered by aluminum chain link fencing to discourage access on the sides (and the deck overhangs the access ladder). There would be a taught 0.12 inch (3 mm) stainless steel wire on top of the railing, and a 25 inch (0.65 m) solid panel to restrict the view of birds from the deck. The spacing between the wire and the rail would be 1.2 inch (3 cm). The ESP would have a perimeter railing and the ladders and railing would be equipped with stainless steel wire, chain-link fence, and panels similar to the WTG foundations. The use of tubular towers instead of lattice towers also discourages perching. Therefore, it is not anticipated that migrant raptors would use structures in the site of the proposed action for perching habitat.

The presence and operation of WTGs may result in a barrier to the flight path of migrating raptors. Due to the northeast to southwest orientation of the Atlantic Coast, many raptor and owl species follow the major ridgelines and the Atlantic coastline as 'leading lines' while migrating. Some species are known to occasionally migrate offshore and others may be blown offshore by changing weather conditions. Most raptor species are not expected to occur in the area of the proposed action during migration as most species generally avoid major water crossings (Wheeler, 2003). Exceptions include peregrine falcon, merlin, Northern harrier, and, occasionally, sharp-shinned hawk, and short-eared owl (Wheeler, 2003; Warkentin et al., 2005; MacWhirter and Bildstein, 1996; Wiggins et al., 2006). Wind direction and speed could result in migrants getting blown offshore while following the coast, however, raptors have been observed making adjustments to their flight behavior to avoid flying away from land in changing wind conditions (Crocoll, 1994; Bildstein and Meyer, 2000; Curtis, 2006). There are no

topographic features (such as leading lines or shortest crossings) that would funnel migrants that may occur offshore into the area of the proposed action. If migrants were to occur offshore, they would not be expected to concentrate in the area of the proposed action. Therefore, it is not anticipated that development of the proposed action would result in a significant barrier effect to raptors that may occur offshore. Raptors may make alterations to their flight behavior to avoid encountering turbines during migration (refer to the following section describing turbine avoidance behavior); however, increases in energy expenditure are anticipated to result in negligible impacts to migrating raptor.

Raptors may be among species of terrestrial animals impacted by artificial sources of EMF. Some birds can detect the earth's magnetic fields and may use magnetic fields for orientation during migration (Hanowski et al., 1996). Artificial sources of EMF could potentially influence the navigational systems and reproductive success of birds, including raptors (Fernie et al., 2000; Hanowski et al., 1996). However, the addition of the onshore transmission cable system would not change electric field levels. The electric field within the existing NSTAR Electric ROW would be effectively contained within the body of each underground onshore transmission cable system by a grounded metallic shield. No external electric field would be produced. Upon completion of the onshore transmission cable system, the electric fields within the existing NSTAR Electric ROW are expected to be approximately the same as the existing condition, due primarily to the presence of the existing overhead 115 kV lines. Therefore, impacts associated with EMF to raptor species are anticipated to be negligible.

There is a risk of collision of migrant raptors with the operating turbines. The risk of collision depends on the frequency of occurrence in the area of the proposed action, weather conditions and visibility during encounters with WTGs, and the flight height of traveling raptors. Daytime boat and aerial surveys between 2002 and 2006 documented no raptor observations within the area of the proposed action. HSS is not anticipated to be an area of concentrated use by migrant raptors. The flight behaviors of raptors, if they were to occur in the area of the proposed action would depend on weather conditions.

The majority of raptor migration flights have been documented at elevations well above the proposed rotor zone 75 to 440 ft (23 to 134 m) (Poole et al., 2002; MacWhirter and Bildstein, 1996) although some have been documented flying just above the surface of the waves (Warkentin et al., 2005). Limited information on owl migration flight behaviors suggest owls occur at relatively low altitudes. Observations of barn owls over coastal migration sites reported flight altitudes greater than 32.8 ft (10 m) (Marti et al., 2005). Long-eared owls have been observed flying at altitudes of 98 to 164 ft (30 to 50 m) just after sunset (Marks et al., 1994). The majority of raptors migrate during the day during periods of strong thermal development when the risk of collision is low. However, some species of raptor, including peregrine falcon and Northern harrier, and owls are known to make movements at night (Wheeler, 2003). Merlin and Northern harrier will fly in periods of light rain and fog when conditions would increase the risk of collision (Wheeler, 2003; MacWhirter and Bildstein, 1996). However, the occurrence of raptors in HSS is anticipated to be infrequent and sporadic therefore the chance of turbine encounters is anticipated to be minimal. Some species of raptor have demonstrated high turbine collision avoidance behaviors at existing onshore wind farms. Whitfield and Madders (2006) used the Band Collision Risk Model to estimate the avoidance rate of hen harriers (*Circus cyaneus*) at eight wind farms in the U.S.: estimates were 100 percent turbine collision avoidance at 6 sites, 99.8 percent at 1 site, and 93.2 percent at 1 site. Another study reported a 99.5 percent turbine avoidance rate for golden eagle (*Aquila chrysaetos*) at a U.S. facility (Chamberlain et al., 2006). These avoidance behaviors reduce the risk of raptor collisions. Additionally, there are observations of raptors waiting out poor weather during migration (White et al., 2002). Although most owl migration occurs at night, movements are associated with clear weather during periods of light following winds (Marti et al., 2005; Cannings, 1993). Therefore, the chance of migrants occurring in the area of the proposed action during periods of elevated risk of collision is low. The risk for collision of raptors with operating WTGs is anticipated to be low; therefore, impacts associated with collision mortality are anticipated to be negligible.

The proposed action is anticipated to result in negligible impacts to raptor foraging habitat. The presence and operation of the WTGs is not expected to present a major barrier to the flight paths of migrating raptors because raptors are expected to occur infrequently and sporadically over the Sound. The overall risk of raptor collisions with WTG structures is low as raptor occurrence in the area of the proposed action is expected to be infrequent and sporadic. Therefore, operation of the proposed action is expected to result in negligible impacts to raptors.

Passerines

A substantial portion of the land bird population of North America consists of neotropical and regional migrant passerines. A number of local or migrant passerine species occur in the area of Nantucket Sound at varying times of the year. While it's a conventional belief that coastal areas concentrate migrant songbirds during active migratory flights and during stopover events, little information exists on the actual numbers of night migrants in the air along the Atlantic Coast. While relatively few species routinely use open water, marine habitat, large numbers of songbirds could occur in and over the area of the proposed action during both nighttime and daytime migration. Migrants may be blown offshore depending on the prevailing wind direction during nighttime movements along the coast. Some neotropical migrant species, specifically those of the family *Paurilidae* (wood warblers), may make substantial water crossings during nocturnal migration (Richardson, 1978a). Although a number of terrestrial ornithological radar studies have been conducted to determine the characteristics of nocturnal migration, there is little information available that thoroughly quantifies nocturnal migration over the ocean.

Potential impacts to migratory songbirds during construction, operation, and decommissioning of the proposed action include risk of collision mortality, and potential impacts associated with EMF from the onshore transmission cable system.

Known Collision Mortality at Existing Facilities

Passerines are the most abundant group of birds occurring in North America and species of this group (e.g., warblers, vireos, thrushes, sparrows) account for up to 80 percent of known fatalities reported at onshore wind facilities (Johnson et al., 2003; Erickson et al., 2001). The estimated mortality rate of birds in Eastern North America due to terrestrial wind energy facilities is approximately 0 birds per kW per year to 11.7 birds per kW per year. However, due to the small size of most passerine species and the inherent difficulty in finding and identifying carcasses near turbines, it is likely that mortality rates have been underrepresented by post-construction mortality surveys (NRC, 2007). Mortality of these species has included both daytime and nocturnal fatalities (Erickson et al., 2001). A wide variety of species have been found during mortality surveys but, to date, no large fatality events, as have been occasionally observed at tall communications towers, have been reported in the literature. In the U.S., outside of California, wind turbines have generally been found to not pose a substantial threat to any one species of bird, though potential impacts at any facility can vary according to location and species presence.

Erickson et al. (2001) provided a summary of known avian collisions with wind turbines. Fatality rates varied from 0 to 4.5 fatalities/turbine/year with most of the reported rates being less than 2 fatalities/turbine/year although more recent work has documented rates as high as 7.28 fatalities/turbine/year (GAO, 2005). They estimate an average of 2.19 bird fatalities/turbine/year in the United States, although this estimate does not reflect the variability in fatalities among wind energy facilities (i.e., some have reported dozens of fatalities while others have reported very few or none). However, they do recognize that sites in California have significantly more fatalities than elsewhere, and estimate the fatality rate to be lower outside of California, at approximately 1.83 fatalities/turbine/year (corrected for searcher efficiency and scavenging).

There are limited data available from existing offshore facilities. A study conducted at a coastal wind farm in the Netherlands documented songbird, water bird, and shorebird collision fatality rates ranging from 0.04 to 0.14 fatalities per turbine per day (Kerlinger and Curry, 2002). The study indicated that these coastal turbines created higher fatality rates than other, onshore wind farms, likely as a result of the large concentrations of migrant and wintering waterfowl, shorebirds, and songbirds in the area (Winkelman, 1995, *as cited by* Kerlinger and Curry, 2002). It was believed that these fatalities were not only linked to migratory flight but also to birds undertaking low flights between feeding locations (Winkelman, 1995, *as cited by* Kerlinger and Curry, 2002).

Risk of Collision

An assessment of nocturnal migration over Cape Cod was made in the early 1960's, using radar. This survey at South Truro, Massachusetts, showed that migration was occurring at heights of approximately 600 ft to over 6,000 ft (183 m to 1,829 m) above ground level (Nisbet, 1963). Subsequent assessments of nocturnal migration in Nantucket sound, using modern radar systems, documented that the majority of nocturnal targets occurred at heights greater than 75 ft (23 m) AMSL (see [Table 4.2.4-4](#); [Report Nos. 4.2.4-5](#), [4.2.4-6](#) and [4.2.4-7](#)).

Flight heights documented during 69 radar surveys conducted over eight seasons in terrestrial ecosystems throughout the Northeast, revealed that flight heights typically average 1,401 ft (427 m) above ground level, and nightly average flight heights ranged from 505 ft (154 m) to 2,112 ft (644 m) above ground level. Average seasonal passage rates ranged from 64 targets/km/hour to 732 targets/km/hour, with an overall average of 313 targets/km/hour (see [Table 5.3.2-1](#)).

In general the characteristics of migration documented at the Nantucket Sound radar site are similar to the characteristics of migration documented across the northeast, over land. However, the average flight heights documented over Nantucket sound are slightly lower than those documented above terrestrial ecosystems, and the passage rates were lower over Nantucket Sound than at the majority of terrestrial radar sites. It is reasonable to assume that although flight heights were on average lower at the Nantucket Sound radar site than at terrestrial sites, the risk of collision with turbines migrants over both inland radar locations and over Nantucket Sound may be comparable and perhaps lower over the Sound due to the slightly lower passage rates observed over the Sound.

It is evident from radar ornithology studies that the majority of nocturnal migrants move above the height of modern turbines. The Nantucket Sound surveys indicate that flight heights there are generally lower than average flight heights documented above terrestrial radar sites, although the majority of targets were flying above the rotor swept zone. The observed lower flight heights at Nantucket may be a result of difference in the radar systems used at the site and those used elsewhere. However, if the data reflect an accurate portrayal of migration over the Nantucket sound, the observed flight heights, which are slightly lower than the average terrestrial flights heights, are likely mitigated by the lower overall passage rate of targets in the area.

Despite the majority of migration occurring well above turbine height birds have been known to collide with tall solid structures, although minimal evidence is available documenting direct turbine blade collisions (Erickson et al., 2001). The ecological significance of the number of birds killed by turbines on regional populations has not been adequately addressed. Similarly, the significance of turbine related deaths in relationship with other anthropogenic mortality events has not been adequately defined. It is estimated that tens of millions of birds are killed annually by colliding with buildings, transmission lines, and vehicles, where as the annual estimate of birds killed by wind turbines numbers in the tens of thousands (Erickson et al., 2001).

Calculating risk of collision to species or groups of birds is difficult because of a paucity of information identifying exposure to collision. Certain passerine species may be more likely to fly within the rotor swept zone and are therefore at higher risk. The specific behavior patterns of birds species or groups coupled with their relative abundance in the proposed development area, must also be considered.

The results of radar surveys can help to identify the magnitude of birds using the air space proposed for turbine construction, and the characteristics of their flight. Because the majority of passerine species avoid water crossings and because nocturnal migration is of a lower magnitude over Nantucket sound than over other inland radar sites available for comparison, it is likely that the risk of collision by nocturnal migrants is less than at terrestrial sites. Comparisons of risk to individuals at terrestrial wind energy facilities and at near shore and off shore facilities can help to put the potential magnitude of mortality into perspective.

It is likely that the specific risk to passerine migrants moving above the proposed Cape Wind facility is similar to the risk presented by inland wind energy facilities. Due to the characteristics of the nocturnal migration documented above Nantucket Sound, the risk to passerines may be similar to or less than that posed by inland facilities, due to the passage rates and flight heights observed ([Report Nos. 4.2.4-5, 4.2.4-6 and 4.2.4-7](#)).

In general nocturnal migrant passerines do not fly within the turbine zone, and those flying over open water often return to land at dawn (Kerlinger and Curry, 2002). Despite the possibility that songbirds may be flying at relatively lower altitudes over Nantucket Sound it is likely that during periods of decent visibility these individuals would not be at risk for collision. The lighting of turbines is an important factor that can change the amount of risk to passerines and can be easily adapted. However, some evidence has shown that lighting structures can increase the risk of collision to birds during migration (Kerlinger and Curry, 2002), particularly during periods of fog or rain (Huppopp et al., 2006).

Collision risk associated with operation of the proposed action for nocturnal migrant passerines is anticipated to be low due to the relatively low passage rates observed over Nantucket Sound, and due to the majority of flight heights well above the rotor zone. It is suspected that the risk posed by the proposed action would be similar to or less than the collision mortality observed at existing facilities. Therefore, the impacts associated with collision mortality are anticipated to be minor.

Electromagnetic Fields

Birds may be among species of terrestrial animals impacted by artificial sources of EMF. Some birds can detect the earth's magnetic fields and may use magnetic fields for orientation during migration (Hanowski et al., 1996). Artificial sources of EMF could potentially influence the navigational systems and reproductive success of birds (Fernie et al., 2000; Hanowski et al., 1996). However, the addition of the onshore transmission cable system would not change electric field levels. The electric field within the existing NSTAR Electric ROW would be effectively contained within the body of each underground onshore transmission cable system by a grounded metallic shield. No external electric field would be produced. Upon completion of the onshore transmission cable system the electric fields within the existing NSTAR Electric ROW are expected to be approximately the same as the existing condition, due primarily to the presence of the existing overhead 115 kV lines. Therefore, impacts associated with EMF to passerine species are anticipated to be negligible.

Coastal Birds

Operation

The potential impacts to shorebirds or wading birds during proposed action operation may include impacts associated with disturbance from vessel activity during cable repair, impacts associated with oil spills or WTG or ESP damage fluid spills, the risk of collision of migrants with WTG structures, as well as barrier effects to traveling birds.

Vessel Traffic

There would be an increase in vessel activity associated with maintenance of the WTGs during the operation of the proposed action. During operation, maintenance vessels would mainly operate out of Hyannis or similar Cape Cod ports. These ports have adequate facilities for berthing and loading of the maintenance vessels. These ports occur in developed areas and currently experience similar uses. There are no known important coastal bird areas in the vicinity of these ports, therefore, the increase in vessel activity in these areas is anticipated to result in negligible impacts.

There may be an increase in vessel activity associated with offshore cable repair during the operation phase. However, the cable is designed under normal conditions to last the life of the proposed action. The buried cables at their closest point would occur approximately 820 ft (250 m) from Kalmar Point/Dunbar Beach and approximately 1,210 ft (369 m) from Great Island. Near shore maintenance activities in Lewis Bay would be temporary and there would be an 820 ft (250 m) or greater buffer between the offshore cable maintenance activities and potential shorebird habitat. Therefore, disturbances associated with maintenance activities are anticipated to result in negligible impacts.

Oil Spills

The presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions and possibly oil spills. Oil spills may result in the release of contaminants from vessels or from the WTG or ESP foundations themselves. Depending on the location and the size of a spill, shorebirds and wading birds may be impacted. If the feathers of birds become coated with oil, birds lose their ability to repel water and to insulate, and in some instances, lose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2005). Shorebird habitat was impacted by the oil spill, particularly at Barney's Joy, Dartmouth, and shorebird mortality was a resulting impact (NOAA, 2005), including 18 shore birds (12 dunlin, 2 willet, 4 yellow-leg), but no wading birds were documented (BBNEP, 2005).

Monopile collapse, vessel collisions, or storm damage to the ESP or WTG structures could result in oil or other fluid contamination. The total maximum oil storage on the ESP is expected to be approximately 42,000 gallons at any given time. The total oil storage at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). In the unlikely event that an oil spill was to occur, the oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent). It has a 90 percent chance of impacting any shoreline in the area.

The potential impacts of oil spills associated with the operation of the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the mortality of coastal birds if nesting, staging, or over-wintering areas were to be impacted. However, the event of an oil spill is unlikely, and due to the distance between the WTG area and the closest potential habitat on either the mainland or island shores of Nantucket Sound, the potential for impacts are reduced. Therefore, oil spills are anticipated to result in minor adverse impacts to coastal birds.

Risk of Collision

Risk of collision is based on the frequency of occurrence through the area of the proposed action, visibility conditions during encounters with wind turbines, and the flight behaviors of birds during crossings of the area of the proposed action. Shorebirds and wading birds typically remain onshore except during migration although they occasionally cross water bodies such as bays to access foraging or high-tide roosting locations. As the site of the area of the proposed action is located over five miles (8 km) offshore, coastal birds may only occur within the area of the proposed action during migration movements. Migrants may occur over areas of Nantucket Sound; however, there are no known shorebird or wading bird migration corridors that occur over HSS. During operation of the wind farm, shorebirds or wading birds would be at risk of collision with WTGs, particularly birds that migrate at night or during periods of low visibility.

There is data that suggest refraction caused by lighting mounted on tall structures during periods of fog and rain can disorient birds traveling at night (Huppopp et al., 2006). Lighting on tall structures is believed to be associated with high collision rates of nocturnal songbird migrants (Huppopp et al., 2006, Shire et al., 2000). The effects of lighting on nighttime migrating shorebirds and wading birds are not well studied. Shorebirds and wading birds represent a small fraction of collisions documented with tall, lit structures (Huppopp et al., 2006; Shire et al., 2000); however, the effects of refraction to lighting during periods of rain or fog may contribute to increased collision risk of these birds. However, Petersen et al. (2006) observed a substantial decrease in the volume of migrating birds at an offshore wind farm in Europe during weather periods of elevated collision risk. Fewer waterbirds migrated during periods of low visibility and strong headwinds (Petersen et al., 2006).

Due to limitations of boat and aerial surveys, there is no coastal bird data available for nighttime migration or inclement weather conditions within the area of the proposed action. However, shorebird species have been documented at flights greater than 1.2 miles (2,000 m), well above the proposed rotor zone during nighttime migration movements (Richardson, 1978b). Shorebirds that migrate both day and night have been documented at heights as high as 2.8 to 3.7 miles (4,500 to 6,000 m) (Sibley, 2001). Shorebird species are known to migrate at altitudes from just above the surface of the water to 3.7 miles (6,000 m), depending on the altitude where favorable wind conditions exist (Sibley, 2001). Available data from existing offshore facilities in Europe indicate shorebird species generally migrate at altitudes well above the rotor zone, and birds that occur in the vicinity of the wind farm make efforts to avoid flying within the wind farm. Visual confirmation coupled with radar surveys during migration periods from 2003 to 2005 at the Nysted and Horns Rev offshore facility in Denmark observed shorebird migration through the project area. Shorebird migration generally occurred at altitudes high above the wind turbines >0.18 miles (>300 m). The flight altitude of one flock of shorebirds was estimated to be 0.25 miles (398 m) above sea level.

Many species are known to depart beaches for migration on rising tides, during all times of the day, but mainly in the late afternoon or early evening (Sibley, 2001). Other observations indicate shorebirds may depart for migration mainly on sunny days, in the few hours before twilight (Harrington 2001). Inclement weather may deter the departure of migrants as many shorebird species move inland during

coastal storms to nearby agricultural fields (Sibley, 2001). It is, however, during periods of inclement weather when birds are traveling at lower altitudes or when birds are arriving or departing stopover habitats that these birds could be most at risk of encountering the proposed wind turbines. In fact, studies from the existing offshore wind farms in Europe indicate that shorebirds can be at risk of collision at stopovers during short flights to foraging or resting areas (Kerlinger and Curry, 2002, Everaert, 2004). However, the location of the proposed turbines would be at least five miles (8 km) from concentrated shorebird or wading bird use areas such as shorelines and shallow areas exposed at low tide; therefore, the risk of collision is reduced.

Due to the generally high altitude of migrating shorebirds and the low risk of occurrence of shorebirds or wading birds in the area of the proposed action during periods of inclement weather, the risk of collision is low. Therefore, collision mortality associated with the proposed action is anticipated to result in minor negative impacts to shorebirds as well as wading birds, with the exception of species of conservation concern. Any level of collision mortality of the threatened piping plover would represent a more substantial impact because the loss of one breeding individual is detrimental to the regional population (the risk of collision of piping plover is discussed in more detail in [Appendix C](#)). Although the risk of collision is low, impacts associated with collision are anticipated to be minor to moderate for coastal bird species.

Barrier Effect

The presence of operating WTGs may present a barrier to the flight path of migrating shorebirds or wading birds. The creation of a barrier may result in increased energy expenditure to avoid the wind farm. Visual confirmation coupled with radar surveys during migration periods from 2003 to 2005 at the Nysted and Horns Rev offshore facility in Denmark observed shorebird migration through the project area. The behavior of shorebirds flying towards the wind farm was noted for four flocks of shorebirds: Golden Plover (N = 11), Curlew (N = 4), Whimbrel (N = 1), and Oystercatcher (N = 15). The flocks of golden plover and oystercatcher passed above the turbines, while the single Whimbrel entered the wind farm at the height of the rotors and flew southward through the wind farm. The one flock of Curlews hesitated before entering the wind farm, then increased their flight altitude and increased their wing beat frequency in order to pass above the wind farm (Petersen et al., 2006). These observations suggest that some birds may increase energy expenditure to fly above or around offshore wind turbines. The energy expended while birds make efforts to avoid offshore wind farms is believed to result in small increases in energy expended during migration movements. These increases are believed to be comparable to other increases in energy spent to avoid additional migration hazards including adverse weather (Petersen et al., 2006). There are no known migration corridors that would concentrate shorebird or wading bird migration through the site of the proposed action, therefore, barrier effects associated with the operating turbines are expected to result in minor adverse impacts to migrants.

Marine Birds

Operation

Operation of a wind facility can result in more long-term disturbances including habitat loss, disturbances associated with EMF from the offshore cable, or barriers to flight movement due to the presence of operating turbines. Additional disturbances associated with operation of a facility include increased vessel traffic or human presence during routine maintenance activities associated with monopile collapse or cable repair, impacts associated with oil spills, as well as the risk of collision with operating turbines.

The following sections summarize marine bird uses of Nantucket Sound, describe the potential proposed action impacts to marine birds according to taxonomic group during the operational phase, and

finally, attempt to gauge the magnitude of impacts to marine bird populations. Detailed analysis for roseate tern, a federally-endangered species has been provided in [Appendix C](#).

Scour control around monopiles and ESP piles would be accomplished either through the use of rock armor or scour control mats. These mats and the monopiles would increase the available surface area and provide substrate for the colonization of benthic invertebrates and habitat for prey fish. Fish may concentrate around turbine foundations similar to how invertebrates cluster around oil platforms (Vella, 2002 *as cited by* Jarvis, 2005). Habitat with more 'physical heterogeneity' can result in greater fish abundance (Jenkins et al., 1997 and Charbonnel et al., 2002 *as cited by* Gill, 2005). The underwater structures could create a localized 'artificial reef effect', providing foraging habitat for terns and gulls. Wide spacing of turbines (0.39 to 0.63 miles [0.63 to 1.0 km] apart) would allow for tern and gull foraging between turbines (see section Risk of Collision below).

The boundary of the area of the proposed action would include approximately 25 square miles (65 km²) of WTGs and ESP (electrical service platform) foundations, and 5.89 acres (0.024 km²) of transmission cable. The total area represents 11 percent of Nantucket Sound (Jarvis, 2005). However, the total area of seabed that would permanently be disturbed would be less than 1 percent of the total wind farm area: including less than one acre (0.004 km²) for the 130 turbines, 100 by 200 ft (30 by 60 m) for the ESP platform, and approximately 2.4 acres (0.01 km²) for scour mat coverage (Jarvis, 2005). The additional amount of surface area (approximately 1,200 ft² or 0.03 acres [111 m²] per tower would result in a minor addition to the substrate that is currently available (Section 3.9 in ESS, 2007). Due to the small amount of additional surface area in relation to the total area of the proposed action in Nantucket Sound, and the spacing between WTGs, the proposed structures are not expected to have a significant effect on the benthic community, the presence of prey fish, or foraging terns or gulls. However, the additional substrate would be oriented vertically in the water column, and could result in localized and minor increases in certain fish prey species.

As the area of the proposed action is not a significant foraging location or traveling corridor, and because of the small footprint of the actual development area, minimal habitat loss is anticipated during proposed action operation activities.

Human Disturbances

While the proposed turbines are in operation, there would be regular vessel trips made from Falmouth and New Bedford harbors to the site of the proposed action. The expected maintenance schedule would be approximately two vessel trips per day for 252 days per year (five maintenance days per turbine per year) (see Section 2.4.3.1). However, the vessels would depart busy ports where similar uses occur, and therefore impacts are limited to areas along the offshore transmission cable system as well as the WTG area.

Terns and gulls are expected to be among those species of bird that would habituate to the presence of increased boat traffic associated with maintenance activities. Therefore disturbances associated with increases in human presence and vessel activity are anticipated to have minor impacts on terns.

Electromagnetic Fields

There is a concern that electromagnetic fields emitted from the offshore cables may impact prey fish. It has been suggested that EMF may disorient or attract prey fish, however, it is unknown what these actual impacts may be (Gill, 2005).

The specifications of the proposed cable system require the cable to be shielded. Since electric field lines start and stop on charges, this shielding would effectively block the electric field produced by the

conductors. Magnetic fields, however, can not be completely shielded because the magnetic field lines do not stop on objects; they form continuous loops around conductors carrying currents. The actual magnitude of typical 60 Hz magnetic fields in the vicinity of the offshore cables is, in most locations, well below that of the geomagnetic field (~ 500 mG). Therefore, no additional electric field impacts are expected to result from the submarine cables. There are no anticipated substantial adverse impacts to foraging birds or their prey from the 60 Hz magnetic fields associated with the operation of the proposed action.

Oil Spills

During operations, the presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions and possibly oil spills. Oil could be released from tankers or damage to WTG structures or the ESP could result in the release of fluid contained within these structures. The total maximum oil storage on the ESP is expected to be approximately 42,000 gallons at any given time. The total oil storage at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). In the unlikely event that an oil spill was to occur, the oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent). It has a 90 percent chance of impacting any shoreline in the area.

Because terns and gulls forage at the water's surface, they are among those species of birds that are particularly vulnerable to oil spills (Jarvis, 2005). If the feathers become coated with oil, birds lose their ability to repel water and to insulate, and in some instances, lose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2005). At least three adult roseate terns were found dead with traces of oil. Terns were discouraged from nesting on Ram Island in 2003 because it was soiled from the oil spill. Consequently, 250 pairs of roseate terns nested on Penikese Island that year and productivity suffered due to the late initiation of egg-laying (BBNEP, 2005). Gull species represented 15 of 315 dead birds collected after the spill.

The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in mortality or could lead to decreased nesting success. Oil spills could directly impact tern colonies, as the Ram Island colony was affected in 2003. However, due to the distance of the proposed action from nesting colonies, oil spills associated with the proposed action are unlikely to impact nesting gull or tern colonies. Some individuals foraging in the direct oil spill area may be displaced from the area, or may become slicked with oil. However, the event of an oil spill is unlikely. Therefore, potential oil spills are anticipated to result in minor adverse impacts to terns or gulls.

Monopile Collapse

In the event of a monopile collapse, recovery and replacement activities would be similar to decommissioning and construction of a single WTG. A very minor amount of benthic habitat would be disturbed with a short term and localized increase in suspended sediments. Foraging opportunities for terns and gulls would be reduced in areas of elevated suspended sediments. Some lubricating fluid would likely leak from the submerged nacelle, but would rapidly disperse given the small quantity involved. However, should a tern or gull dive for fish within this small plume, it could be harmed (see previous section for description of impacts associated with oil spills). There is a low likelihood of this occurrence

and low probability of it occurring coincidentally with tern or gull use of the immediate area. Potential impacts to tern or gull in the event of a monopile collapse would therefore be negligible.

Cable Repairs

Cable repair activities would be similar to cable installation activities, but would occur for a short period in a small discrete location. Cable jetting, splicing, and re-jetting would result in minor and temporary increases in suspended sediments and would temporarily disturb benthos. Tern or gull foraging in areas of elevated suspended sediments would be reduced. In both instances the habitat and species would recover and no impacts to terns or gulls are anticipated from cable repair activities.

Barrier Effect

The presence of wind turbines and the spinning of the blades could present barriers to the flight paths of terns or gulls and could potentially affect or restrict access to breeding, staging, or foraging habitat. A wind farm could potentially lead to significant impacts if it were to occur in an area of high use by birds (Drewitt and Langston, 2006). Barriers can result in increases in energy expenditure if birds are forced to travel greater distances while accessing foraging habitats or while undertaking migration movements. However, there are no known situations where a wind farm has created a 'barrier effect' resulting in an avian population level impact (Drewitt and Langston, 2006).

Terns and gulls have been observed to continue to use WTG areas at existing offshore facilities during both migration and breeding periods. Post-construction radar studies during migration at the Nysted and Horns Rev wind farms in Denmark indicate that, although the greatest levels of movement occurred outside of the wind farms, terns continued to migrate through the wind farm areas (Petersen et al., 2006). The facility is located 8.7 miles (14 km) offshore and is comprised of 80 turbines with a rotor zone of 98 to 360 ft (30 to 110 m). The turbines are spaced 1640 ft (500 m) apart, half the distance of the proposed action turbines. Visual data collected at the Nysted and Horns Rev facility indicate that the majority of terns generally avoided the direct wind farm area but increased their use of the 1.2 miles (2 km) zone surrounding the facility (Petersen et al., 2006). Terns were observed foraging at the outer edges of the facility around turbine structures. Small flocks flew into the farm, but then exited the area after passing through the second row of turbines (Petersen et al., 2006). Sandwich terns (*S. sandvicensis*) entered the wind farm between two turbines more frequently when one or both of the turbines were not active (Petersen et al., 2006). Common and arctic terns (*S. paradisaea*), observed flying in the vicinity of turbines at a facility in Kalmar Sound, Sweden, flew between turbines or right next to the turbines instead of veering off in wide curves as waterfowl species were observed to do (Pettersson, 2005).

A post-construction study at the Zeebrugge wind farm in Belgium investigated the level of project disturbance on nesting terns. An artificial peninsula, created to provide nesting habitat for common, sandwich, and little (*S. albifrons*) terns, was built adjacent to 25 small to medium-sized turbines on a jetty. In 2004, terns nested as close as 98 ft (30 m) from the turbines, while the majority of nests were situated 328 ft (100 m) or further from the turbines (Everaert and Stienen, 2006). In 2005, terns nested as close as 164 ft (50 m) from the turbines. The greater distance between nests and turbines in 2005 was believed to be a result of the distribution of vegetative growth on the peninsula and not due to the operation of the turbines themselves (Everaert and Stienen, 2006). While terns traveled to and from the colony past the turbines, many made no apparent changes in their flight paths. The terns that exhibited a reaction to the turbines made slight changes in their flight paths to fly between turbines (Everaert, 2004). The turbines did not present barriers to the flight paths of terns and observations suggest the presence of turbines resulted in minimal increases in energy expenditure for the terns. It was concluded that the presence of the turbines represented little disturbance to the activity of breeding terns (however, the project has resulted in high numbers of collisions due to the facility's location in close proximity to the colony, discussed in the following section, Risk of Collision).

A tern-turbine interaction study closer to the area of the proposed action was conducted at the Massachusetts Maritime Academy (MMA) campus turbine. The MMA turbine has a maximum height of 243 ft (74 m) (85 to 243 ft [26 to 74 m] rotor zone) and is located at the western entrance of the Cape Cod Canal. The turbine is situated 328 ft (100 m) from the water's edge on a landmass adjacent to a popular common and roseate tern foraging location, the Mashnee Flats Shoal located 5.3 miles (9 km) from one of the largest roseate tern breeding colonies, Bird Island. Visual surveys and mortality searches were conducted from April 24 to November 30, 2006, during the breeding, staging, and fall migration periods (see the following Risk of Collision for information regarding mortality searches). Terns were most abundant in the area during the post-breeding period when they were foraging in large, mixed-species flocks. Terns were most abundant in the turbine airspace (within 164 ft [50 m] of turbine tower, rotor, and blades) during the chick-rearing period and least abundant during the nesting period. The average flight height of terns in the turbine airspace was 83 ft (25.4 m) and the mean flight height was 49 ft (15 m). The one positively identified roseate tern observed in the turbine airspace flew at 26 ft (8 m). In summary, of the terns observed in the 164 ft (50 m) airspace surrounding the turbine: 17 percent flew within, 74 percent flew below, and 9 percent flew above the rotor zone (85 to 243 ft [26 to 74 m]). The study demonstrated that terns continued to use the 164 ft (50 m) airspace around the turbine while traveling between foraging locations (Vlietstra, 2007). However, the operating rotors and spinning blades were observed to deter terns from flying directly within the rotor zone of the turbine when the rotor velocity was greater than 1 rotation per minute (rpm). Under these conditions, terns were found to be 4 to 5 times less abundant in the turbine airspace. Therefore, it was assumed that the terns visually and acoustically detected the spinning blades when the rotor was operating (Vlietstra, 2007). Despite the turbine's location in between foraging locations, terns continued to use the area and their access to habitat was not evidently restricted.

As terns and gulls are known to travel and forage around other man-made structures, including lighthouses, bridges, and wind turbines, it is likely terns would continue to travel through and around the area of the proposed action after construction of the proposed action. Although the majority of terns are expected to avoid the direct WTG rotor swept area (refer to the following section, Risk of Collision for detailed information of avoidance behavior), it is anticipated that terns would continue to travel and forage in the vicinity of the proposed action. Also, because the turbines are widely spaced (0.39 to 0.63 miles [0.63 to 1.0 km] apart), it is anticipated that most terns and gulls would occur between turbines while traveling at heights within the rotor swept zone. Barrier effects are anticipated to result in minimal increases in energy expenditure for terns and gulls as they generally avoid direct encounters with turbines while continuing to use the site of the proposed action for foraging and traveling purposes. Therefore barrier effects are expected to result in no measurable impacts to terns or gulls.

Risk of Collision

The potential exists for terns and gulls to collide with WTGs under operation, including the blades and tubular towers during the breeding, staging, and migration periods. The results of available mortality studies indicate that the majority of avian collisions with man-made structures take place at night during periods of inclement weather (Kerlinger, 2000). Birds that fly within the rotor zone of the proposed turbines (75.5 to 440 ft [23 to 134 m]) during periods of low visibility would be at greatest risk of collision.

Poorly sited facilities can result in high collision rates for terns and for gulls. A mortality study conducted at the Zeebrugge, Belgium facility reported notably high tern collision mortality. At this facility, terns have nested on a peninsula as close as 98 ft (30 m) from a string of 25 small to medium sized turbines located on an adjacent breakwater. The mean number of terns killed for all turbines was 6.7 terns per turbine per year, and the mean number of terns killed at the 14 turbines closest to the colony

was 11.2 terns per turbine per year for 2004 and 2005 (Everaert and Stienen, 2006). The rotor zone (52.5 to 164 ft [16 to 50 m]) of the 14 turbines that are responsible for the high number of tern fatalities is lower than that of the proposed turbines, and the turbines are spaced closer together (394 ft [120 m] apart) (Report No. 5.3.2-1). The collision mortality observed at the Belgium facility was determined to have an adverse impact on the breeding terns. However, the majority of these collisions occurred at the 14 turbines located closest to the tern colony and most collisions may have been associated with the circular, erratic flight behaviors that terns exhibited near the colony (Everaert and Stienen, 2006). Ten tern collisions were documented when observers were onsite and it is likely that the observers themselves caused a disturbance to the colony, resulting in the observed collisions (Everaert and Stienen, 2006). If the peninsula colonized by the terns had not been created adjacent to the string of turbines on the breakwater, it is very likely that the observed collision mortality would have been substantially lower. Because no colony is located adjacent to HSS, this data is not particularly relevant to the proposed action's potential impacts. Gulls are known to occasionally collide with bridges and vehicles, as well as communication towers. Some studies suggest that gulls could be particularly vulnerable to wind turbine mortality as they are often observed flying 100 ft (30 m) off the ground (Airola, 1987 *as cited in* Kingsley and Whittham, 2001). A study conducted at Blyth Harbour, Great Britain, concluded that great black-backed gulls were killed by turbines 'disproportionately to both their overall abundance and natural mortality' (Kingsley and Whittham, 2001). The collisions were associated, however, with poor weather and periods of low visibility.

If terns or gulls were to cross the area of the proposed action during crepuscular periods or at night, aspects of the proposed action design are expected to reduce the risk of collision. Each perimeter WTG nacelle would be lit at night with one red flashing FAA light. Corner WTGs would be equipped with medium intensity FAA L-864 lighting. The other perimeter WTGs would be equipped with low intensity lights visible up to 1.15 miles (1.9 km). The eight turbines adjacent to the ESP would have one L-810 flashing red light. FAA lighting would be synchronized to flash in unison at 20 FPM (Section 2.0 in ESS, 2007). Construction structures and equipment would be lit at night and construction activities would be limited during inclement conditions, particularly at night.

The lighting mounted on nacelles as well as natural sources of nighttime lighting are expected to decrease the risk of tern and gull collisions if their migratory movements result in nighttime crossings of the area of the proposed action during periods of good visibility. At the Nysted and Horns Rev wind farm in Denmark, all the wind turbines are equipped with yellow navigational lighting. In addition, all wind turbines positioned at the outer edge of the wind farm are equipped with two medium intensity flashing red lights on the top of the nacelles. The lights operate at a frequency of 20 to 60 FPM (Petersen et al., 2006). Radar observations suggest that birds approached the turbines at closer distances at night than during the day, and that more birds entered the wind farm at night than during the day; however, observations indicated avoidance behavior of the turbines by nighttime migrants. The typical distance at which an avoidance reaction occurred was 1,640 ft (500 m) from turbines at night and 1.8 miles (3 km) during the day (Petersen et al., 2006). It may be that that migrating birds react later to the turbines at night due to decreased visibility, but are eventually able to detect the turbines due to lighting mounted on the nacelles or natural sources of night lighting. Another study conducted with a vertically oriented radar suggests that migrating birds may also react to turbines by 'vertical deflection' at night instead of the linear avoidance primarily observed during the day (Blew et al., 2006 *as cited by* Petersen et al., 2006).

However, refraction from lighting may be associated with collisions during periods of fog or rain. A mortality study conducted at a potential wind farm site in the North Sea found that collisions occurred at a radar platform that was illuminated at night, and that 50 percent of these collisions occurred on two nights with conditions of fog and drizzle during a heavy migration period (Huppopp et al., 2006). Of the 442 birds (mainly passerines) believed to have collided with the lit research platform, four were gulls. It was believed that the birds may have been attracted to the lighting on the platform during inclement

conditions. However, Petersen et al. (2006) observed a substantial decrease in the volume of migrating waterbirds during weather periods of elevated collision risk. Fewer waterbirds migrated during periods of low visibility and strong headwinds (Petersen et al., 2006).

Based on the available data, terns have been observed at heights well above the rotor zone when making migratory movements. There have been observations of what were assumed to be both roseate and common terns departing South Beach in the fall around sunset, apparently heading toward their wintering grounds, and quickly gaining altitudes of hundreds of meters (Veit and Petersen, 1993). Other species of terns have been observed migrating at heights above 4,270 ft (3,000 m) when migrating over land (Alerstam, 1985). It is likely that nighttime migration movements, if they were to cross the area of the proposed action, would occur well above the rotor zone. The flight height, however, would be dependent on weather conditions. If terns were to depart in unfavorable conditions such as strong headwinds, their flight heights would likely be lower as other tern species have been observed flying close to the water's surface during strong headwinds (Alerstam, 1985). However, it is unlikely that flocks of staging terns would depart for migration in unfavorable weather conditions during the day, and less likely at night. More data would be necessary to assess tern and gull flight behavior in the area of the proposed action during a variety of weather conditions.

Above water foundations are not anticipated to create perching habitat or result in increased risk of collision for terns or gulls. The above water foundations, WTGs, and the ESP would be equipped with stainless wire and vision restriction perch deterrent devices. Each turbine foundation would have a deck which would be covered by aluminum chain link fencing to discourage access on the sides (and the deck overhangs the access ladder). There would be a taut 0.12 inch (3 mm) stainless steel wire on top of the railing, and a 25 inch (0.65 m) solid panel to restrict the view of birds from the deck (some species prefer perches with views). The spacing between the wire and the rail would be 1.2 inch (3 cm). The ESP would have a perimeter railing and the ladders and railing would be equipped with stainless steel wire, chain-link fence, and panels similar to the WTG foundations. The use of perch deterrent devices has discouraged terns perching on the fence and deck of the platforms supporting the Cape Wind SMDS. The final design of perch deterrents would be based on recommendations from USFSW. The use of tubular towers instead of lattice towers also discourages perching under the rotors. Vibrations and low level noise created by operating WTGs may also deter terns and gulls from perching. Therefore, perching opportunities are not expected to increase the risk of collision of terns and gulls with the proposed turbines.

Terns and gulls are anticipated to continue minimal foraging and traveling activities in the vicinity of the site of the proposed action with a low risk of collision given the turbine-avoidance behavior exhibited by terns at the majority of existing offshore and near-shore facilities. Terns and gulls would be expected to make direct flights while traveling through HSS to access foraging or breeding locations. The majority of flight heights observed in the area of the proposed action occurred below the rotor zone. During conditions of good visibility, terns would be expected to visually detect and react to turbine structures. Terns are not expected to frequent the area of the proposed action during those periods of inclement weather or at night, however, surveys have not been conducted under these conditions and therefore the potential for collision under these conditions can not be ruled out. However, if flying into strong headwinds, terns would be expected to fly closer to the water's surface. If flying at night, they would be expected to avoid encountering the proposed turbines based on the observed turbine avoidance behavior observed by other waterbirds at night. Skimmers are known to forage during periods of low visibility, however, they do so just above the surface of the water (Sibley, 2001); therefore, they are at a decreased risk of collision. These factors decrease the risk of tern collisions with the proposed action's structures. Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) used a collision probability model to estimate the number of roseate tern, least tern, and common tern collisions with the proposed turbines per year. Their estimates

suggest that 0.8 roseate terns, 12 common terns, and minimal least tern fatalities per year may occur as a result of the proposed action.

Some studies suggest that gull flight altitudes often occur below 100 ft (30 m) but do occur within the rotor zone of modern wind turbines (Kerlinger and Curry, 2002). Due to the great abundance of gulls in the area and their typical flight characteristics, there is a moderate risk of collision with the proposed turbines. Population-level effects from those collisions, however, would be less likely to occur because of their overall larger population sizes relative to other species, like terns, and therefore the impacts to gulls would be minor. The risk of collision for tern species is anticipated to be low; however, impacts associated with collision are anticipated to be moderate for tern species of conservation concern as the loss of a single breeding individual may be detrimental to the regional population. A discussion of collision related impacts for roseate terns is included in [Appendix C](#).

Pelagic Species (shearwaters, petrels, gannets, auks)

Risk of Collision

The magnitude of collisions with wind turbines by these species is expected to be lower than other species, as they are expected to be infrequently present. However, if the presence of these species is typically associated with storm events and reduced visibility, the actual potential for collisions may be greater under these conditions. Additionally, these birds could be at risk of collision because they may react differently to turbines as they are not as habituated to obstacles in their flight path as near-shore species are (Tulp et al., 1999). However, observations from a study conducted in the North Sea near Denmark suggest that many species, including gannets, actively avoided the wind farm area and only occasionally entered turbine areas (Christensen and Houninsen, 2005).

Within this group of birds, some species may be more at risk than others. Soaring species (shearwaters) and species that plunge dive for food (gannets) may occur more commonly in the rotor swept zone of the proposed turbines while those that feed at the waters surface (storm-petrels) and heavy-bodied divers (the alcids) may spend far less time at heights above the water that would put them at risk of collisions with turbine blades. Aerial and boat surveys conducted in the study area were limited to daytime periods of good visibility. While documenting these species during periods of inclement weather (when they are most likely to occur near shore) presents difficulties, additional information on the frequency of occurrence and activity patterns should be investigated during a variety of weather conditions both day and night. However, due to the anticipated infrequent occurrence of pelagic species in the area of the proposed action, the risk of collision with WTG structures is anticipated to be low. Therefore, the risk of collision is expected to result in minor impacts.

Waterfowl and Non-Pelagic Water Birds

There are a number of sea duck, waterfowl, and diving species that occur within Nantucket Sound, particularly during the winter months. There are a number of sea duck, waterfowl, and diving species that occur within Nantucket Sound, particularly during the winter months. Species such as scoter, eider, and long-tailed duck over-winter in large flocks in the region. A number of common and red-throated loon (*Gavia stellata*), as well as grebes, geese, brant, and dabbling ducks are also local to the bay during various times of the year. Double-crested cormorant are abundant in the site of the proposed action through the breeding season and late-fall. Great cormorant occur in the area mainly in the winter months.

Habitat Modification

Habitat modification as a result of the operating facility could displace sea duck and waterfowl. Displacement can lead to over-crowding and competition at alternative foraging sites and can ultimately

result in increased mortality of more vulnerable species (Maclean et al., 2006). The impact of habitat modification on sea ducks would be dependent on the location of the turbines in relation to suitable feeding areas.

Petersen et al. (2006) found that common scoters (*Melanitta nigra*) were among those species that exhibited complete avoidance of turbine areas, however were numerous in the surrounding waters. Sea duck may avoid the direct area of the wind farm; however, they are expected to continue to forage in the vicinity of the proposed action, assuming that their food sources were not displaced.

Sets of six scour-control mats (each mat would be 16.5 ft by 8.2 ft [5 m by 2.5 m] with 8 anchors to secure the mat to the seafloor) would be placed at the base of each monopile. The underwater structures could create a localized 'artificial reef effect', providing foraging habitat for sea ducks and other waterbirds. Wide spacing of turbines (0.39 to 0.63 miles [0.63 to 1.0 km] apart) would allow for diving between turbines.

The boundary of the area of the proposed action would include approximately 25 square miles of WTGs and ESP (electrical service platform) foundations, and 5.89 acres of transmission cable. The total area represents 11 percent of Nantucket Sound (Jarvis, 2005). However, the total area of seabed that would permanently be disturbed would be less than 1 percent of the total wind farm area: including approximately 0.004 km² (less than one acre) for the 130 turbines, 30 by 60 m (100 by 200 ft) for the ESP platform, and 0.01 km² (approximately 2.4 acres) for scour mat coverage (Jarvis, 2005). The additional amount of surface area (approximately 1,200 ft² or 0.03 acres [111 m²]) per tower would result in a minor addition to the substrate that is currently available (Section 3.9 in ESS, 2007). Due to the small amount of additional surface area in relation to the total area of the proposed action in Nantucket Sound, and the spacing between WTGs, the proposed structures are not expected to have a significant effect on the benthic community, the presence of prey fish, or sea duck or other water birds. However, the additional substrate would be oriented vertically in the water column, and could result in localized and minor increases in certain invertebrates and prey fish species.

Although there may be minimal impacts to the prey base due to construction of the proposed action, sea duck and waterfowl are among species of birds that may experience habitat loss due to the presence of operating turbines. Petersen et al. (2006) found that common scoters (*Melanitta nigra*) were among those species that exhibited complete avoidance of turbines, yet were numerous in the surrounding waters.

At Tuno Knob in Denmark, aerial and ground surveys were used to compare the abundance of birds before and after the construction of the wind farm determined that there were fewer birds post-construction although numbers remained stable in a control site (Guillemette et al., 1998). However, the change was believed to be due to differences in natural changes in food availability and not the presence of the wind facility. It was concluded that the wind turbines did not have any effect on the abundance and distribution of eiders during the winter of 1996 to 1997 (Guillemette et al., 1998). Scoter numbers however, did not increase to their original, pre-construction numbers (Drewitt and Langston, 2006). At Horns Rev, divers and scoters occurred in numbers lower than expected in the wind-farm area post-construction. At the Horns Rev and Nysted wind farm in Denmark, loons and common scoters showed an increased avoidance of both wind facilities and this effect was documented to two to four km around the facility (Petersen et al., 2006). These results suggest that these birds may avoid wind farm areas.

Kaiser (2002) used field data in combination with a modeling approach to predict the change in over-winter mortality rates of common scoter as a result of displacement from potential feeding habitat through avoidance of wind facilities in Liverpool Bay. The study indicated that the displacement of common scoter from areas around four of five wind facilities (existing, authorized, or proposed) would have no adverse effects to the over-winter mortality of the population.

Due to the small footprint of the actual development area in relationship to the overall habitat available in Nantucket Sound, and due to the relatively low abundance of sea duck and other waterfowl species in the area of the proposed action, minimal habitat loss is anticipated during proposed action construction, decommissioning, and operation activities. Impacts associated with displacement of prey fish during construction are anticipated to be minimal and temporary. The natural benthic substrate and prey fish communities would be essentially maintained after a short recovery period, therefore, adverse impacts associated with loss of habitat or modification are not anticipated. The impacts associated with decommissioning are anticipated to be similar to or less than construction activities because pile driving would not be required (Jarvis, 2005). Therefore, impacts associated with loss of habitat or habitat modification during operations are anticipated to be minor.

Human Disturbances

Disturbances, such as increased human presence and vessel activity during proposed action operation, may result in impacts to sea ducks and waterfowl. Divers including loons and scoters are particularly sensitive and could be disturbed during maintenance activities due to their strong reaction to boats (Maclean et al., 2006).

Observations at existing offshore facilities indicate that increased vessel activity during the operational phases could result in disturbances to sea duck or waterfowl foraging in the vicinity of the area of the proposed action. Helicopters and boats approaching a wind farm in Denmark for maintenance services flushed flocks of scoter. It was observed that birds tended to eventually return to the same area after the helicopter or service boats had left the area (Petersen et al., 2006). At a Sweden facility, it was observed that service boats are more of a disturbance to birds than the operating turbines (Pettersson, 2005). Long-tailed duck and scoter foraging in the immediate vicinity of turbines were flushed as facility service boats approached (Pettersson, 2005). Spring 2003 studies showed that long-tailed duck and possibly scoter that stage in the wind farm area leave the area when the service boat comes but were observed to return in the evening after the boat was out of the area (Pettersson, 2005). It was suggested that was it the boat activity in the area that displaced the birds, not the wind farm structures themselves; the birds were present in the morning and evening when the boats were not present (Pettersson, 2005). Despite the presence of turbines and service boats, many species of waterfowl continued to use the area as foraging and staging habitat at the Sweden facility. Eider feeding in vicinity of the turbines at the Sweden facility in an area that receives less boat activity, appeared to be unaffected by the presence of the boats suggesting boat disturbance is limited to the immediate vicinity of the boats, for most species.

The area surrounding the proposed development experiences regular vessel activity, therefore, increased human presence or vessel activity is not anticipated to present a substantial increase in disturbances. Human disturbances are not expected to result in long-term or adverse impacts to foraging sea duck or waterfowl. Minor adverse impacts are anticipated to result from human disturbances associated with operation of the proposed action.

Electromagnetic Fields

There is a concern that electromagnetic fields emitted from the offshore cables may impact prey fish. It has been suggested that EMF may disorient or attract prey fish, however, it is unknown what these actual impacts may be (Gill, 2005).

The specifications of the proposed cable system require the cable to be shielded. Since electric field lines start and stop on charges, this shielding would effectively block the electric field produced by the conductors. Magnetic fields, however, can not be completely shielded because the magnetic field lines do not stop on objects; they form continuous loops around conductors carrying currents. The actual

magnitude of typical 60 Hz magnetic fields in the vicinity of the offshore cables is, in most locations, well below that of the geomagnetic field (~ 500 mG). Therefore, no additional electric field impacts are expected to result from the submarine cables. There are no anticipated substantial adverse impacts to foraging birds or their prey from the 60 Hz magnetic fields associated with the operation of the proposed action.

Oil Spills

The presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions and possibly oil spills. Oil could be released from tankers or damage to WTG structures or the ESP could result in the release of fluid contained within these structures. The total maximum oil storage on the ESP is expected to be approximately 42,000 gallons at any given time. The total oil storage at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). In the unlikely event of an oil spill, the oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent). It has a 90 percent chance of impacting any shoreline in the area.

Because sea duck and waterfowl dive at the water's surface, they are among those species of birds that are particularly vulnerable to oil spills. If the feathers become coated with oil, birds lose their ability to repel water and to insulate, and in some instances, lose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening.

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2003). Diving species including loon and scoter suffered relatively high mortality from the spill. Over 100 loons were collected dead. More than double this number were slicked and collected alive. This likely represents a high regional population impact to these birds. Over 70 diving duck, sea duck, merganser, and grebe (combined) were collected dead. Cormorant species (N=17) also represented a substantial portion of the dead birds found (315 total) associated with the oil spill (BBNEP, 2005).

The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in mortality. Some individuals foraging in the direct oil spill area may be displaced from the area, or may become slicked with oil. However, the event of an oil spill is unlikely. Therefore, potential oil spills are anticipated to result in minor adverse impacts to sea duck and other waterfowl.

Monopile Collapse

In the event of a monopile collapse, recovery and replacement activities would be similar to decommissioning and construction of a single WTG. A very minor amount of benthic habitat would be disturbed with a short term and localized increase in suspended sediments. Foraging opportunities for sea duck and other waterfowl would be reduced in areas of elevated suspended sediments. Some lubricating fluid would likely leak from the submerged nacelle, but would rapidly disperse given the small quantity involved. However, should a bird dive for food within this small plume, it could be harmed (see previous section for description of impacts associated with oil spills). There is a low likelihood of this occurrence and low probability of it occurring coincidentally with bird use of the immediate area. Potential impacts to sea ducks or waterfowl in the event of a monopile collapse would therefore be negligible.

Cable Repairs

Cable repair activities would be similar to cable installation activities, but would occur for a short period in a small discrete location. Cable jetting, splicing, and re-jetting would result in minor and temporary increases in suspended sediments and would temporarily disturb benthos. Sea duck or waterfowl may be temporarily displaced from areas of suspended sediments. In both instances the habitat and species would recover and no impacts to sea duck or waterfowl are anticipated from cable repair activities.

Barrier Effect

Structures that extend above the natural landscape such as towers, buildings, and bridges can act as barriers in the flight paths of birds. A barrier effect to migrating sea duck or waterfowl may occur if their movements were to cross HSS. Barriers to the flight paths of birds can result in increases in energy expenditure during migration movements. Significant impacts may result if access to preferred foraging habitat is restricted or if movements along migration corridors are impeded. There are no existing facilities known to create a barrier effect that has resulted in a population level impact. A wind facility, however, could potentially lead to significant impacts if it were to occur in a frequented flight path between nesting and foraging locations (Drewitt and Langston, 2006).

Observations at existing wind farms indicate that migrating waterbirds make efforts to avoid entering or encountering wind farms. At the Horns Rev wind farm in Denmark, radar studies showed that 71 to 86 percent of birds approaching the windfarm avoided entering the wind farm. There was a 78 percent observed avoidance of the wind farm by approaching birds (Petersen et al., 2006). For eider, it was found that of 10 flocks that would have entered the wind farm prior to construction, eight flocks would avoid the wind farm during post-construction (this number however, was believed to be over-estimated due to detection bias) (Petersen et al., 2006).

At a Sweden wind facility, it was observed that the post-construction migratory flight paths of ducks, geese, and cormorants shifted up to 1.2 miles (2 km) eastward from the baseline corridor as the birds made efforts to avoid flying less than 0.6 miles (1 km) from turbines (Pettersson, 2005). The birds' increased energy expenditure was calculated; it was estimated that their migration flight path was extended by 0.7 to 1.8 miles (1.2 to 2.9 km) resulting in a 0.2 to 0.5 percent extension of the total estimated migration distance of the waterfowl (Pettersson, 2005).

At the Utgrunden wind facility in the Baltic Sea, long-tailed ducks were observed to fly between turbines as they traveled between foraging locations (Pettersson, 2005). The birds made minor changes to their flight behavior to avoid encountering turbines.

At the MMS turbine in Buzzards Bay, cormorants, geese, and other birds were observed heading toward the turbine, and as they approached, they abruptly changed their flight direction to avoid the turbine (Vlietstra, 2007). Generally, the likelihood of terns and other birds including double-crested cormorants, rock doves, and gulls entering the turbine airspace was dependent on the velocity of the rotor and blades. However, no measurable impacts were observed as birds traveled between foraging locations and their access to these areas was not believed to be restricted. Therefore, the effects of the barrier appeared to be minor.

Barrier effects may result in changes in the flight behavior of traveling birds. Observations at existing facilities indicate there are no known situations where a barrier effect has resulted in a population level impact to birds. Sea duck and waterfowl are expected to make alterations to their flight behavior to avoid encounters with turbines. However, these alterations are anticipated to result in minimal increases

of energy expenditure. No adverse impacts associated with barrier effects are anticipated for sea duck or waterfowl.

Risk of Collision

The potential exists for migrating or dispersing water birds to collide with WTGs under construction, large construction equipment, or operating WTGs. The risk of collision depends on use of the area of the proposed action, visibility during crossings of the area of the proposed action, and flight behaviors exhibited during encounters with turbines.

Sea duck and waterfowl exhibit certain characteristics that may decrease their ability to avoid wind turbines: they travel in flocks, and due to their large size, they are less agile fliers than smaller seabirds. Sea duck and waterfowl can be active during a variety of times of the day, including at night. Studies suggest that the vast majority of collisions with turbines take place at night and in twilight, especially on those nights with strong winds and poor visibility (Winkelman, 1992 *as cited by* Tulp, 1999).

Diving ducks may fly just above the surface of the water in lines or V's during their daily movements between foraging locations, and may migrate at heights just above the surface of the waves to altitudes well above the rotor zone (Bordage and Savard, 1995; Cramp and Simmons, 1977 *as cited by* Savard et al., 1998). During surveys in the study area, diving species typically flew below 98 ft (30 m) above the waves, although they were occasionally observed flying between 98 and 197 ft (30 and 60 m) ([Report No. 4.2.4-10](#)).

Observations of waterfowl from onshore wind facility sites, particularly the Top of Iowa project, indicate that collisions with wind turbines can be extremely low, even in areas with very high waterfowl use (Koford et al., 2005). Tulp (1999) found that waterbirds diverted their daytime and nighttime movements away from turbines at even greater distances. Results from offshore wind facilities in Denmark and Sweden showed that flocks of migrating eiders (and other waterfowl) change their flight path around the wind facility and/or avoided turbines by flying between the rows or by changing height (Desholm and Kahlert, 2005; Desholm, 2006; Pettersson, 2005).

Survey results from offshore European facilities provide additional evidence that waterfowl can detect and avoid offshore turbines at night. Observations from a study conducted in the North Sea off of Denmark suggest that divers, gannets, and scoters actively avoided the wind farm area and only occasionally entered the wind farm (Christensen and Houninsen, 2005). Eiders at that facility often deflected their flights away from the turbines beginning at distances of 1,300 to 1,640 ft (400 to 500 m) from the turbines (Christensen and Houninsen, 2005 *as cited by* Maclean et al., 2006).

The lighting mounted on nacelles as well as natural sources of nighttime lighting are expected to decrease the risk of bird collisions if their migratory movements result in nighttime crossings of the area of the proposed action. At the Nysted and Horns Rev wind farm in Denmark, all the wind turbines are equipped with yellow navigational lighting. In addition, all wind turbines positioned at the outer edge of the wind farm are equipped with two medium intensity flashing red lights on the top of the nacelles. The lights operate at a frequency of 20 to 60 FPM (Petersen et al., 2006). Radar observations suggest that birds approached the turbines at closer distances at night than during the day, and that more birds entered the wind farm at night than during the day; however, observations indicated avoidance behavior of the turbines by nighttime migrants. The typical distance at which an avoidance reaction occurred was 1,640 ft (500 m) from turbines at night and 1.8 miles (3 km) during the day (Petersen et al., 2006). It may be that that migrating birds react later to the turbines at night due to decreased visibility, but are eventually able to detect the turbines due to lighting mounted on the nacelles or natural sources of night lighting. Another study conducted with a vertically oriented radar suggests that migrating birds may also react to

turbines by 'vertical deflection' at night instead of the linear avoidance primarily observed during the day (Blew et al., 2006 as cited by Petersen et al., 2006).

During periods of inclement weather, however, lighting may result in increased avian collisions. A mortality study conducted at a potential wind farm site in the North Sea found that collisions occurred at a radar platform that was illuminated at night, and that 50 percent of these collisions occurred on two nights with conditions of fog and drizzle during a heavy migration period (Huppopp et al., 2006). The species composition of the 442 birds believed to have collided with the lit research platform include mainly thrushes, common starlings (*Sturnus vulgaris*), and sky larks (*Alauda arvensis*), as well as 1 dunlin, four gulls, and one pigeon (*Columba livia*). It was believed that the birds may have been attracted to the lighting on the platform during inclement conditions. However, the data indicated no mortality of sea duck or waterfowl. Petersen et al. (2006) observed a substantial decrease in the volume of migrating waterbirds during weather periods of elevated collision risk. Fewer waterbirds migrated during periods of low visibility and strong headwinds (Petersen et al., 2006).

For the Nysted offshore wind facility, Petersen et al., (2006) developed a stochastic predictive collision model to estimate numbers of common eiders likely to collide with turbine blades each autumn. Using data derived from radar studies and infrared video monitoring, they predicted with 95 percent certainty that 0.018 to 0.020 percent of 235,000 passing birds (41 to 48 individuals) would collide with all 72 turbines in a single autumn (one eider/turbine/year). Collision mortality predicted by Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) for sea duck at the proposed facility was estimated to be lower than the fatalities predicted for the facility in Denmark due to the relatively fewer migrants along the Atlantic Coast. The number is estimated to be well below the annual hunt of 15 to 20,000 eider and long-tailed duck along Atlantic Coast states (USFWS 2006 as cited in [Report No. 5.3.2-1](#)).

Potential impacts may be associated with increased collision mortality due to perching opportunities under turbines. Cormorants, in particular, are a bird group that may be attracted to the WTG area for perching opportunities. However, above water foundations are not anticipated to create perching habitat or result in increased risk of collision. The above water foundations, WTGs, and the ESP would be equipped with stainless wire and vision restriction perch deterrent devices. Each turbine foundation would have a deck which would be covered by aluminum chain link fencing to discourage access on the sides (and the deck overhangs the access ladder). There would be a taught 0.12 inch (3 mm) stainless steel wire on top of the railing, and a 25 inch (0.65 m) solid panel to restrict the view of birds from the deck (species such as cormorant prefer perches with views). The spacing between the wire and the rail would be 1.2 inch (3 cm). The ESP would have a perimeter railing and the ladders and railing would be equipped with stainless steel wire, chain-link fence, and panels similar to the WTG foundations. The use of tubular towers instead of lattice towers also discourages perching under the rotors. Vibrations and low level noise created by operating WTGs may also deter birds from perching.

Although certain species may fly within the rotor zone of the proposed turbines, sea duck and waterfowl have demonstrated turbine avoidance behavior. These birds likely have reduced movements during periods of darkness and inclement weather, therefore, this bird group is at a lower risk of collision with turbines than other species groups. In general, populations of many of these species are relatively large, and could likely sustain low levels of collision-related fatalities. Therefore, collision mortality is anticipated to result in minor impacts to sea duck and waterfowl species.

Conclusions on Operation Impacts

Based on research cited and information discussed herein, with respect to affects resulting from habitat modification, human disturbance, and risk of collision, the overall operational impacts of the proposed action to non T&E avifauna would be minor.

5.3.2.5 Subtidal Offshore Resources

5.3.2.5.1 Construction/Decommissioning Impacts

Impacts on Hard Bottom Benthic Communities

Potential impacts to hard bottom benthic communities that have been reported in limited areas of the proposed action locale would be associated with indirect affects from sediment suspension and deposition resulting from cable jetting, the vessel anchoring process associated with jetting, and the introduction of new and additional hard substrate due the presence of the monopiles and rock scour armor, if that is used. Sessile epifauna and macroalgae noted to occur in these areas could be subject to effects of sediment suspension and deposition and filter feeding organisms may experience clogging of feeding and respiration organs. These effects are expected to range from negligible to minor and be temporary. Such sediment would be expected to be removed by natural processes occurring in the adjacent mobile and dynamic sandy substrate environment. Although not anticipated, a thick layer of deposited sediments could permanently cover hard substrate areas, such as glacial till/cobble surfaces.

Impacts on Soft-Bottom Communities

Potential impacts to soft bottom communities relate to areas of the seafloor that are temporarily disturbed by geotechnical investigation methods such as coring and boring, and construction/decommissioning activities such as cable jetting, monopile and ESP pile installation, HDD of the shoreline crossing, and scour protection installation. Indirect impacts would occur from water withdrawals associated with construction vessels and jetting, which entrain the planktonic larvae of benthic species, assumed to result in 100 percent mortality of the entrained organisms.

Soft-Bottom Benthic Invertebrate Communities

Direct Seafloor Disturbance

Potential areas where seafloor impacts may occur were determined based on the proposed action design and construction methodologies. The length of cable needed for linking all the wind turbine towers to the ESP is approximately 66.7 miles (107.3 km). A zone of disturbance between 4 and 6 ft (1.2 and 1.8 m) wide is anticipated for burial of the inner-array cables to a target depth of 6 ft (1.8 m). Thus, the seafloor area anticipated to be disturbed during the inner-array cable installation is between approximately 1,408,704 and 2,113,056 ft² (32.34 and 48.51 acres or 130,872 and 196,309 m²). Also, two 3 ft (0.9 m) wide skid pontoons would ride on the substrate surface on either side of the jet plow to help control the depth of cable embedment. Pontoon impacts that result from installation of the inner-array cables would be 2,113,056 ft² (48.51 acres or 196,309 m²). Combined temporary disturbance would be up to 4,226,112 ft² (97.02 acres or 392,618 m²) of sea bottom within the perimeter of the WTGs, or approximately 0.61 percent of the 25 square miles (64.7 km²) area defined as the total area of the proposed action (see [Table 5.3.2-2](#)).

Approximately 12.5 miles (20.1 km) of offshore transmission system cable is required for joining the ESP to the mainland. A disturbance zone of 4 to 6 ft (1.2 to 1.8 m) wide is expected for burial of each of the two offshore transmission cable circuits to a target depth of 6 ft (1.8 m). Thus, the seafloor area that would be disturbed during installation of the offshore transmission cable system along the proposed route would be approximately 792,000 ft² (18.18 acres or 73,579 m²). The two skid pontoons would impact another approximately 792,000 ft² (18.18 acres or 73,579 m²). The resulting combined temporary disturbance is expected to be up to 1,584,000 ft² (36.36 acres or 147,158 m²) of sea bottom or approximately 0.228 percent of the area of the proposed action (see [Table 5.3.2-2](#)).

Since there are shallow water depths in Nantucket Sound, shallow draft vessels/barges are necessary for installation. These types of vessels/barges commonly use anchors for positioning. The processes of positioning, anchoring and movement of cable installation barges are expected to result in impacts occurring along cable installation paths. The impact area would vary with water depth, weather and sea conditions, and the type of bottom substrate. Average impact areas for each anchor deployment can be made using properties of anchor behavior that have been described by the U.S. Navy (NAVFAC, 1985; NCEL, 1987; Taylor, 2002). Using the width of an anchor (10.6 ft [3.23 m] including stabilizer bar), the number of anchors necessary for securing and moving a vessel (6), and the required setting drag length for deep water (20 ft [6.1 m]), the estimate is that up to 7,230 ft²/mile (0.17 acre/mile or 420 m²/km) would be disturbed from the deployment and retrieval of anchors. Anchors would disturb the substrate to a depth of 4 to 6 ft (1.2 to 1.8 m) for each anchor deployment and leave a temporary irregularity to the seafloor with localized mortality of infauna. In addition, the seafloor area that would be swept by anchor cable as the jetting barge moves along the cable routes was calculated to be 311,880 ft² (7.16 acres or 28,975 m²) per linear mile (1,609 m) of cable. Use of mid-line anchor buoys would minimize potential impacts but cannot eliminate them entirely. Anchor cable sweep impacts would be expected to disturb sediment to a depth of up to 6 inches (15.2 cm) (Algonquin Gas Transmission Company, 2000). Organisms that may be subject to impacts from anchor line sweep include mollusks such as soft shell clams, surf clams, and whelks and other sessile species such as tube dwelling polychaetes or mat forming amphipods which make up a large portion of the taxa occurring in the area of the proposed action. Organisms that are mobile, such as certain polychaete species, amphipods, Tanaidacea, Mysidacea, and crabs could be expected to avoid impacts from the anchor line sweep.

Total anchoring and anchor sweep impacts that are part of the installation of 66.7 miles (107.3 km) of inner-array cables would be approximately 21,030,177 ft² (482.79 acres or 1,953,768 m²), or approximately 3.02 percent of the area of the proposed action (see [Table 5.3.2-2](#)). Vessel anchoring and anchor sweep impacts that are part of the installation of the 115 kV transmission system that would span the approximately 12.5 mile (20.1 km) route between the ESP and the mainland are anticipated to impact approximately 7,979,925 ft² (183 acres or 741,359 m²), or approximately 1.15 percent of the area of the proposed action.

In addition to temporary construction impact from installation of offshore transmission cable systems, it is expected that there would be temporary impacts to the seafloor in the proposed wind turbine tower locale from placement of jack-up barges that would be used for installing each tower. These jack-up barges would not require any anchoring. However, jack-up barges that have a range of four to six jacking legs are expected to have pads that contact the sea floor over an area of 172 ft² (0.0039 acres or 19 m²) each. The maximum expected temporary impact area related to the jack-up barge for installation of the WTG and ESP pilings (136) would be 140,352 ft² (3.22 acres or 13,039 m²).

After pilings are in place, a second vessel would need to jack-up at each piling for installation of turbines, blades and other equipment. A second vessel would also need to jack-up near the ESP pilings for construction of the ESP platform. In order to connect inner-array cables to the WTGs and the ESP platform, a third vessel would need to jack-up at each tower and the ESP. A vessel would also need to be located at each piling for installation of the scour control mats or rock armor that are to surround each piling.

According to the calculations and assumptions described, it is anticipated that total combined temporary impact from the jack-up barge use related to installing turbine towers and association equipment, the ESP platform, connection of inner array-cables (using J-tubes) to WTGs, and installation of scour control mats would be approximately 411,133 ft² (9.4 acres or 38,195 m²), or 0.06 percent of the total area of the proposed action (see [Table 5.3.2-2](#)).

In the locale where temporary disturbance of the seafloor occurs due to cable and monopile placement substantial mortality of benthic organisms is expected; however, the impacts are expected to be minor since the area disturbed is somewhat limited, abundant area of similar habitat type occurs in the surrounding vicinity, and the sand bottom community typical to the area is adapted to frequent natural sediment movement that creates localized temporary impacts. Information reported in the scientific literature indicates that certain benthic invertebrate species opportunistically invade substrate areas that are unoccupied after disturbances have occurred (Hynes, 1970; Rhoads et al., 1978; Rosenberg and Resh, 1993; Howes et al., 1997).

Suspended Sediment and Deposition Impacts

For determination of volume of suspended sediments from the jet plow embedment process SSFATE modeling was conducted (Report No. 4.1.1.2). The results of the SSFATE model indicated that sediments suspended by the jet plow would settle alongside the cable route, primarily because of the relatively coarse nature of the sandy sediments. Depending on horizontal distance from the trench, trench geographic orientation, and tidal current direction deposition of sediment is predicted to range from 0.04 to 0.2 inches (1.0 to 5.0 mm) thick. Depositions that range in thickness from 0.4 to 1.8 inches (10 to 45 mm) are expected to occur in isolated locations when tidal currents are in slack water (Report No. 4.1.1.2).

Sediment suspension times vary according to particle size, distance from the cable route and tidal current strength. Sediments may remain suspended approximately 2 to 18 hours. Gravel and sand settle more quickly than silts and clays. Sediment transport modeling studies concluded that sediment deposition from the jet plow embedment operations would be minimal compared to active sediment transport that has been observed in Nantucket Sound during natural tidal and weather conditions (Report No. 4.1.1.2).

Results from sediment transport modeling indicate that benthic organisms would suffer some mortality due to the temporary disturbance from jet plowing activities. Species-specific responses to suspended sediments and sediment deposition have been studied and vary depending on a particular species' feeding mode and mobility (see Table 5.3.2-3). Benthic organisms that are mobile and species that can burrow can evade areas with sediment deposition. This includes species such as crabs and lobsters. Sedentary organisms, such as the northern quahog and the eastern oyster, not able to evade sediment deposition may be subject to mortality or impact to reproduction and growth. Due to the highly dynamic environment in Nantucket Sound and that most naturally occurring species are adapted to settle and move in the sandy environment and recover from burial, the expected sediment deposition is expected to have minimal adverse impacts to benthic resources. Since sediments expected to be suspended by jet plow operations are minimal in comparison to active sediment transport known from Nantucket Sound, filter and deposit feeding benthic organisms are not expected to be substantially impacted from suspended sediments from the jet plow installation. Compared to the Horseshoe Shoal locale, impacts may be greater from the jet plowing activities in nearshore areas of Lewis Bay since weak currents and finer sediments may remain in an elevation of suspended sediments as long as 48 hours.

Benthic community recovery rates have been studied by Dernie et al. (2003) who has shown that sediment particle size and rate of disturbance infilling have an effect on recovery rates. Disturbed areas that infill under natural circumstances have longer recovery rates than areas that are infilled after installation of cables. Also, benthic communities adapted for surviving in high-energy types of environments recover more quickly after disturbances (Dernie et al., 2003). Since the WTG area is a naturally dynamic environment, benthic organisms that occur are adapted to fluctuations in concentrations of suspended sediments in the water column. These organisms are not expected to be impacted substantially by sediment resuspension occurring on a short-term basis and could be expected to recover

as quickly as they have reproductive mechanisms allowing for rapid colonization. Thus, benthic invertebrate populations occurring at the site of the proposed action could be expected to recover fully in a timeframe of one to two years (Rhoads et al., 1978; Hall, 1994; C-CORE, 1995; Rhoads and Germano, 1986; Newell et al., 1998; Whitlatch et al., 1998; Byrnes et al., 2004).

Moderate long-term (permanent) impacts related to installation of the pilings that support the wind turbine towers and the ESP would be anticipated to affect the soft-bottom benthic communities in the area of the proposed action. Round pilings to be constructed include 130 for the wind turbine towers and six for support of the ESP. Dimensions of each wind turbine piling depend on the depth of water in which it is located. Dimensions would be 16.75 ft (5.1 m) diameter at the seafloor for a piling that is situated in water depths ranging from 0 to 40 ft (0 to 12.2 m), and 18.0 ft (5.5 m) diameter for pilings situated in water depths ranging from 40 to 50 ft (12.2 to 15.2 m). The diameter of ESP pilings would be 42 inches (106.7 cm) at the seafloor. Thus, there is a direct impact area that is equal to 220 ft² (0.005 acre or 20 m²) for each 16.75 ft (5.1 m) diameter wind turbine tower piling (111 pilings) and 255 ft² (0.005 acre or 21 m²) for each 18 ft (5.5 m) diameter wind turbine tower piling (19 pilings). The impact of the ESP would be expected to be approximately 9.6 ft² (0.0002 acre or 0.9 m²) per piling. This would result in a total area of permanent impact of approximately 29,351 ft² (0.67 acre or 2,727 m²) for the 130 wind turbine towers and the 6 ESP pilings. This is approximately 0.004 percent of the area of the proposed action and an even smaller percentage of similar habitat within Nantucket Sound (see [Table 5.3.2-2](#)).

Permanent Alteration of Habitat

Scour protection would be placed at the base of each of the pilings to minimize scour related to prevailing currents. Synthetic fronds that mimic seafloor vegetation were determined to be an option that would provide needed scour protection but minimize possible changes to the soft-bottom and fish communities that are associated with the Horseshoe Shoal locale. When they are attached to the bottom as a network, these synthetic fronds trap sediments and eventually become buried. As a result of this sediment trapping mechanism, this form of scour protection provides a low bottom relief similar to that which exists on Horseshoe Shoal rather than traditional boulder revetment. A scour control mat has an area of 135 ft² (0.003 acre or 13 m²), and it is estimated that six mats would be required to protect a wind turbine piling. The area around a piling protected with scour control mats would be 810 ft² (0.02 acre or 75 m²), which results in a total scour protection area of 105,534 ft²/2.4 acres (9,804 m²) for all 130 wind turbine towers and 4,871 ft² (0.11 acre or 452 m²) for the 6 ESP pilings. Thus, scour protection using mats would alter approximately 0.015 percent of the area of the proposed action (see [Table 5.3.2-2](#)).

Permanent colonization of the scour control mats by attached benthos is expected to be minimal since the scour control mats are designed to capture and retain sediment from the surrounding sea floor. The sediment that these mats trap is expected to be colonized by the benthos typically found in the shifting mobile sands of Nantucket Sound. Although it is expected that the trapped sediment would be scoured from the mat during periods of intense current movement or storm driven wave action, it is unlikely that the mat would be utilized by any attached benthic organisms. Evidence from the Field Report on Seabed Scour Control Mats ([Report No. 4.1.1-8](#)) showed photos of crabs on the mats. Crabs are not attached to the mat and are likely to be opportunistically utilizing the mat as a stable substrate during a period when the mat was exposed. Crabs were also present on the meteorological tower pilings, as previously described in Section 4.2.5.3, and common in benthic samples collected and analyzed from sandy substrates of Horseshoe Shoal and Nantucket Sound ([Report Nos. 4.2.5-1 and 4.2.5-2](#)). Since the scour control mats are designed to trap sediment and regularly be buried, no permanent colonization by epilithic fauna would be expected.

Rock armor scour control has also been considered as an option to provide scour protection at the base of each of the pilings to reduce scour related to prevailing currents. This type of scour control

involves use of geosynthetic fabric overlaid by rock armor stones. These materials would be placed so that final elevations would approximate bottom contours similar to those prior to installation of the monopiles. The filter layer material serves to fill most of the scour hole that may be expected to form after the monopile installation. It would also reduce the possibility of wave action to remove natural underlying sediments and reduce possible settlement of the rock armor into the natural underlying sediments. Armor stones would be large enough to deter removal by current conditions and wave effects and small enough for prevention of removal of stone fill material that is placed beneath them. This would result in total scour protection area of 2,064,964 ft² (47.41 acres or 191,841 m²) for all 130 wind turbine towers and 17,664 ft² (0.41 acre or 641 m²) for the 6 ESP pilings. Thus, rock armor scour protection would alter approximately 0.298 percent of the area of the proposed action (see [Table 5.3.2-2](#)).

If rock armor were used for scour control, it would be only as fill in a scoured area around the turbine piling and would not appreciably change the local seafloor topography. This design would promote deposition of a sand/silt matrix in the interstices of the boulder framework with the eventual burial of all the rock armor. Tidal currents may expose portions of the rock armor at the surface for short periods of time. However, the bi-directional nature of these currents should lead to establishment of a dynamic equilibrium, allowing the average condition of the scour-protected zone to be buried by sand. Thus, the faunal composition around the base of wind turbines at the site of the proposed action could be similar to that found pre-construction.

In the case that a portion of the rock armor becomes permanently exposed above the sandy seafloor, the fauna that colonize it would likely be similar to that found on the turbine pilings. As previously described in Section 4.2.5.3, macroinvertebrate sampling on support pilings of a meteorological tower in June 2005 yielded 26 taxa including seven species that were not observed during other baseline surveys at Horseshoe Shoal. These seven species, as previously described in Section 4.2.5.3, are likely to be within the site of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders.

Oil Spills

During construction there is the potential for spills and accidental releases of material such as diesel fuel, lubricants, and hydraulic fluid. Commitment to careful construction practices to minimize potential for spills and accidental releases and having a SPCC Plan that includes rapid spill response and clean-up capabilities are measures that should minimize the potential for harm to benthos and benthic habitats relative to spills and accidental releases during construction activities.

Decommissioning Specific Impacts

Impacts related to removal and decommissioning (refer to decommissioning procedure details in Section 2.0) of proposed action-related structures including wind turbine towers, foundations, scour control mats, ESP and offshore cables, would be expected to result in temporary seafloor impacts comparable to those that have been described above for construction activities during installation.

Monopiles would be decommissioned by removing sediments from inside the pile, cutting and removing the pile 15 ft (4.6 m) below the seabed, and then returning sediments to the sea floor to re-establish pre-proposed action seabed conditions. For each WTG constructed in water depths less than 40 ft (12.2 m), approximately 3,744 ft³ (106 m³) of material would be moved and returned. For each WTG constructed in water depths greater than 40 ft (12.2 m), approximately 4,324 ft³ (122 m³) of material would be moved and returned. During removal it is anticipated that any sediment plume would be minimal due to sediments being contained in the monopile and pump hoses. After cutting of the monopile, best practices available would be employed to minimize any sediment plume. Once removed, sediments inside monopiles would be suctioned out to a depth of approximately 15 ft (4.6 m) below

existing sea bottom. Sediments would be pumped and stored on a barge and then returned to the excavated pile site using a vacuum pump and diver assisted hoses to minimize sediment disturbance and turbidity. Impacts related to removal and return of sediments from inside the monopile are anticipated to be temporary and localized.

Removal of the wind turbine tower foundations and ESP piles would result in a local shift from structure-oriented habitat to the original shoals type of habitat that was present prior to installation of the proposed action. There would be a return to pre-construction conditions. Decommissioning activities would also include removal of the network of inner-array cables and offshore transmission cable system linking the ESP to the mainland. These actions would result in temporary resuspension of bottom sediments along each cable path and anchor and anchor line impacts associated with any required vessel anchoring similar to those described above for the construction phase.

Impacts to Shellfish and Lobsters

The activities that would affect shellfish include installation of monopile foundations, inner-array cables, and the offshore transmission cable system and HDD activities in Lewis Bay, which is similar to those described above for general benthos.

In the locale where temporary disturbance occurs some mortality is expected. However, the impacts are expected to be minor since the area disturbed is somewhat limited and areas of similar habitat type occur in the surrounding vicinity. However, certain shellfish species can be long lived, such as quahogs, and recovery of similar aged species would take longer.

As described in Section 4.2.5.4.2, the lobster fishery in Nantucket Sound does not appear to be a major fishery. In a Survey of Commercial and Recreational Fishing Activities ([Report No. 4.2.5-6](#)) it was commented that the Horseshoe Shoal locale was too sandy for support of a viable lobster fishery. Direct impacts to lobsters are anticipated to be minor and any possible mortality limited to individuals that are less mobile and may be in the immediate post lease geological and geophysical assessment and proposed action construction activity area. Use of the hydraulic jet-plow installation method would reduce impacts to the immediate construction corridor. Sediment suspension during installation of both the cable and monopiles is not anticipated to result in significant indirect impacts since the sediments settle relatively quickly. Review of the literature has indicated that lobsters have been described as having high tolerance to sediment deposition and suspended sediment (Stewart, 2000) (see [Table 5.3.2-3](#)). In addition, lobsters have a rapid retreat response when threatened and the mobility and sensory capabilities of adult lobsters would allow them to largely avoid areas sediment disturbance is actively occurring (Jury et al., 1995).

Interpretation of results from sediment transport modeling indicate that shellfish would suffer some mortality due to the temporary disturbance from jet plowing activities. Species-specific responses to suspended sediments and sediment deposition have been studied and vary depending on a particular species' feeding mode and mobility (see [Table 5.3.2-3](#)). Species such as crabs and lobsters may be able to avoid areas of heavy sedimentation. Sedentary organisms, such as the northern quahog and soft shell clam, not able to evade sediment deposition may be subject to mortality or impact to reproduction and growth. Due to the highly dynamic environment in Nantucket Sound and that most naturally occurring species are adapted to settle and move in the sandy environment and recover from burial, the expected sediment deposition is not anticipated to have more than minor adverse impacts to shellfish resources. Since sediments expected to be suspended by jet plow operations are minimal in comparison to active sediment transport known from Nantucket Sound, filter and deposit feeding shellfish are not expected to be substantially impacted from suspended sediments from the jet plow installation.

The proposed cable route has been located to avoid privately licensed shellfish areas or grants in Lewis Bay. The proposed cable route would cross approximately 600 ft (182.9 m) of the recreational shellfish bed in Lewis Bay. The HDD would be used for crossing the area that is 200 ft (61 m) closest to shore. Moderate impacts to the benthic community are likely to occur from the placement of the pre-excavation pit that would be necessary for the transition from the seaward terminus of the HDD conduit to the offshore transmission cable system. Temporary impacts from the pre-excavation pit would involve 2,925 ft² (0.07 acre or 272 m²) of seafloor which is approximately 0.0004 percent of the area of the proposed action. Thus, approximately 12,525 ft² (0.29 acre or 1,164 m²) would be directly disturbed in the recreational shellfish bed 2,925 ft² (0.07 acre or 272 m²) from the pre-excavation pit and 9,600 ft² (0.22 acre or 892 m²) from jet plow embedment of the offshore transmission cable system. The applicant has committed to providing the town of Yarmouth with funds for mitigation of direct impacts to shellfish resources in accordance with the Town's shellfish mitigation policy.

Impacts on Meiofauna and Plankton

Meiofauna

The meiobenthic community is likely to be adversely affected in a very similar manner to the sessile or less mobile soft bottom benthos discussed above. Because benthic meiofauna are extremely small and live in the interstices between sediment particles they are susceptible to bottom disturbing activities and sediment deposition. Recovery of the meiobenthic community from sediment disturbance is expected to be as fast as or faster than that of the macrobenthos. Past studies of meiofauna and sediment disturbance have generally documented quick recolonization following disturbance, with predisturbance densities usually reached in a few hours to a few days (Alongi et al., 1983; Fegley, 1988; Ingole et al., 2005). In some instances, the rapid recovery may be attributable to an increase in food availability (Ingole et al., 2005). However, even in experiments where the sediment was completely defaunated, recolonization occurred in a few weeks (Alongi et al., 1983). Meiobenthic assemblages also recover quickly, with predisturbance species compositions achieved within 90 days (Alongi et al., 1983). Thus, temporary and highly localized disturbance of sandy substrate during post lease G&G investigations, and construction and decommissioning activities should have minor long-term impacts on the meiobenthos. Also, the nature of the construction and decommissioning activities are such that work progresses in sequence over a period of several months. Thus, impacts to the meiofauna that could potentially impact the marine food web would only be expected to occur on a localized level as the work takes place. An example of the ability of the meiofauna community to survive frequent sediment disturbance is evidenced by the continued use of large benthic organisms and fish of areas that experience regular and repeated bottom fishing. Further evidence of this community's ability to survive disturbed sediments is reflected in the abundance of these organisms within those portions of Nantucket Sound experience high movement of bottom sediments, visible as sand waves, due to natural conditions.

Plankton

Phytoplankton and zooplankton are not expected to be affected by post lease geotechnical and geophysical investigations nor construction or decommissioning activities. These activities are anticipated to temporarily increase suspended sediment concentrations in the area of activity. This may limit depth of maximum light penetration and thereby reduce ability of phytoplankton to photosynthesize. However, due to Nantucket Sound's intense tidal flushing, suspended sediment concentrations would be flushed away from the offshore cable route and are expected to settle approximately three hours after the jet plow passes. At most, this could result in small-scale, temporary reduction of primary production by phytoplankton, which could in turn suppress grazing zooplankton populations for a short time. During jet plow installation activities, direct mortality is expected for those phytoplankton and zooplankton that are entrained into the jetting system and injected into the sediments at high pressures. However, the hetting water withdrawal volumes represent a small fraction of the water in Nantucket sound at any one time and

loss of these individuals would not be detectable in their populations nor have any adverse affect on the marine food web.

Similar negligible impacts to plankton would occur due to the water withdrawals and subsequent entrainment of plankton into the engine cooling and other water use system on board the construction and decommissioning vessels. Because this mostly occurs while ships are underway, the impacts are diffuse and temporary, spread along the transit route of the vessels. Hundreds of similar water withdrawals occur throughout Nantucket Sound and adjacent waters due to the operation of recreational boats, and commercial shipping, such as the ferries between the islands and Cape Cod and commercial fishing vessels. There is no reported harm to plankton communities due to these existing water withdrawals, and the short period, a year or two each, during which construction and decommissioning would occur, is unlikely to measurably alter or reduce the plankton community.

Sediments found in the area of the proposed action have been reported to be mainly sand and chemical constituent concentrations have been noted to be below the established thresholds that are in applicable reference sediment guidelines. Sediment core samples that were obtained at the proposed WTG site locale and along the proposed offshore cable routes had chemical constituent concentrations that were all below Effect Range-Low (ER-L) and Effect Range-Median (ER-M) marine sediment quality guidelines (Long et al., 1995). Disturbance and suspension of the sediments associated with the monopile foundation, inner-array and offshore transmission cable system installation activities are not anticipated to cause phytoplankton and zooplankton to be exposed to such contaminants during proposed action activities.

In the event of an unplanned activity, such as an oil spill during construction, the plankton community within the plume area would experience toxic affects of the released hydrocarbons. The applicant would construct and decommission the proposed action with an OSRP in place that should serve to minimize the harmful affects of an accidental oil spill.

Conclusion

Overall the post lease G&G investigation, and construction and decommissioning impacts on soft-bottom benthic invertebrate communities, shellfish, meiofauna, and plankton are expected to range from negligible to minor as these impacts would be for the most part temporary in nature and localized. Furthermore, much of the Nantucket Sound benthos in shoal areas, have adaptive mechanisms for surviving in and on sediments that experience regular and ongoing disturbance due to the energetics of tidal currents and wave action in shallow water ecosystems.

5.3.2.5.2 Operational Impacts

Potential impacts to benthic communities that are associated with operation of the proposed action relate to areas of the seafloor that remain altered by the proposed action's features, or that could be affected by accidental and unplanned activities.

Soft-Bottom Benthic Invertebrate Communities

The vertical structures introduced by the installation of the wind turbine towers would be a source of new hard substrate with vertical orientation. These structures would be present during the full time of the operation of the proposed action. The Horseshoe Shoal area of Nantucket Sound has limited amounts of this type of habitat. Monopile foundations that were selected for this proposed action are smooth and lacking in complexity in comparison to scaffolding that is often used for oil platforms (MMS, 2000). Substrates that are irregular and rough offer organisms structural complexity for protection from predation and/or exposure to high current velocities and scour. Thus, the new substrate is not favorable

for colonization or reef formation because of its low complexity and rugosity (CARPG, 1998). Organisms that may settle on such structures include algae, sponges, tunicates, anemones, hydroids, bryozoans, barnacles, and mussels. These organisms are known to occur on other hard substrate areas in Nantucket Sound. Organisms including polychaetes, oligochaetes, nematodes, nudibranchs, gastropods, and crabs are expected to occur as fouling organism growth develops. Results from the 2005 Macroinvertebrate Survey of the Meteorological Tower (described previously in Section 4.2.5.3.2) indicated that a benthic macroinvertebrate community similar to the surrounding sea floor community had colonized the support pilings. Noted were seven species not observed during other baseline surveys at Horseshoe Shoal. These new taxa were noted to likely be in the site of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders. It was expected the pilings would support more taxa since they may attract organisms from both sandy substrate habitats and those that would be attracted to fixed structures.

Although use of the monopile structures is expected by some hard-bottom and fouling organisms, individual monopiles are not anticipated to act as true artificial reef structures that would significantly change benthic or fish communities in Nantucket Sound. Research that has been conducted on design of artificial reefs indicates that major design features affecting artificial reef function are, as previously described, complexity and rugosity (material used and roughness), and, in addition, surface area, shape, profile, size, and orientation (CARPG, 1998). Adequate interstitial spaces are also a factor in establishment of a diversity of mobile invertebrates and numerous cryptic fish species (CARPG, 1998). The monopiles would not have interstitial space and their wide spacing (0.34 to 0.54 mile (629 to 1,000 m) apart) does not create collectively sizeable interstitial space beneficial for benthic organisms or most fish. Additional amounts of surface area that are being introduced, approximately 1,200 ft² (0.03 acre or 111 m²) per tower with 30 ft (9.1 m) as an assumed average water depth, for a total of about four acres, would be minor. The addition of rock scour armor would significantly increase this acreage compared to that of the monopiles alone, but representing a small fraction of change in the overall site of the proposed action.

Observations that are similar to those made at the meteorological tower in Nantucket Sound have been made at the monopile foundation installations at existing European wind farms such as Denmark's Horns Rev and Nysted offshore wind farms (Birklund and Petersen, 2004; Bio/consult as., 2005). At these wind farms, hard-bottom attachment sites are created habitat for the benthic organisms that require a fixed (non-sand) substrate. Two annual post-construction/operation surveys of monopile communities at the Horns Rev wind farm identified taxa of seaweeds and faunal invertebrates, some of which were mobile species. Some epifaunal species had not previously been reported at the mostly sandy habitat. It was noted that the monopiles and scour control devices (raised hard-bottom platforms) had changed the substrate from all sand to one with foundations of steel, gravel, and stones. The monitoring reports noted further that native infaunal communities had been replaced with epifaunal communities usually found in the hard-substrate type of environment. In the year between the two surveys significant species and population variations were noted along with variation in spatial and temporal distribution. Such changes may have occurred because of regular scouring and recolonization due to severe storms and winter conditions. Studies have noted that though heavily populated fouling communities can establish themselves in as short a time as a year with placement of new hard-bottom habitat, stability of such a community is not reached till five to six years after a structure's establishment (Bio/consult as., 2005).

A post-construction survey at Nysted windpark found blue mussels, barnacles, bryozoans, and macroalgae at various depths on the monopile. Macroalgae were found on the monopile foundation and anti-scour concrete and stone base platform. Other invertebrate species noted along the base of the monopile foundation and raised scour protection platform included polychaetes, amphipods, gastropods, and bivalves (Birklund and Petersen, 2004). The raised hard-bottom platforms used at the Horns Rev and Nysted wind farms had greater substrate complexity than that proposed for this proposed action with

scour control mats, although the alternative proposed rock armor backfill would increase substrate complexity around monopiles. In comparison to the Danish wind farms that provided greater surface area for colonization, hard-bottom colonization is anticipated to be less at the site of the proposed action in Nantucket Sound.

In addition, post-construction monitoring results from these European wind farms documented that a significant alteration to the food-chain basis (benthic organisms) did not occur. Therefore, it is not anticipated that the proposed action would impact the food chain or greatly impact predator-prey relationships supported by the benthic resources.

The presence of the ESP, with a surface area of 20,000 ft² (0.46 acre or 1,858 m²), may affect the soft-bottom benthic invertebrate communities in its immediate locale due to shading. It is expected these possible effects would be negligible since the ESP structure is to be located approximately 39 ft (12 m) above the MLLW datum plane in 28 ft (8.5 m) of water. The shadow from the structure is expected to move rapidly across the seafloor during the daylight hours.

Impacts from Unplanned or Accidental Events

In addition to the referenced operational impacts on benthic resources, there are potential impacts that could result from the unlikely requirement for repair of the electric cable. Such impacts would include temporary turbidity and some localized deposition of sediments during the repair process. Turbidity would be caused by the jetting of sediments to uncover the damaged portion of the cable, hoisting of the cable after it is cut, laying the cable back down, and then jetting of sediments for reburial of the repaired cable. Cable repair procedures are discussed in more detail in Section 2.4.6. Temporary impacts would also occur in the area where anchors were deployed or anchor cable sweeps the bottom. Impacts on benthic resources as a result of cable repair would be temporary, occupy a very small area of the seafloor and would therefore be negligible overall.

Other accidental situations, such as vessel collision or monopile collapse are most likely only going to have an affect on the benthos in the immediate area around the damaged monopile. Impacts would be consistent with and similar to those discussed above for construction and decommissioning, although in reverse occurrence, since the damaged monopile would be removed and a new one installed. Because of the temporary nature and localized impacts from sediment disturbance and vessel activities associated with this type of event, impacts to benthic resources would be negligible.

Shellfish

Potential impacts to shellfish due to operation of the proposed action are similar to those described above for soft-bottom benthic invertebrate communities.

In addition, with cable installation involving burial with a minimum of 5 ft (1.8 m) of cover below the seafloor possible interference with lobster or other shellfish migration or use of nursery or habitat areas is not expected. Use of submarine cable installation methods may result in temporary depressions in the seafloor, but since these are similar to natural topographic relief there is not expected to be interference with lobster, crab, gastropod or other mobile benthos movement or migration (Fogerty, 2000).

No adverse impacts from heat associated with submarine cables are expected for benthic and shellfish resources. Burying of cables below the seafloor and proper cable system design, serve to minimize potential thermal impacts during the operation of the proposed action.

During operational related activities there is the potential for spills and accidental releases of material such as diesel fuel, lubricants, and hydraulic fluid. Commitment to careful operational related practices to

minimize potential for spills and accidental releases and having an SPCC Plan that include rapid spill response and clean-up capabilities are measures that should minimize the potential for harm to benthos and benthic habitats relative to spills and accidental releases during operation of the proposed action.

Impacts on Meiofauna and Plankton

Meiofauna

The meiobenthic community may be affected from sediment disturbance from maintenance activities during operation. Recovery of the meiobenthic community from sediment disturbance is expected to be as fast as or faster than that of the macrobenthos, as previously described in the construction/decommissioning impacts. Thus, temporary and highly localized disturbance of sandy substrate during periodic maintenance activities should have minor impacts on the meiobenthos.

Plankton

Phytoplankton and zooplankton are not expected to be significantly affected by operational activities. Temporary and localized disturbance of sandy substrate during periodic maintenance activities should have minor impacts on phytoplankton and zooplankton.

Wind turbine operation would shade small areas of water which may result in minor reduction of photosynthesis by phytoplankton. This potential for shading is expected to be inconsequential since water in Nantucket Sound typically moves rapidly through the site of the proposed action due to tidal currents. Thus, there should be minor potential for phytoplankton disturbance.

Conclusion

Wind Turbine operations are expected to have negligible impacts on soft and hard bottom benthic invertebrate communities, shellfish, meiofauna, and plankton. Since the proposed action's operation does not involve planned activities resulting in seafloor disturbance, only those unplanned or accidental events that occur would result in the potential to impact these species. It is inherent in an activity that is unplanned that it have a low probability of occurrence, and for this proposed action, any such activity is likely to involve on a short duration and a small area.

5.3.2.6 Non-ESA Marine Mammals

5.3.2.6.1 Construction/Decommissioning Impacts

Non-ESA listed marine mammal species may be impacted by activities associated with proposed action construction, operation/maintenance and decommissioning. This section discusses the impacts on the specific species mentioned in Section 4.2.6. These species are all protected under the MMPA. The applicant would be required to abide by any measures required by NOAA Fisheries under the terms of its review and approval process under the MMPA. Threatened or endangered marine mammals protected under the federal ESA are presented in Section 5.3.2.9 and [Appendix C](#).

The NMFS has established acoustical guidelines that set thresholds to prevent acoustic injury (Level A) and acoustic harassment (Level B) to marine mammals. The Level A threshold is 190 dB for pinnipeds and 180 dB for cetaceans, and the Level B threshold is 160 dB.

Pinniped Species

Acoustical Harassment

Short-term noise level measurements of underwater noise were collected at Buoy G5 in the North Shipping Channel and at Buoy R20 at the edge of the Main Channel. Measured L_{eq} underwater sound levels were found to be 90 dB and 93 dB at Buoys G5 and R20, respectively. The sound level at Buoy R20 is slightly higher due to the shallower water and greater current. The depth at this location is also more representative of the water depth on Horseshoe Shoal, and accordingly, the Buoy R20 data were used as a baseline for the proposed action.

Underwater sound levels with higher wind speeds (as would occur with proposed action operation) would be higher. Studies conducted in other coastal water areas indicate that the sound level increases 7.2 dB per doubling of wind speed. Accordingly, the estimated underwater L_{eq} sound level for the design wind speed of the proposed action would be 107.2 dB. The frequency spectrum for the existing condition is provided in [Figure 4.1.2-12](#).

Underwater sound level measurements conducted on Horseshoe Shoals at the site of the SMDS at the time that three support piles were driven into the seabed were also utilized for this study. The weather conditions at the time of the measurements included moderate winds of less than 12 mph and moderate seas of less than 5 ft (1.5 m). The measured existing underwater L_{max} level (without pile driving) was 123 dB.

Modeling Methodology

Underwater sound effects from construction and operation of the proposed action were evaluated by utilizing the results of the ambient measurements and a noise modeling study ([Report No. 5.1.5-1](#)). The design wind speed corresponds to the maximum underwater sound levels for the proposed action. Sound wave propagation and attenuation underwater is a very complex phenomena influenced by gradients of temperature, salinity, currents, sea surface turbulence, and bottom conditions. Underwater acoustic modeling for the proposed action used standard methods for representing how sound waves spread out underwater (spherical wave spreading) and diminish in intensity and for seawater absorption effects. Research has shown this method provides a reasonable fit to measured underwater sound levels under a wide variety of conditions. The acoustic model consisted of utilizing a spreadsheet type model that accounted for spherical spreading and standard seawater sound absorption factors.

Sound source data for construction and operational effects underwater were provided by GE Wind Energy from recent tests at the Utgrunden and Gotland Projects ([Report No. 4.1.2-1](#)) which have similar environmental conditions to Nantucket Sound and provide the best available data. Data obtained during pile driving at the Utgrunden Project revealed L_{max} sound levels of 177.8 dB at 1,640 ft (500 m). Noise levels of pile driving at the SMDS were found to range from 145 dB to 167 dB at a distance of 1,640 ft (500 m). The higher Utgrunden pile driving sound level data were utilized in the modeling analysis because the monopile foundations for the proposed action would be similar in size to those used at Utgrunden, and because of similarities in environmental conditions between Nantucket Sound and the Baltic Sea. Baseline underwater sound levels under the design wind condition are 107.2 dB.

Underwater Construction Impacts

The underwater sound effects of construction would be associated with the installation of 130 16 to 18 ft (4.8 to 5.5 m) diameter monopiles (one for each WTG), installation of six smaller 4 ft (1.2 m) diameter piles for the ESP, vessel traffic for transporting equipment, piles, and workers to the site and vessel traffic associated with installation of offshore cables. According to divers experienced in jet plow

installations, the jet plow itself produces no audible noises other than the sound of water exiting the nozzles, which is only audible when immediately adjacent to the nozzles. The principal sound from construction would therefore be temporary pile driving of the WTG monopiles using a drop hammer similar to an IHC S-600.

The NMFS has established acoustical harassment guidelines that set thresholds to prevent acoustic injury (Level A) and acoustic disturbance (Level B) to marine mammals. The Level A threshold is 190 dB for pinnipeds and 180 dB for cetaceans, and the Level B threshold is 160 dB. The hearing threshold is the minimum sound level in a 1/3-octave band that can be perceived by an animal in the absence of significant background noise. The hearing bandwidth for an animal is the range of frequencies over which an animal can perceive sound. Calculated underwater pile driving noise levels were shown to be below the NMFS Level A acoustic harassment threshold at and beyond the 1,640 ft (500 m) safety radius. However, sound levels would be above the Level B 160 dB threshold. It is currently anticipated that 10 WTGs would be installed per month, with all WTGs being installed in two seasons. While pile driving noise would be temporary and intermittent, it would occur over a two season period.

Pile Driving

Pile driving noise is most concentrated in the lower frequencies, below 1000 Hz, and in particular below 250 Hz. The calculated maximum underwater sound levels (L_{\max}) from pile driving in the proposed action would range from 172 dB at a distance of 1,640 ft (500 m) to 170 dB at a distance of 4,002 ft (1,220 m) and down to 145 dB at a distance of 13 miles (21 km). In the near-shore waters of Cape Cod and Martha's Vineyard, the L_{\max} levels would range from 140 to 155 dB. Levels would be lower in Lewis Bay due to the barrier attenuation provided by the land-mass of Great Island in Yarmouth. [Figures 5.3.2-1](#) and [5.3.2-2](#) show the temporary underwater L_{\max} sound levels throughout Nantucket Sound for pile driving at the southwest and northeast corners of the proposed action, respectively. The frequency spectrum of the underwater sound at a distance of 1,640 ft (500 m) from a monopile is given in [Figure 5.3.2-3](#). Vessel underwater noise has been measured at 162 dB at one meter, and its energy peak is below 1000 Hz.

The hearing threshold sound level (dB_{ht}) of protected species were calculated by passing the frequency spectrum of the expected underwater sound through a filter that mimics the frequency dependent hearing threshold of the species. This allows for a single dB number to be used to describe the effects of a sound on a species. This methodology is similar to that used to calculate dBA levels, which are used to determine how humans perceive sound. The hearing bandwidth for an animal is the range of frequencies over which an animal can perceive sound. Pinnipeds (hair seals) have a hearing bandwidth of from 100 Hz to 100 kilohertz (kHz), but their most sensitive hearing is at the middle frequencies of 1 kHz to 30 kHz where their hearing threshold is 60 to 80 dB re 1 μ Pa (Richardson et al., 1995). In the low frequencies where pile driving noise is concentrated, pinnipeds have a high hearing threshold of 80 to 100 dB.

A hearing threshold sound level (dB_{ht}) was calculated for several species of seals to determine the actual underwater sound level that is heard by seals from monopile installation at different distances from construction activities. The results of the dB_{ht} analysis show that no physical injury to seals are predicted if an individual were to approach as close as 98 ft (30 m) to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB. Therefore, although the animal may hear the underwater construction sounds they are not expected to cause physical harm to pinnipeds.

Research has shown that marine mammal avoidance reactions occur for 50 percent of individuals at a 90 dB_{ht} (e.g., when the sound level exceeds the species' hearing threshold by 90 dB). The 90 dB_{ht} threshold is consistent with NOAA Fisheries Service guidelines defining a zone of influence (e.g.,

annoyance) for marine mammals as a sound level of 80 to 100 dB above a species hearing threshold. Using the hearing threshold data, sound levels were calculated for seals for the project's loudest construction noise (pile driving). If seals are in the construction area, they are likely to temporarily avoid the zone of behavioral response around the monopile being driven. Behavioral effects (avoidance) would occur at a range of 820 to 4,593 feet (250 to 1,400 m) when $dB_{ht}=90$ dB re 1 μ Pa. Marine mammals may experience limited and temporary noise harassment, as the anticipated noise levels will be slightly greater than the NMFS Level B standard, but is not expected to be greater than the NMFS Level A standards, and thus not result in any injury to marine mammals. MMS recommends that the applicant contact NMFS to determine if an Incidental Harassment Authorization (IHA) under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may "take" marine mammals.

Vessels

Maximum hearing threshold levels for proposed action vessels were calculated for seals at a distance of 150 ft (45.7 m). A level of 44 dB_{ht} was calculated, well below the injury threshold of 130 dB_{ht} and the harassment threshold of 90 dB_{ht} .

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound would be generated during HDD.

Given the known areas that the seals within Nantucket Sound inhabit, minor impacts would be anticipated for seals due to proposed action construction generated noises, and any noise should not affect the migration, nursing/breeding, feeding/sheltering or communication of seals. If seals are in the proposed action construction area, they are likely to temporarily avoid a given area around the construction.

Noise produced by the decommissioning of the proposed action is expected to be similar to those produced during proposed action construction. Proposed action decommissioning would not require pile driving activities, which cause the highest sound levels of any activities associated with the proposed action. Pile driving only takes place during the construction phase of the proposed action. Decommissioning would involve the use of similar vessels, cranes, jet plow, cutting and welding equipment and other tools that were involved in construction, but would not include any pile driving, blasting or activities which approach the noise level of pile driving. During decommissioning, the monopiles and transition pieces would be cut off at approximately 15 ft (4.6 m) below the seabottom. As such, the noise impacts from decommissioning activities would appear to be less than the worst case impacts already presented for construction and would be minor.

In addition to noise associated with boat traffic and pile driving, the proposed action would result in noise associated with the post lease G&G field investigation, which would include vibracores and drilling of bore holes to acquire subsurface geological information on the sea bottom. The vibracores would be accomplished via a small gasoline motor and the drilling of cores would be accomplished via a truck mounted drill rig on a barge. Both of these activities would be very short term, and these devices generate sound levels that are much lower than sound levels associated with pile driving. Sound levels from a small gasoline motor would be comparable to that associated with a small motorized boat. Sound levels from a truck mounted drill rig would be comparable to those on a small ship or large boat. These types of sounds occur regularly in the area. Thus impacts to marine mammals are expected to be negligible with respect to the G&G activity.

Increased Vessel Traffic

As previously mentioned, the proposed action would temporarily increase the number of vessels within the vicinity of the area of the proposed action, especially in the route between Quonset, Rhode Island and the area of the proposed action. The additional traffic from construction and decommissioning vessels may increase the chance of a strike or harassment of seals.

Vessel Strikes

Collisions between proposed action vessels and seals may cause severe damage or even mortality to the animal. Vessel strikes were determined to be the cause of death in some stranded harbor seals and other species in New England waters (Waring et al., 2006).

Seals are agile and aware of their surroundings in the water; at the sight or sound of an approaching vessel seals are known to dive into the water and swim away. The proposed action's vessels, such as the tugs and barges used for proposed action construction and decommissioning, would be clearly audible and can be detected easily by seals. Seals have been known to both avoid vessel traffic and approach vessels, especially fishing vessels, and appear to habituate to most anthropogenic noises and activities, such as those at harbors and coastal airports (Vella et al., 2001). Gray seals were observed to habituate to construction activities, including pile installation, during construction of the Näsrevet Wind Farm in Sweden (Westerberg, 1999).

The assumed risk of vessel strikes to seals is considered minor, as seal haul-out and breeding sites, where the highest densities of seals have been observed are not in close proximity to proposed action activities and proposed action vessels would be traveling at slower speeds (less than 14 knots [7.2 m/s]).

Vessel Harassment

Any impact on MMPA protected seal species due to the physical presence of the proposed action's vessels are expected to be minor. MMS recommends that the applicant contact NMFS to determine if an IHA under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may "take" marine mammals.

The central portion of Nantucket Sound and the vessel routes proposed to be used by the proposed action vessels are not within what is considered a high use area for listed seal species. If any seals are present in the area of the proposed action, potential behavior changes in response to the proposed action-related vessel traffic would be short-term and would likely be similar to the behaviors observed during regularly occurring activities in Nantucket Sound such as the personal boat use, whale watching cruises, ferry traffic and fishing. However, as seals are coastal marine mammals, and readily habituate to vessels in locations of high vessel traffic, they may be more susceptible to vessel strikes.

The effects of vessel harassment on the migration, breeding and feeding behaviors of seals are expected to be minor. Important coastal habitat for gray and harbor seals exists in Nantucket Sound, but at distances from the area of the proposed action that would result in minor harassment from the proposed action-related vessel traffic. Some displacement of seals from feeding grounds due to an increase in vessel traffic may occur if the vessel makes repeated approaches or if vessel traffic is heavy. However, prey for all seal species is prevalent in Nantucket Sound and foraging can occur in locations less disturbed by proposed action vessels. In addition proposed action vessels would be similar to typical vessel traffic occurring in Nantucket Sound on a regular basis, to which seals are already acclimated.

If seals are present in the area of the proposed action or along the vessel routes, potential behavioral changes in response to vessel traffic would be short-term, and would likely be similar to the behaviors observed during activities that regularly occur in Nantucket Sound.

Both construction and decommissioning-related impacts would be short-term and localized and are expected to be similar to or less than impacts during construction. Seals in the Nantucket Sound area are accustomed to substantial amounts of suspended sediment on an irregular basis, and would be minimally impacted by a temporary increase in turbidity from proposed action decommissioning activities.

Temporarily Reduced Habitat

Activities related to proposed action construction and decommissioning may cause a temporary reduced availability of habitat for seals in the vicinity of the area of the proposed action. The main anticipated impact would be part or complete avoidance of areas of high traffic mainly the route the proposed action-vessels would use to and from the proposed action. However, as under normal conditions the seals are exposed to high volumes of vessel traffic due to commercial and recreational ships within Nantucket Sound, the increase in traffic is not anticipated to displace the seals for long periods of time. Some avoidance may also occur during construction activities due to acoustical harassment from pile driving, as mentioned previously. However, this disturbance would be temporary and would not result in any major effects on the listed seals. Studies conducted throughout the construction of offshore projects in Denmark, showed that only during pile driving activities was there a slight change in seal behavior or distribution, reducing haul-outs on nearby landfalls and temporary avoidance of the general area at great distances. Normal behavior and distribution returned quickly after pile driving activities ceased and continued through the operation of the Wind Farm (Danish Offshore Wind – Key Environmental Impacts, 2006).

As most seals forage and inhabit areas inshore, the HDD operations within Lewis Bay may cause temporary displacement from near-shore foraging areas. Studies do show that seals can rapidly habituate to construction activities, including pile construction, only showing alarm when support vessels moved within hundreds of meters of the seals (Westerberg, 1999). Some disturbance from vessel traffic and construction noise may occur, temporarily displacing seals from feeding or haul-out sites, but this impact would be minor and would terminate when proposed action construction concluded.

Known breeding and haul out sites for seals do not coincide with the proposed action in Nantucket Sound. Since the proposed action's proposed location is approximately 8 to 12.7 miles (13 to 20.4 km) from haul-out and breeding sites; Monomoy, Muskeget and Tuckernuk Islands; seals utilizing these breeding and haul-out grounds would be minimally impacted by proposed action construction.

The proposed action may cause some displacement of prey during construction and decommissioning activities; however, seals that may feed on fish would be able to find suitable prey in areas adjacent to the area of the proposed action. Construction activities may result in an increased availability of seal prey species, especially during winter construction periods when fish may experience higher levels of injury or mortality, providing a short-term increased opportunity to feed on injured fish and macroinvertebrates ([Report No. 4.2.5-5](#)).

Habitat Shift (Non-structure Oriented to Structure)

As seals do not often utilize the waters within the vicinity of the area of the proposed action for foraging, but rather remain closer inshore, the change of habitat structure with the addition of the WTGs would have minor impacts on seal populations. However, as the proposed action has the potential for the establishment of "fouling communities", the hard substrate may have minor impacts for seals.

Habitat Shift (Structure to Non-structure Oriented)

Removal of the WTG monopile foundations and ESP piles at the time of decommissioning would result in a localized shift from a structure-oriented habitat near the WTGs and ESP to the original shoal-oriented habitat present prior to construction to the proposed action. However, as the addition of the monopiles would be a minor addition to the hard substrate that was present prior to the construction of the proposed action, the removal of the WTGs and ESPs would not cause a great impact in the overall habitat structure. Therefore, any seal that may have been attracted to the WTGs for feeding would have to forage in other locations within Nantucket Sound, which has ample supplies of prey species and impacts from the habitat shift would be minor.

Turbidity and Total Suspended Solids

The increase of TSS would impact the foraging abilities of the seals, decreasing visibility within the water. As with sea turtles, seals within the area of Nantucket Sound and Lewis Bay are accustomed to substantial amounts of suspended sediment on an irregular basis, from storms and strong tidal currents, and should not be substantially impacted by a temporary increase in turbidity from proposed action activities. Further, seals are mobile and can move away from any disturbance, including any increases in suspended sediments. The total expected impacts of increased turbidity and TSS are minor for seals within Nantucket Sound.

Seals bioaccumulate contaminants from their ocean environment almost exclusively through their food sources. The potential mechanism by which sediments suspended during proposed action construction can harm seals is through bioaccumulation of sediment-associated chemicals through ingestion of contaminated prey (indirectly).

Analysis of sediment core samples obtained from the area of the proposed action indicate that sediment contaminant levels were below established thresholds in reference ER-L and ER-M marine sediment quality guidelines (Long et al., 1995). Therefore, the temporary and localized disturbance and suspension of these sediments during proposed action construction activities are not anticipated to result in increased contaminants in lower trophic levels. Thus, seals are unlikely to experience increased bioaccumulation of chemical contaminants in their tissues from the consumption of prey items in the proposed action vicinity, and any impacts are expected to be minor.

During the nearshore installation, the release of contaminants from the HDD operation within Lewis Bay would be minimized through a drilling fluid fracture or overburden breakout monitoring program, minimizing the potential of drilling fluid breakout into the water.

Pollution/Potential Spills

Seals have thick layers of blubber that prevent them from becoming hypothermic if they were to become coated in oil as result of a spill. While in the water, seals are most vulnerable when they surface for air, at which time they may inhale hydrocarbon vapors which can damage lungs. Contact with eyes and skin can also cause irritations.

Because the seals rely on coastal areas to haul-out and some to reproduce, they have the potential to be exposed on land as well as at sea. Seal pups are most vulnerable if oil reaches the shoreline, because they have not developed the protective blubber. Pups are also more likely to ingest oil while nursing on contaminated teats. The gray seal, which breeds in Nantucket Sound during the winter, is most susceptible to impacts from an oil spill. Seals can also become impacted by an oil spill through bioaccumulation of the pollutants from their prey species. In the event of an oil spill during construction or decommissioning, the impacts on seals are expected to be minor.

Impacts to Cetaceans

The MMPA protected cetacean species that could occur in the site of the proposed action may be impacted by activities associated with proposed action construction and decommissioning. This section discusses the impacts on the specific species mentioned in Section 4.2.6.2.2.

Acoustical Harassment

Pile Driving

In general, toothed whales have a hearing bandwidth of 100 Hz to over 100 kHz, with the most sensitive hearing in the HF range of 10 kHz to 65 kHz where their hearing threshold is 40 to 60 dB (Richardson et al., 1995). Baleen whales react primarily to sounds at low frequencies below 1 kHz, which is consistent with the fact these whales usually communicate at frequencies in the 20 Hz to 500 Hz range (Richardson et al., 1995). The hearing threshold for baleen whales ranges from 82 dB at 500 Hz to 88 dB at 20 Hz (Nedwell et al., 2004).

A dB_{ht} was calculated for several species of cetaceans to determine the actual underwater sound level that is heard by cetaceans from monopile installation at different distances from construction activities. The results of the dB_{ht} analysis show that no physical injury to cetaceans are predicted if an individual were to approach as close as 30 m to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB. Behavioral effects (avoidance) would occur at a range of 1,050 to 4,626 feet (320 to 1,410 m) when $dB_{ht}=90$ dB re 1 μ Pa. Therefore, although marine mammals may hear the underwater construction sounds they are not expected to cause physical harm to cetaceans. Marine mammals may experience limited and temporary noise harassment, as the anticipated noise levels will be slightly greater than the NMFS Level B standard, but is not expected to be greater than the NMFS Level A standards, and thus not result in any injury to marine mammals. MMS recommends that the applicant contact NMFS to determine if an IHA under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may “take” marine mammals.

Vessels

Maximum cetacean hearing thresholds for vessels were calculated for a distance of 100 ft (30.5 m). Levels of 42 dB_{ht} and 45 dB_{ht} were calculated for whales and for toothed whales, respectively. These levels are well below the injury threshold of 130 dB_{ht} and the harassment threshold of 90 dB_{ht} . In this range, the animal would be able to hear the vessel, but no physical harm or behavioral effects would occur.

The jet plow embedment process for laying the two offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound would be generated during HDD.

Any cetaceans are likely to temporarily avoid a given area around the construction, and only minor impacts would be anticipated due to proposed action construction generated noises. Any noise should not affect the migration, nursing/breeding, feeding/sheltering or communication of cetaceans.

Noise produced by the decommissioning of the proposed action is expected to be similar to those produced during proposed action construction. Proposed action decommissioning would not require pile driving activities, which cause the highest sound levels of any activities associated with the proposed action. Pile driving only takes place during the construction phase of the proposed action. Decommissioning would involve the use of similar vessels, cranes, jet plow, cutting and welding

equipment and other tools that were involved in construction, but would not include any pile driving, blasting or activities, which approach the noise level of pile driving. During decommissioning, the monopiles and transition pieces would be cut off at approximately 15 ft (4.6 m) below the seabottom. As such, the noise impacts from decommissioning activities would appear to be less than the worst case impacts already presented for construction and would be minor.

Increased Vessel Traffic

As mentioned above, the additional traffic from construction and decommissioning vessels may increase the chance of a strike or harassment of cetaceans.

Vessel Strikes

Vessel strikes to listed cetaceans can result in injury or death of the animal. The potential risk to listed whale and dolphin species from collisions with proposed action-vessels is evaluated below.

Ship collisions are a significant threat to large cetaceans and is considered the single important source of human-caused mortality in some species (Jensen and Silber, 2003; Waring et al., 2006). While ship strikes occur throughout the world, several studies document that the greatest number of incidents occur within the North American east coast (Laist et al., 2001; Jensen and Silber, 2003; Waring et al., 2006). Along the North American east coast there is a high concentration of large cetaceans and a significant volume of vessel traffic, enabling a greater chance of a collision but also the greater likelihood of reporting of any strikes possibly biasing any assumptions (Jensen and Silber, 2003).

The majority of vessels that have documented whale strikes are large, fast moving vessels such as container ships, tankers or military vessels (Jensen and Silber, 2003). There are several documented collisions of cetaceans with smaller vessels (less than 65 ft [19.8 m]); however all of these collisions were with boats traveling at higher speeds (Right Whale News, 2005). Collisions with vessels that are moving at slower speeds (less than 14 knots [7.2 m/s]), such as the construction vessels to be used for the proposed action, are less likely, and there have been no recorded ship strikes from vessels traveling less than 10 knots (5.1 m/s) (Laist et al., 2001).

The humpback, North Atlantic right and fin whales are the most often documented victims of ship strikes. Ship strikes of the other whale and dolphin species mentioned in Section 4.2.6.2.2 are less common, and general assumptions and impacts discussed for these three whales would apply to other MMPA protected cetaceans. Detailed discussion of these three whale species is presented in [Appendix C](#), which provides information on T&E species and potential effects to T&E species.

Humpback, right and fin whales should be able to detect any tugboat, barge and other slow-moving vessels within the area of the proposed action, as baleen whales can easily detect and respond to sounds of the frequency range and intensity of those produced by tugboats and barges (Miles et al., 1987; Richardson et al., 1991; McCauly, 1994). Humpback whales are relatively tolerant of boats, but, due to this habituation they may be more susceptible to ship collisions. Whale response, however, are unpredictable and may depend on the activity of the whale at the time, or its previous experience with other motor vehicles.

Despite the expected ability of right whales to hear approaching vessels, they continue to die from vessel collisions (Richardson et al., 1995; Nowacek et al., 2004). A study by Nowacek et al., (2004), reported that right whales did not respond to the sounds of approaching vessels or the actual vessels. Some anecdotal observations suggest that right whales only respond when vessels approach to within a very close range. Right whales off the eastern coast of North America are frequently exposed to vessels,

and they may have habituated to the sounds of approaching vessels at great distances (Richardson et al., 1995; Terhune and Verboom, 1999; Laist et al., 2001).

The other species of whales and dolphins discussed in Section 4.2.6.2.2 should also be able to hear approaching vessels, as the noise associated with the vessel fall within their hearing range.

Vessel Harassment

Any impact on marine species due to the physical presence of the proposed action-vessels is expected to be minor. MMS recommends that the applicant contact NMFS to determine if an IHA under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may “take” marine mammals.

There have been many studies of the effects of vessels on cetaceans, particularly the underwater noises they make (Richardson et al., 1985, 1991). It is likely that whales and dolphins react primarily to the sound generated by vessels, and not their physical presence (NMFS, 2001; NMFS, 2002). Moreover, the central portion of Nantucket Sound and the vessel routes proposed to be used by the proposed action vessels are not within what is considered a high use area for listed whale species. If any MMPA protected animals are present in the area of the proposed action, potential behavior changes in response to proposed action-related vessel traffic would be short-term and would likely be similar to the behaviors observed during regularly occurring activities in Nantucket Sound such as the personal boat use, whale watching cruises, ferry traffic and fishing. Close encounters between proposed action vessels and species are likely to be rare and result in minimal physical disturbance to the animals.

The effects of vessel harassment on the migration, breeding and feeding behaviors of cetaceans are expected to be minor. Based on the undeveloped source of whale prey in Nantucket Sound, it is highly unlikely that cetaceans would be migrating through, nursing or feeding in Nantucket Sound, but further offshore. The physical presence of vessels associated with proposed action construction would not contribute to the harassment of migrating, nursing or feeding humpback, fin or right whales. These large migratory whales are only expected to be within the vicinity of New England waters during the spring and summer feeding seasons. However, preferred whale prey is not found abundantly within Nantucket Sound, rather most feeding grounds for these species are further offshore and would not be directly impacted by proposed action construction. Some seasonal residents of Nantucket Sound, such as harbor porpoises, may experience some displacement from traditional feeding grounds, however this should be temporary and most species found within the vicinity of the proposed action are habituated to high volumes of vessel traffic.

As mentioned previously, vessel strikes have caused mortality in cetaceans in New England waters (Waring et al., 2006). During decommissioning activities, as during construction activities, it is estimated that 4 to 6 stationary or slow moving vessels would be present in the general vicinity of the pile removal. Vessels delivering demolition materials or crews to the site would also be present in the area between the mainland and the site of the proposed action. The barges, tugs and vessels carrying materials would be limited to speeds below 10 knots (5.1 m/s) and may range in size from 90 to 400 ft (27.4 to 122 m), while the vessels carrying crews would be traveling at a maximum speed of 21 knots (10.8 m/s) and would typically be 50 ft (15.2 m) in length. The vessels used for the decommissioning of the proposed action would be smaller, slower moving vessels than those that regularly cruise Nantucket Sound, with expected impacts on cetacean populations in Nantucket Sound to be minor.

Temporarily Reduced Habitat

Activities related to proposed action-construction may cause a temporary reduced availability of habitat for cetaceans in the vicinity of the area of the proposed action. The main anticipated impact

would be avoidance of areas of high traffic mainly the route the proposed action vessels would use to and from the proposed action. However, as under normal conditions the cetaceans are exposed to high volumes of vessel traffic due to commercial and recreational ships within Nantucket Sound, the increase in traffic is not anticipated to displace cetaceans for long periods of time. Some avoidance may also occur during construction activities due to acoustical harassment, as mentioned previously. However, this disturbance would be temporary and would not result in any major effects on the listed cetaceans. Studies at off-shore Danish wind farms showed that harbor porpoises temporarily avoided the area in the vicinity of the turbines only during construction, and mainly during pile-driving activities (Danish Offshore Wind – Key Environmental Impacts, 2006). Abundances for harbor porpoises slowly returned to close to pre-construction values for most of the area, with only a limited area with strong negative impacts that continued through the operation of the wind farm. Therefore any impacts are expected to be minor for the cetaceans in Nantucket Sound, and any changes would be temporary.

Proposed action construction and decommissioning are not anticipated to result in changes in cetacean prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this would be limited to areas directly surrounding the given activities, causing both prey species and cetaceans moving to an undisturbed area. Pelagic prey tends to be highly variable and animals foraging on these sources move with the food source, as seen with many cetaceans and their prey species. Any temporary disturbance to pelagic prey is likely to mimic typical temporal and spatial variability, and is likely available in other areas of Nantucket Sound and surrounding waters for foraging by cetaceans. Therefore, proposed action construction is anticipated to have minor impacts on cetaceans in regards to reduced habitat and prey availability.

Habitat Shift (Structure to Non-structure Oriented)

The presence of 130 monopile foundations, six ESP piles and their associated scour control mats in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from soft sediment, open water habitat system to a structure-oriented system, with minor effects to cetaceans.

Habitat Shift (Structure to Non-structure Oriented)

Removal of the WTG monopile foundations and ESP piles at the time of decommissioning would result in a localized shift from a structure-oriented habitat near the WTGs and ESP to the original shoal-oriented habitat present prior to construction to the proposed action. However, as the addition of the monopiles would be a minor addition to the hard substrate that was present prior to the construction of the proposed action, the removal of the WTGs and ESPs would not cause a great impact in the overall habitat structure. Therefore, any cetacean that may have been attracted to the WTGs for feeding would have to forage in other locations within Nantucket Sound and surrounding waters, which have ample supplies of prey species.

Turbidity and Total Suspended Solids

Cetaceans within the area Nantucket Sound are accustomed to substantial amounts of suspended sediment on an irregular basis, from storms and strong tidal currents, and a temporary increase in turbidity from proposed action activities would have minor impacts.

Cetaceans bioaccumulate contaminants from their ocean environment, almost exclusively through their food sources. The potential mechanism by which sediments suspended during proposed action construction can harm cetaceans is through bioaccumulation of sediment-associated chemicals through ingestion of contaminated prey (indirectly).

Analysis of sediment core samples obtained from the site of the proposed action indicate that sediment contaminant levels were below established thresholds in reference ER-L and ER-M marine sediment quality guidelines (Long et al., 1995). Therefore the temporary and localized disturbance and suspension of these sediments during proposed action construction activities are not anticipated to result in increased contaminants in lower trophic levels. Therefore, cetaceans are unlikely to experience increased bioaccumulation of chemical contaminants in their tissues from the consumption of prey items in the proposed action vicinity, and any impacts are expected to be minor.

During the nearshore installation, the release of drilling fluid from the HDD operation within Lewis Bay would be minimized through a drilling fluid fracture or overburden breakout monitoring program, minimizing the potential of drilling fluid breakout into the water.

During the post lease G&G field investigation, vibracores and drilling of bore holes would take place to acquire subsurface geological information on the sea bottom. This would result in turbidity, which would be localized and temporary, and impacts on marine mammals would be negligible.

Decommissioning-related impacts would be short-term and localized and are expected to be similar to or less than impacts during construction. The suspension of solids are expected to be temporary and localized, as the removal technology that would be used to install the monopile foundations and the offshore cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Further, the physical composition of the sands and the physical characteristics of the Sound environment provide reason to assume that any localized turbidity would settle back to the sea floor within a short period of time (one to two tidal cycles) and distance.

Cetaceans in the area are accustomed to substantial amounts of suspended sediment on an irregular basis, and would be minimally impacted by a temporary increase in turbidity from proposed action decommissioning activities.

As discussed previously in proposed action construction impacts, there is little potential for cetaceans to bioaccumulate chemical contaminants in their tissue from consuming prey within the area of the proposed action. The suspension of the sediments due to proposed action decommissioning activities is not anticipated to increase the amount of contaminants found within lower trophic levels.

The preliminary assessment is that those activities associated with the proposed action's construction and decommissioning would have minor impacts on the cetaceans species that may be found in that area. Some temporary avoidance of the area of the proposed action may occur due to elevated acoustic and vessel harassment, however this should be short-lived and normal conditions are expected to resume once construction and decommissioning activities have ceased.

Pollution/Potential Spills

As they rely on blubber for insulation, cetaceans are less vulnerable to oil spills than fur-coated marine mammals, such as seals. Cetaceans are most vulnerable to oil spills when they are surfacing for air when skin and eyes can be irritated. Direct exposure to oil spills can result in the inhalation of harmful fumes, lethargy, poor coordination and difficulty breathing which can lead to drowning (Hammond et al., 2001). Migratory cetaceans may limit their exposure to a persistent oil slick in a small geographic area by avoiding that area. Of the three listed large whale species, the right whale population should be considered at greatest risk to being negatively impacted by an oil spill because of the small population size and slow recovery of their numbers from earlier depletion events. Due to the low probability of an oil spill and limited cetaceans in the area, impacts during construction and decommissioning from an oil spill would be minor.

Conclusion

The overall impacts on marine mammals from construction and decommissioning activities associated with the proposed action are expected to range from negligible to moderate (for pile driving). The moderate impacts would be limited to the construction phase of the proposed action. Marine mammals may experience limited and temporary noise harassment, as the anticipated noise levels will be slightly greater than the NMFS Level B standard, but is not expected to be greater than the NMFS Level A standards, and thus not result in any injury to marine mammals. It is anticipated that marine mammals would avoid the WTG locations while pile driving is occurring. A recent study by Thomsen et al. (2006) revealed that seals and porpoise left the area of the proposed action during pile driving. Seals subsequently returned although porpoise had not as of the study's publication. Negligible impacts would be confined to the duration of the proposed action and the area of the proposed action activities. MMS will work with NMFS through the NEPA comment process to further refine, if needed, its assessment on the impacts of pile driving on marine mammals as well as any mitigation or monitoring measures that will reduce the potential for these impacts to occur. MMS has also advised the applicant that MMS believes there is a potential for pile driving and other activities under the proposal for behavioral harassment to marine mammals and that the applicant should contact NMFS to determine if an Incidental Harassment Authorization under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may "take" marine mammals. In addition, MMS is consulting with NMFS under Section 7(a)(2) of the ESA to address impacts of the proposed activities on ESA-listed marine mammals or ESA-designated critical habitat for listed species. A discussion of mitigation is provided in Section 9.0.

5.3.2.6.2 Operational/Maintenance Impacts

Pinniped Species

Vessel Strikes/Harassment

The proposed action's operation and maintenance activities are expected to require two vessel trips per working day for 252 days of the year. The vessels are anticipated to consist of small crew boats and slower moving vessels, as were used in proposed action construction.

As mentioned previously, vessel strikes have caused some mortality in seals in New England waters (Waring et al., 2006). Because of the ability of seals to habituate to vessels and because seals inhabit coastal shores, they may be more susceptible to ship collisions. However, seals are extremely agile and aware of their surroundings in the water, and able to detect approaching vessels in time to swim away. The vessels used for the operation and maintenance of the proposed action would be smaller and slower moving than those that regularly cruise Nantucket Sound. As a result, impacts on seal populations in Nantucket Sound would be minor.

It is possible that some increased recreational fishing effort may occur after the proposed action is operational due to the "fouling potential" of the WTGs. Seals may be attracted to the WTGs for foraging purposes, but would be minimally impacted by increased fishing vessel traffic to the site of the proposed action since vessels approaching or operating near the WTGs would be traveling at slow speeds.

Acoustical Harassment

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Existing underwater sound levels for the design condition are 107.2 dB. The calculated sound level from operation of a WTG is 109.1 dB at 65.6 ft (20 m) from the monopile (i.e.,

only 1.9 dB above the baseline sound level), and this total falls off to 107.5 dB at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 361 ft (110 m).

An analysis of predicted underwater sound levels perceived by seals from proposed action operation show that no injury or harassment to seals are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the proposed action is operating at the design wind speed as all dB_{ht} values at this minimum distance are well below 90 dB. In fact, proposed action operation would be inaudible for all hair seals at the close distance of 65.6 ft (20 m). Therefore, it is anticipated that underwater operation sounds from the proposed action would result in negligible impacts on hair seals in Nantucket Sound.

Electro Magnetic Fields (EMF)

Potential impacts to seals during the normal operation of the inner-array cables and the offshore transmission cable system circuits are expected to be minor, as the electric field would be completely contained within the shields surrounding the cables. The magnetic fields associated with the operation of the cables are not anticipated to result in an adverse impact to seals or their prey. The burial depth of 6 ft (1.8 m) below the seabed would also minimize potential thermal impacts from the operation of the cables. Therefore, it is anticipated impacts to seals or their prey species during the normal operation of the cable systems are expected to be negligible.

Pollution/Potential Spills

Seals have thick layers of blubber that prevent them from becoming hypothermic if they were to become coated in oil as result of a spill. While in the water, seals are most vulnerable when they surface for air, at which time they may inhale hydrocarbon vapors which can damage lungs. Contact with eyes and skin can also cause irritations.

Because the seals rely on coastal areas to haul-out and some to reproduce, they have the potential to be exposed on land as well as at sea. Seal pups are most vulnerable if oil reaches the shoreline, because they have not developed the protective blubber. Pups are also more likely to ingest oil while nursing on contaminated teats. The gray seal, which breeds in Nantucket Sound during the winter, is most susceptible to impacts from an oil spill. Seals can also become impacted by an oil spill through bioaccumulation of the pollutants from their prey species. In the event of an oil spill, the impacts are expected to be minor to moderate depending on the location and amount of oil released.

“Fouling Communities”

Seals may be attracted to the WTG fouling communities as a source of food once fish and invertebrate communities are established. Atlantic herring (*Clupea harengus*) and alewife (*Alosa pseudoharengus*) are the only two species of seal-preferred prey anticipated to potentially forage within the area of the proposed action. However, seals will pursue other fish species if necessary and readily available. Since the preferred fish species of migratory seals are not likely to aggregate at the proposed action structures, the attractiveness of the WTGs to seals for foraging purposes and any impacts associated with the additional hard substrate are expected to be minor.

The preliminary assessment is that those activities associated with operation and maintenance would have minor impacts on the pinniped species that may be found in that area. Those that would have the greatest effect on the pinniped species are the concepts of “fouling communities” that may attract seals to that proposed action site that are not normally present there, and only in the unlikely chance of an oil spill would any impacts be greater. Any operational related impact would be minor.

Impacts to Cetaceans

Vessel Harassment/Strikes

As previously discussed, cetaceans do not appear to be exceedingly disturbed by the physical presence and sound produced by vessels, and the vessel traffic itself (NMFS, 2001; NMFS, 2002). Cetaceans should be able to detect and move away from any proposed action vessel by diving into deeper waters. Any impact would be limited to temporary avoidance of an area; however, this is unexpected due to the high volumes of vessel traffic that normally travel the waters of Nantucket Sound. Therefore, the impacts of increased vessel traffic should have minor impacts on listed cetaceans.

It is possible, yet difficult to predict, whether there would be increased fishing activity after the proposed action is operational. Such fishing efforts would mainly be by private and recreational charter boats using hook and line fishing gear, which should not adversely impact any whale or dolphin species.

Acoustical Harassment

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Existing underwater sound levels for the design condition are 107.2 dB. The calculated sound level from operation of a WTG is 109.1 dB at 20 m from the monopile (i.e., only 1.9 dB above the baseline sound level), and this total falls off to 107.5 dB at 50 m and declines to the baseline level at a relatively short distance of 110 m.

An analysis of predicted underwater sound levels perceived by cetaceans from proposed action operation show that no injury or harassment to cetaceans are predicted even if an individual were to approach as close as 20 m to a monopile when the proposed action is operating at the design wind speed as all dB_{ht} values at this minimum distance are well below 90 dB. In fact, proposed action operation would be inaudible for toothed whales, and only slightly audible to baleen whales at the close distance of 20 m. Therefore, no behavioral effects to cetaceans are anticipated even if an individual were to approach within 20 m of the structures. Proposed action operations would result in negligible acoustic impacts on cetaceans in Nantucket Sound.

Electro Magnetic Fields (EMF)

Potential impacts to cetaceans during the normal operation of the inner-array cables and the offshore transmission cable system are expected to be negligible, as the electric field would be completely contained within the shields surrounding the cables. The weak magnetic fields associated with the operation of the cables are not anticipated to result in an adverse impact to cetaceans or their prey. The burial depth of 6 ft (1.8 m) below the seabed would also minimize potential thermal impacts from the operation of the cables. Therefore, it is anticipated impacts to cetaceans or their prey species during the normal operation of the cable systems are expected to be negligible.

“Fouling Communities”

The WTG monopile foundations would represent a source of new substrate with vertical orientation in an area that has a limited amount of such habitat, and as such may attract fish and benthic organisms. Of the cetaceans that may be found within the vicinity of the proposed action, only the prey of humpback whales, Atlantic herring (*Clupea harengus*) and menhaden (*Brevoortia tyrannus*) may potentially occur within the proposed action area. However, as these species are migratory fish they are not anticipated to aggregate around the WTGs. The remaining whale and dolphin species do not rely, but may occasionally feed, on the fish or benthic organisms that may be attracted to the WTG as prey and therefore would not be attracted to the structures for feeding purposes. Any impact to cetaceans with respect to changes in the fouling community would be expected to be negligible to minor.

Pollution/Potential Spills

As they rely on blubber for insulation, cetaceans are less vulnerable to oil spills than fur-coated marine mammals, such as seals. Cetaceans are most vulnerable to oil spills when they are surfacing for air when skin and eyes can be irritated. Direct exposure to oil spills can result in the inhalation of harmful fumes, lethargy, poor coordination and difficulty breathing which can lead to drowning (Hammond et al., 2001). Migratory cetaceans may limit their exposure to a persistent oil slick in a small geographic area by avoiding that area. Of the three listed large whale species, the right whale population should be considered at greatest risk to being negatively impacted by an oil spill because of the small population size and slow recovery of their numbers from earlier depletion events. Due to the low probability of an oil spill and limited cetaceans in the area, impacts during construction and decommissioning from an oil spill would be minor.

The preliminary assessment is that those activities associated with operation and maintenance would have minor impacts on the cetacean species that may be found in that area. Those that would have the greatest effect on the cetacean species are acoustical harassment from the operation of the turbines, and only in the unlikely chance of an oil spill would any impacts be greater.

Turbidity and Total Suspended Solids

There are potential impacts related to turbidity and total suspended solids that could result in the unlikely requirement for repair of the electric cable. Such impacts would include temporary turbidity and some localized deposition of sediments during the repair process. Turbidity would be caused by the jetting of sediments to uncover the damaged portion of the cable, hoisting of the cable after it is cut, laying the cable back down, and then jetting of sediments for reburial of the repaired cable. Cable repair procedures are discussed in Section 2.4.6. Impacts on MMPA resources as a result of cable repair would be temporary and result in only minor impacts.

Conclusion

The operation of the proposed action is expected to have negligible to minor impacts on MMPA listed pinnipeds and cetaceans. Maintenance vessels would generally operate at slower speeds (less than 14 knots) and maintenance activities should not result in water quality, benthic, or water column effects that alter the habitat. Under the MMPA, the applicant is required to abide by any measures required by NOAA Fisheries under the terms of its review and approval process to reduce the potential for harassment, injury or mortality to marine mammals. A discussion of mitigation is provided in Section 9.0.

5.3.2.7 Fisheries

5.3.2.7.1 Construction/Decommissioning Impacts

Potential Impacts on Commercial and Recreational Fisheries

There would be impacts to fisheries resources as a result of construction and decommissioning (including post lease G&G investigations). The magnitude, extent, and duration of these impacts would be highly variable. Possible direct and indirect impacts on the fishery resource and fish habitats during the various phases of the proposed action are discussed below. A discussion of possible impacts on gear types and fishing techniques used by recreational and commercial fishermen is presented along with information on possible effects related to fishery usage activities.

Fish Habitat Disturbance and Loss

Permanent loss of benthic habitat from the installation of WTG and ESP monopile foundations would involve an area that is approximately 0.67 acres or approximately 0.0042 percent of the total area of the proposed action (see [Table 5.3.2-2](#)). Temporary impacts to the benthic habitat would be expected from activities including jet plow embedment of the inner-array cables, jet plow embedment of two circuits that comprise the 115 kV offshore transmission cable system, installation of scour protection devices, construction vessel positioning, anchoring, and the anchor line sweep that is associated with the construction of the proposed action structures. Temporary disturbance could be approximately 812 acres or approximately 5.1 percent of the total area of the proposed action with the use of scour control mats (see [Table 5.3.2-2](#)). Temporary disturbance could be approximately 866 acres or approximately 5.4 percent of the total area of the proposed action with use of rock armoring for scour control (see [Table 5.3.2-2](#)).

Sediments disturbed during cable jetting are anticipated to settle out soon after cable embedment and refill the cable trench and the immediate surrounding area. Temporary bottom impacts are anticipated at the post lease geotechnical boring and coring locations but the area disturbed is a negligible amount of the entire site of the proposed action. Temporary impacts along the cable installation paths are associated with other components of cable installation activities such as barge positioning, anchoring, anchor cable sweep, and the pontoons on the jet plow. Impacts that are associated with the anchor cables used for positioning of the cable lay vessel are anticipated to be temporary and localized, since the invertebrate prey community would recover and the physical characteristics of the sediments would not be altered. It is anticipated that sediments would be affected to a depth of up to 6 inches (15.2 cm) (Algonquin Gas Transmission Company, 2000). Impacts would be minimized with the use of mid-line buoys. Frequent anchor re-positioning would occur with each anchoring location having disturbances that could be up to five feet deep, but covering a small area of the seafloor. Jet plow embedment would directly disturb sediments to deeper depths of approximately 8 ft (2.4 m), through the process of injecting high pressure water. Since the jetting does not result in excavation of a trench, and the biologically active portion of the sediments are within the top 1 ft, jetting results in a narrower zone of impact to the benthic habitat of demersal fish species than mechanical or hydraulic dredging where sediments are physically removed from the seafloor and either sidecast or loaded on barges for disposal.

Benthic habitat disturbance associated with the post lease geotechnical investigations would result in a negligible and one time loss of demersal fish eggs, such as those produced by winter flounder if they occur during the time of post lease geotechnical investigations. Temporary impacts to benthic habitat may cause mortality or displacement of benthic organisms that serve as prey for fish. Thus, there may be some disruption of feeding of some fish species. During construction/decommissioning activities, the greatest area of impacts to surficial benthic habitat would be due to anchor positioning and anchor line sweep. Total expected temporary impacts to upper sediments from these activities would make up approximately 4.2 percent of the area of the proposed action (see [Table 5.3.2-2](#)). During construction and decommissioning activities demersal fish species are likely to find suitable benthic habitat in areas in proximity to the area of the proposed action. When construction activities are completed fish species are expected to return to the area of the proposed action.

Water withdrawals are another impact factor that would occur within the water column, and would affect the pelagic egg and larval lifestage of certain fish species. Water pumped through the cable jetting device would entrain fish eggs and larvae and cause mortality as this water is jetted at high pressures into the sediment. Other water withdrawals would occur in association with the operation of the construction and decommissioning vessels, which need engine cooling water, hoteling water, and ballast water. Fish eggs and larvae entrained with this water are assumed to suffer mortality because of mechanical stresses associated with passing through pumps, temperature affects, and holding time.

The HDD operation would involve HDD borehole exit hole dredging activities in Lewis Bay that are expected to directly affect benthic habitat. Dredging activity would involve either sediment disturbance or sediment removal volume of approximately 840 yd³ (642.2 m³). This material would either be contained in a cofferdam structure measuring approximately 2,925 ft² (0.067 acre or 272 m²) (see [Table 5.3.2-2](#)) or transported to an approved onshore disposal site. With removal of the cofferdam sheeting the sediment surface would potentially have a depression area that is several feet deep. Clean fill material would be placed as needed to fill this area to match natural bottom contours. These activities are expected to have minor impacts due to the contained nature of the dredging activities in the cofferdam and small area disturbed.

Potential impacts from decommissioning activities are expected to be similar to the impacts described above for the construction phase. Decommissioning efforts, however, would not include pile driving or HDD activities. Monopiles would be decommissioned by removing sediments from inside the pile, cutting and removing the pile 15 ft (4.6 m) below the seabed, and then returning sediments to the sea floor to re-establish pre-project seabed conditions. For each WTG constructed in water depths less than 40 ft (12.2 m), approximately 3,744 ft³ (106 m³) of material would be mechanically dredged from inside the base of the monopile, loaded on a barge for storage until the monopile is cut and removed, and then returned into the depression. For each WTG constructed in water depths greater than 40 ft (12.2 m), approximately 4,324 ft³ (122 m³) of material would be moved and returned. During removal it is anticipated that the sediment plume at a WTG would be minimal due to the sandy nature of the sediments and the short duration. After cutting of the monopile, best practices available would be employed to minimize any sediment plume.

Fish Mortality or Displacement

The post lease G&G investigations and proposed action construction/decommissioning activities would have negligible direct mortality to juvenile or adult pelagic fish. These life stages have mobility within the water column, and therefore have the ability to move from or avoid areas of active construction where elevated suspended sediment concentrations are created or where increased sound levels occur. The juvenile and adult lifestages of these species would temporarily occupy the water column in nearby areas and other portions of Nantucket Sound. It is possible that displacing fish from one area to another could lead to increased competition or predation, however the zone of avoidance around construction vessels and equipment is likely to range from a few dozen feet to a few hundred feet and it is unlikely that many fish would be impacted in the small area around a WTG under construction or removal or around the jetting vessel. Details on avoidance due to sound and increased suspended sediments are discussed below.

Demersal fish species may be subject to some injury or mortality due to slower avoidance response, particularly in the colder winter construction timeframe. To protect sensitive fish species, such as winter flounder, the applicant has committed to avoid in-water construction in Lewis Bay between January 15 and May 31 of any year. Demersal eggs and larvae of fish may be subject to moderate impacts from anchor line sweep and anchor placement due to a lack of or limited mobility. Temporary impacts to demersal fish habitats related to construction stage anchoring activities are anticipated to make up less than 4.2 percent of the total area of the proposed action (see [Table 5.3.2-2](#)). As with pelagic species, displacement of demersal fish may make them more susceptible to competition and predation, when they are forced to avoid construction areas and move into adjacent habitats that are already occupied or that are less preferred. This type of displacement affect is likely to have negligible impacts on the populations of demersal fish in the site of the proposed action.

Elevated Total Suspended Solids

The post lease geotechnical investigations and proposed action construction or decommissioning activities that include installation or removal of monopile foundations, scour control mats or rock armoring, the inner-array cables and the offshore transmission cable system would cause localized and temporary increases in suspended sediment concentrations (see Section 5.3.1.6 for more information on water quality impacts). The ability of some fish to forage, navigate and find shelter can be negatively affected when suspended solid concentrations become elevated (Wilber and Clarke, 2001). Any turbidity associated with the post lease geotechnical and geophysical assessment program would include a negligible amount of sediment and is expected to be confined to immediate sampling areas. Localized turbidity related to proposed action construction or decommissioning activities is expected to be limited to the immediate area around the monopiles, inner-array cables and offshore transmission cable system circuits since sediments in the area of the proposed action of Nantucket Sound are mainly fine to coarse-grained sands. Impacts to fish species are anticipated to be minor due to temporarily elevated TSS levels that would be caused by proposed action construction and decommissioning activities.

Simulation studies related to sediment transport and deposition resulting from jet plow embedment of the inner-array cables and the offshore transmission cable system circuits were performed ([Report No. 4.1.1-2](#)). The effect of grain size was shown since the finer sediments occurring in Lewis Bay stayed in suspension longer than sediments in Nantucket Sound, primarily because they have higher silt and clay fractions. Also, because the tidal currents in Lewis Bay are weak, the model results indicated a build up of suspended sediments since dilution and dispersal was less than the Sound. The modeling revealed that sediments may remain suspended approximately 2 to 18 hours. Gravel and sand settle more quickly than silts and clays. In some locations, such as near the Yarmouth landfall, due to weak currents and occurrence of fine sediments, particles can remain in suspension for up to 48 hours. Sediment transport modeling concluded that sediment deposition from the jet plow embedment operations would be minimal compared to active sediment transport that has been observed in Nantucket Sound during natural tidal conditions ([Report No. 4.1.1-2](#)). In addition to the suspended sediment affects in the water column, deposition of these sediments can result in indirect affects at distances further away from the source. This process can result in harm or mortality of demersal fish eggs, but can also result in changes in benthic habitat characteristics, depending upon the nature and extent of the deposition. However, throughout much of the Horseshoe Shoal area, continuously shifting sandy substrates are in evidence, and the incremental increase of sediment reworking due to proposed action activities is likely to have negligible to minor adverse affects on substrate characteristics and the demersal fish inhabiting this area.

During the excavation of the HDD exit holes in Lewis Bay, suspension of sediments is expected to be limited since these activities would be contained within a cofferdam. To help contain turbidity that would be associated with dredging for the HDD exit hole, the sheet piles used for the cofferdam would extend approximately 2 ft (0.61 m) above MHW.

Sound Impacts

It has been noted (Vella, 2002) that certain sounds related to the construction activities of an offshore wind farm can affect local fish populations and cause them to temporarily move from an area. The main sound from construction activities that could adversely affect fish would be the pile driving of monopiles. Use of the jet plow embedment process for laying the inner-array cables and the offshore transmission cable system does not produce sound other than that associated with vessels that are part of that operation (Center, 2003). Information on underwater sound anticipated from such vessels is discussed below in the section on "vessel traffic." Fish in the vicinity of the post lease geotechnical and geophysical assessment activities are anticipated to either not be affected by underwater noise or exhibit a very localized avoidance behavior, since these activities only generate low and intermittent noise. Impacts are expected

to be minor and may be similar to behavior that might occur around a commercial fishing vessel, or an anchored charter or party fishing boat.

Fish are anticipated to avoid areas in proximity to monopiles while they are being driven. Using information on species-specific hearing thresholds the zone of behavioral response for pile driving activities was calculated for the site of the proposed action. Distances from the monopiles where significant avoidance reactions could be expected (where $\text{dB}_{\text{ht}} = 90 \text{ dB re } 1 \mu\text{Pa}$) were determined for several species. Avoidance reactions to pile driving could be expected for tautog at 591 ft (180 m), for bass at 328 ft (100 m), for cod at 1,148 ft (350 m), and for Atlantic salmon at 197 ft (60 m). Injury to fish is not anticipated even if individuals were to approach as close as 98 ft (30 m) to pile driving activities since species specific hearing threshold values are below 130 dB re 1 μPa at this distance. Potential impacts to fish would be reduced with use of a “soft start” of pile driving equipment that the applicant has committed to for protection of marine mammals. This would allow fish to move out of the pile driving activity area at non-harmful sound levels before the full energy of pile driving is employed.

The HDD methodology used for the transition of the offshore transmission cable system to onshore cable in Lewis Bay is anticipated to have temporary minor impacts on fish. Drilling would be conducted through unconsolidated material and it is not expected that there would be transmission of vibration from sediment to water. A low vibratory method rather than impact pile driving would be used during sheet steel installation for the cofferdam. The cofferdam installation is anticipated to have temporary, localized and minor impacts on fish in the proximity of the cofferdam.

Vessel Traffic

When the post lease G&G assessment and proposed action and construction and decommissioning activities are occurring there would be an increase of vessel traffic between the WTG array locale and the offshore transmission cable system route. Fish have been noted to exhibit various types of avoidance behavior when noise-emitting vessels are detected. Response to noise coming from ocean vessels includes lateral movement by demersal species and diving to greater depths in the water column by pelagic species. Increase in swimming speed has also been noted as a response to vessel noise by most fish species. Underwater sound from vessels has its peak energy below 1,000 Hz (Richardson et al., 1995). Information indicates that fish species have a narrow hearing bandwidth. The bandwidth is in the range of 16 to 1,600 Hz in which the hearing threshold ranges from 80 to 130 dB re 1 μPa . [Table 5.3.2-4](#) (Table 5 in [Report No. 5.3.2-2](#)) shows data from several sources that have been combined to provide maximum likelihood estimations of hearing thresholds for several fish species including Atlantic salmon, bass, cod, and tautog. The sound source level for barges or tugs, typical types of construction/maintenance vessels that may be used is 162 dB re 1 μPa at 3.3 ft (1 m) (Malme et al., 1989). Maximum hearing-threshold sound levels (dB_{ht} re 1 μPa) for fish at a 10 ft distance from a proposed action vessel were calculated to be 73 dB_{ht} re 1 μPa . Thus, fish could hear vessels but sound levels would be well below the 130 dB_{ht} re 1 μPa threshold for prevention of harassment or injury. Proposed action vessels that are a 10 ft or greater distance from fish are not expected to cause physical harm to fish species. The 73 dB_{ht} re 1 μPa sound level expected at 10 ft (3.05 m) exceeds the 70 dB_{ht} re 1 μPa threshold for avoidance by very sensitive fish individuals. Therefore, fish in the vicinity of the post lease geological and geophysical assessment, construction, decommissioning, and cable repair procedure vessels are anticipated to display avoidance behaviors when these vessels are in operation. Impacts are expected to be minor and may be similar to behaviors associated with the existing vessel activity, such as ferry traffic, pleasure boat activities, or fishing activities.

Prey Mortality and Displacement

During the post lease geotechnical investigations and construction and decommissioning activities some impacts to benthic habitat are anticipated to cause mortality to benthic organisms that are prey for

some species of fish (see Section 5.3.2.5 for presentation of impacts on benthos). The greatest extent of area affected would include locations where anchor cable sweep occur. However, the areas of greatest impact severity are associated with the WTGs where habitat would be permanently altered and there would be extensive bottom disturbance associated with multiple visits by jack up construction/decommissioning vessels. The total area that would be directly disturbed during construction activities makes up less than approximately 5.0 percent of the total area of the proposed action (see [Table 5.3.2-2](#)). Similar benthic habitat in the proposed action locale would be available for foraging fish species. The benthic habitat disturbance would largely be short-term, with recolonization commencing shortly after the disturbances are over, through movement from adjacent less disturbed areas, as well as through recruitment via planktonic eggs and larvae. Various benthic invertebrate species have been noted to recolonize benthic sediments following disturbances such as these construction activities (Hynes, 1970; Rhoads et al., 1978; Rosenberg and Resh, 1993; and Howes et al., 1997). As recolonization of benthos occurs, fish species would be expected to return to previously disturbed areas for foraging.

Mobile fish prey species such as herring, alewife, or menhaden are anticipated to exhibit similar responses to construction and decommissioning activities as other pelagic fish. In fact, since these are planktivorous feeding fish, they are more likely to avoid areas of elevated suspended sediments than predatory fish since the sediments interfere with the feeding mechanism. When construction and decommissioning activities are completed in a particular location, these fish species are expected to return to the area of the proposed action.

Bioaccumulation from Consumption of Contaminated Prey

Sediments found in the area of the proposed action have been reported to be mainly sand and chemical constituent concentrations have been noted to be below the established thresholds that are in applicable reference sediment guidelines. Sediment core samples that were obtained at the proposed WTG site locale and along the proposed offshore cable routes had all chemical constituent concentrations that were below ER-L and ER-M marine sediment quality guidelines (Long et al., 1995). Thus, fish are not anticipated to be subject to an increased bioaccumulation of contaminants from consuming prey present in the area of the proposed action.

Oil Spills and Other Discharges

During construction and decommissioning, there is a possibility that an accidental oil spill could occur, either during refueling operations, as lubricants are introduced into WTGs, or as transformer cooling oil is installed on the ESP. The applicant would be required to have an OSRP that addresses containment and clean up procedures in the event of an oil spill. However, the accidental release of fuel or oils into the marine environment would have adverse effects on fish resources in and near the proposed action location. Low concentrations of hydrocarbons have been shown to have negative effects on survival and maturation of fish eggs and larvae, lifestages that are particularly vulnerable to such spills. Depending on the type of fluid, an accidental spill could also affect benthic habitats and demersal fish should some form of the fluid sink to the bottom or wash up onto shorelines. Given the low probability of occurrence for a large spill, the potential impacts on fishery resources are negligible. However, given the duration of construction and decommissioning, and the need for refueling, there is a higher probability that some small fuel spills would occur during the refueling process, in which case only a small area would be affected and it could be cleaned up more rapidly, resulting in only a minor impact on fishery resources.

Vessels operating during post lease G&G investigations, construction, and decommissioning would result in various forms of wastewater discharges, as described in Section 5.1.1.1. Given that these are relatively small volumes, often occurring while vessels are underway when dilution and dispersion is rapid and extensive, and would not contain toxic or contaminating elements, the impacts to fish resources would be negligible. In addition, while these discharges would represent an increase over existing levels

of vessel discharges associated with the hundreds of other vessels that operate on the Sound, but only temporarily.

Conclusion

Post lease G&G investigations, construction, and decommissioning impacts on fisheries in general are expected to be minor as they would be short term and localized. Also, many fish would be able to avoid disturbed areas. Demersal eggs and larvae of fish may be subject to moderate impacts in very discrete locations due to limited mobility, but the extent of this is not likely to affect recruitment levels or future population size. Mitigation being considered at this time includes the use of “soft start” procedures for monopile installation to allow fish that may be in the area to move away as a response to construction sounds, time of year restrictions to avoid sensitive periods when spawning takes place; and post-construction monitoring for documentation of habitat disturbance and recovery progress. More discussion of mitigation is provided in Section 9.0.

Potential Impacts to Commercial and Recreational Fishing Activities and Interaction with Commercial and Recreational Fishing Gear

During proposed action development, several potential concerns were identified that relate to the commercial fishing industry. These concerns included potential restriction on fishing activities, potential construction impacts, and potential gear conflict due to presence of the offshore cable systems or WTGs.

During construction and decommissioning, the proposed action would not place restrictions on commercial or recreational fishing activity or create fishing exclusion zones in the proposed action locale. For protection of public safety there may be limited temporary vessel restrictions in proximity to construction sites and vessels, but these would not involve large enough areas or be in place long enough to reduce fishing opportunities. The only exception to this is the placement of fixed gear in the immediate area where WTGs, the ESP, or the cables are scheduled to be installed. The applicant would need to coordinate with lobstermen to make sure that lobster gear is not placed along a section of the cable routes that is going to be installed, since gear damage or loss would occur from the jetting equipment. Once installed, lobstermen would be able to resume placing gear within the cable routes. Similarly a short term exclusion of fixed gear would be required around a WTG to prevent damage or loss due to jack up barge operations. Once a WTG is completely installed, fixed gear could be placed in proximity to it, at the fisherman’s discretion, and in a manner that does not affect maintenance vessel access.

Conclusion

Commercial fishing activities may be subject to temporary disruption in close proximity to construction activities. Potential impacts of construction activities are expected to be minor with regard to commercial fishing activities and commercial fishing gear. Impact minimization measures that the applicant has already incorporated into development of the proposed action, includes the relocation of several WTGs away from popular commercial fishing areas, and burying the inner-array cables and the offshore transmission cable system circuits to a minimum of 6 ft (1.8 m) below the seabed to avoid the potential for conflicts with fishing vessels and gear operation. More discussion of mitigation is provided in Section 9.0.

5.3.2.7.2 Operational Impacts

Potential Impacts on Commercial and Recreational Fisheries

Sound and Vibration from WTGs

Fish species are sensitive to vibrations (underwater sound waves). Fish have two main organs for detection of underwater vibrations, the inner ear and the lateral line system (Thomsen et al., 2006). Hearing capabilities among fish species have been noted to vary greatly (Fay and Popper, 1999). Thomsen et al., 2006 has indicated that more precise information on turbine emissions (particle motion and sound pressure), in situ attenuation measurements, and on hearing capabilities of different fish species are needed for detailed assessments. Research that has been conducted at offshore wind farms in Europe suggests that very low vibrations coming from wind turbines have minor impacts on fish in the region. Dolphins (marine mammals) have been noted congregating for feeding around turbines at Blyth Offshore in Northumberland (Great Britain's first wind farm) (AMEC, 2002). Since dolphins were noted engaged in feeding behavior around the turbines, fish (i.e., prey of the dolphin) also may have been present.

At a Swedish wind farm, the Näsrevet Windfarm, Westerberg (1999) noted that cod appeared to be more numerous in the waters immediately around wind turbines than in areas nearby. Westerberg postulated a possible habituation by this fish species to increases in the decibel level during normal operation. Such habituation has also been noted in proximity to oil rig platforms (Vella, 2002). Westerberg (1999) also noted that normal wind farm operational sounds did not greatly impact eel migration.

Modeling simulations that were conducted to evaluate underwater sound during the proposed action phases ([Report No. 5.3.2-2](#)) suggest that possible impacts to fish species due to normal operation of WTGs would be negligible. Background sound levels are reached within approximately 328 ft (100 m) from an individual WTG, and levels that are a distance of 66 ft (20 m) from a WTG are usually less than 2 dB from the baseline conditions (see [Table 5.3.2-5](#)). Sound would not be emitted from inner-array cables or the offshore transmission cable system when the proposed action is operating. Based on the modeling simulations and observations noted from existing offshore wind farms in Europe (Vella, 2002; Westerberg, 1999), it is anticipated that sound emissions from the WTGs for this proposed action may have minor or negligible impacts and would not substantially affect fish populations in the area.

It is not anticipated that prey for fish species would be displaced due to submarine vibration while WTGs are in operation. Surveys conducted at operating European wind farms (Elsam Engineering A/S and ENERGI E2 A/S, 2005) have reported various species of fish in the turbine site areas indicating that prey organisms may be available in proximity to operating turbines.

Vessel Traffic

Potential vessel impacts on fish during maintenance activities are expected to be similar to the impacts previously described for vessels during the construction/decommissioning phases. During operation and maintenance activities, an increase of vessel traffic can be expected in the WTG array area. Fish are anticipated to display avoidance behaviors when these activities occur. Impacts are expected to be negligible and may be similar to behavior noted when there is ferry traffic, pleasure boat activities, or fishing activities.

Electromagnetic/Thermal Emission from Submarine Cables

EMF/thermal emissions from normal operation of the inner-array and the offshore transmission cable system circuits are expected to have negligible direct impacts to fish species. A review of scientific

literature concerning detection of EMF by marine organisms including elasmobranchs (sharks, skates and rays) was conducted. Though high levels of sensitivity were demonstrated for weak electric fields, the sensitivity was limited to steady, slowly-varying fields. Evidence indicates that some marine organisms use the geomagnetic field for orientation, but this response is limited to steady and slowly-varying fields. The mechanism underlying this sense is not expected to respond to rapid varying (e.g., 60 Hz) AC fields. Power-line EMF was not reported as disrupting marine organism orientation, behavior or migration ([Report No. 5.3.2-3](#)). The cable system to be used for this proposed action is a three-core solid dielectric AC cable design. This cable system was selected since it minimizes potential environmental impacts and reduces any EMF. The proposed action's cable system would have grounded metallic shielding that can block an electric field generated by the cable system. With the electric field fully shielded, impacts to fish would be related to the magnetic field emitted from the cable systems, but in both situations, impacts would be negligible.

The inner-array cables and the offshore transmission cable system circuits that would connect the WTGs to the landfall would be buried 6 ft (1.8 m) below the seafloor. Thus, there would be no barrier to fish passage. Demersal fish could utilize the surface sediments and benthic organisms could colonize surface sediments. This burial depth also minimizes potential thermal impacts of the offshore cable circuits, since the heat dissipated into the surrounding sediments would result in no perceptible increase in temperature at the sediment surface.

Shading

Potential impacts on fish from shading from WTGs on water areas are anticipated to be negligible. Shadows from the WTG structures are anticipated to move rapidly across the water surface during daylight hours. The WTGs are spaced approximately 0.39 by 0.63 miles (629 by 1000 m) apart. Presence of the ESP, with a surface area of 20,000 ft² (1,858 m²)/0.46 acre, may affect the soft-bottom benthic invertebrate communities in its immediate locale due to shading. It is expected these possible effects would be negligible since the ESP structure is to be located approximately 39 ft (12 m) above the MLLW datum plane in 28 ft (8.5 m) of water and sunlight would pass under the ESP, particularly at lower sun angles.

Lighting

Lighting for the proposed action components would include the following: FAA navigation lighting on the tops of the WTGs (257 ft [78 m] above the water, flashing red, oriented to be conspicuous to pilots in the air with negligible ground spread) and USCG navigation lighting on the WTG platforms (32 ft [9.8 m] +/- above the water, flashing low intensity amber, oriented outward to be conspicuous to mariners). The ESP would have utility lighting (in addition to navigation lighting) that would only be in operation when the platform is occupied. The platform would not often be occupied at night except during weather emergencies when crews may not be able to get off the platform. Any lighting on the ESP would be focused on the deck and work areas, and not on the water surface. There would be no steady burning illumination and no lighting focused on the water from any of the proposed action components, therefore there is negligible anticipated impact on fish from proposed action lighting.

Alterations to Waves, Currents and Circulation

Effects to waves, currents and circulation are not anticipated beyond the immediate locale of individual WTGs in the operating WTG array due to the spacing of the structures (Swanson et al., 2005; [Report No. 4.1.1-9](#)). The WTGs are spaced approximately 0.39 to 0.63 miles (629 to 1,000 m) apart and modeling has shown there to be no interaction between individual WTGs. Potential limited changes to waves, currents and circulation that may occur in close proximity to each WTG are anticipated to have negligible impacts to fish populations.

Habitat Change from Non-Structure Oriented to Structure Oriented System

The introduction of 130 WTG monopile structures and six ESP piles in Nantucket Sound would result in an increase of hard substrate that sessile organisms may colonize. Thus, there is a change expected in the immediate localized area around each monopile from a non-structured to a structure oriented system. The diversity of benthic communities that may colonize the monopiles is influenced by characteristics of the substrate and various environmental factors affecting colonization of most marine habitats, such as current, waves, scour, etc. The attached community is anticipated to include sessile animal and plant species and small invertebrates. The presence of this fouling community is expected to attract small fish species and in turn attract both larger demersal and pelagic fish species (Elsam Engineering A/S and ENERGI E2 A/S, 2005). Monopile foundations selected for the proposed action are smooth and devoid of complexity, unlike scaffolding that is often used for oil platforms (MMS, 2000). Though the monopiles would provide vertical habitat and are expected to be colonized by organisms, the degree of the colonization is expected to be minimal since they have a smooth cylindrical form.

Based on macroinvertebrate species observed during a survey on pilings of the meteorological tower (refer to Section 4.2.5.3.2 in this document) results indicated that a benthic macroinvertebrate community similar to the surrounding sea floor community had colonized support pilings. Seven species not observed during other baseline surveys at Horseshoe Shoal were noted. These new taxa are likely to be in the area of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders. It is expected that pilings would support organisms from both the sandy substrate habitat and those that would be attracted to hard substrates.

In addition, should the applicant select the use of scour mats consisting of synthetic fronds for scour protection at the base of the monopiles, which are designed to mimic seafloor vegetation, the potential alteration of the fish community around the monopiles would be reduced compared to the use of rock armor for scour protection. Use of the scour mats is more consistent with the sandy bottom relief of Horseshoe Shoal rather than rock armor scour protection that may introduce additional hard substrate supporting an invertebrate and fish rocky bottom community.

Although both demersal and pelagic fish species are anticipated to congregate around the monopiles the fouling community that may form is anticipated to support organisms that already occur in Nantucket Sound. Impacts from this habitat change are anticipated to be minor and the fish species composition in the area of the proposed action is not anticipated to substantially change from the pre-project conditions.

Removal of the WTG monopile foundations and ESP piles during decommissioning would result in a local shift from structure-oriented habitat in proximity to the WTGs and ESP to the original shoals type of habitat that was present prior to installation of these structures. Impacts as a result of WTG and ESP removal are anticipated to be minor and short term, as this would be a return to the pre-construction conditions.

WTGs Acting as Fish Attracting Devices

As discussed above, the introduction of 130 WTG monopile structures and six ESP piles in Nantucket Sound would result in an increase of hard substrate that sessile organisms may colonize. Thus there is a change expected in the immediate localized area around each monopile from a non-structured to a structure oriented system. When a stable fouling community becomes established that supports certain fish species, it could be expected that fish eating birds such as great black-backed, herring, and ring-billed gulls, cormorants, several species of ducks, and terns may feed in the areas around monopiles (Report No. 4.2.5-4). It has been noted that fish species likely to benefit from artificial structures, such as monopiles include species that have territorial, demersal and reef-obligate life histories (Bohnsack, 1989). Some fish species occurring within the area of the proposed action and other shoal areas within Nantucket Sound

display such characteristics in all or some of their life stages. These species include Atlantic cod, cunner, tautog, black sea bass, and scup. Research that has been conducted (Alessi, 1996) regarding artificial reef design provides some information on potential effects on fish species. Effects of different types of reef designs and spacing patterns on artificial reef populations were tested and results indicated that spacing and design are important factors. It was noted that reefs that are too close together or too far apart are not as effective (Alessi, 1996). Investigations concerning varying reef dispersion for management of targeted fishery assemblages found that approximately the same numbers of fish species were attracted to dispersed reefs and clumped reefs although higher numbers of fish were attracted to clumped reefs (Lindberg et al., 1989 – 1990). From information noted in the described research and the fact that the WTGs would be spaced approximately 0.39 by 0.63 miles (629 by 1,000 m) apart, impacts are anticipated to be minor and the overall environment and fish species composition in the proposed action locale is not anticipated to substantially change from the pre-Project conditions.

As a result of decommissioning, removal of the structure-oriented type of habitat is anticipated to cause these species to disperse to other areas, or be eaten. If there had been any increase of fishing pressure for these species during the operational period, such fishing pressure would decline with a return of the area of the proposed action to pre-construction conditions.

Cable Repair

Procedures used to repair a segment of the inner-array or offshore transmission cable system are anticipated to be similar to those used in construction activities. The cable section would be jetted so the cable is exposed and can be cut. Then a new cable segment is spliced in and the cable section jetted into the seafloor. Potential impacts to the local fish habitat and species from repair activities are expected to be similar to the impacts previously described for the construction phase but much more limited in extent and duration, and would therefore be negligible.

Oil Spills and Other Discharges

As described above during construction and decommissioning, there is the potential for oil spills and vessel discharges to occur during project operation. Since vessel re-fueling would not happen offshore during maintenance activities, a fuel spill is unlikely. However, should a vessel collide with a monopile or the ESP, it is possible that fuel would be released. If an oil or fuel transport barge or commercial transport vessel collide with a monopile, there is the potential for a larger release. Smaller spills could occur as lubricants are raised or lowered from the nacelles during maintenance, or when material is transferred from the maintenance vessel to the storage tank on the ESP. The project would be operated with an OSRP designed to provide rapid response and clean-up in the event of a spill. Regardless, should a spill occur during operations, impacts on fish and fish habitats could range from negligible to moderate, depending upon the specific characteristics of the spill and environmental conditions at the time of the spill. Given the low probability of a major spill, the probability of moderate levels of impact are also low.

During normal operation of maintenance vessels there would be other discharges associated with engine cooling water, ballast water, and other hoteling water uses. These discharges would all be performed in accordance with applicable laws and regulations, and represent a small incremental increase over existing levels of similar discharges that occur from the hundreds of other commercial vessels that operate in Nantucket Sound every year, such as the ferries. Given the mobile nature and small volume of these discharges, impacts to fish species and habitats would be negligible.

Monopile Collapse

In the event of a monopile collapse, there would be a small release of lubricating fluid and other fluids (about 210 gallons total) from the nacelle, but more importantly, there would be localized bottom

disturbance similar to what would occur for decommissioning and construction of a WTG, just in reverse order. While the impacts would be as described above for these types of activities, they would only occur at this one location for a short duration, and impacts to fish habitats and fish populations would be negligible.

Vessel Collisions

As indicated under Oil Spills, collision of a vessel with a monopile or the ESP could result in the accidental release of fuel or lubricants. Oil spill plume modeling was undertaken with the scenario involving accidental release of all 40,000 gallons of oil from the ESP ([Report No. 4.1.3-1](#)). Modeling results are described in Section 5.2.3. In addition, depending upon the extent of damage, a monopile may need to be removed and replaced. Given the variety of scenarios involved in a vessel collision, it is difficult to definitely state the impact level, but when the probability of occurrence is factored in, fish and fish habitat impacts would be negligible to minor.

Conclusion

Wind turbine operations are expected to have negligible to minor impacts on fisheries. Under normal operations, the offshore cable systems should not require maintenance resulting in impacts to benthic habitats or the water column. Remote monitoring of the cable routes would occur periodically to make sure they remain buried. Maintenance of the WTGs and ESP would require daily vessel operations, weather permitting, but no planned activities resulting in disturbance of benthic habitats or the water column. Several accidental or unplanned events with low probability of occurrence could have localized minor to moderate impacts on fish or fish habitats.

Potential Impacts to Commercial and Recreational Fishing Activities and Interaction with Commercial and Recreational Fishing Gear

Proposed action operation is not expected to have substantial impacts to commercial or recreational fishing activities in the area. Measures for minimizing potential impacts include having no restrictions on fishing related activities in the area of the proposed action when the proposed action is in operation. Additional measures include avoiding possible conflicts with fishing vessels and their gear operation by maintaining the burial of the cables below the seafloor. Commercial fishing vessels would have to avoid the WTGs and ESP when trawling or placing pot or trap lines. However, the affects are minor due to the WTGs being spaced 0.39 by 0.63 miles (629 by 1,000 m) apart. Slight course corrections may be required to avoid them.

To minimize or avoid impacts to commercial fishermen who use mobile gear, a number of proposed WTG sites that were in deeper water along the eastern portion of the array have been relocated to shallow water locations in the northwestern portion of Horseshoe Shoal. Commercial fishermen who use mobile gear had identified the deeper as an area they frequently fish.

5.3.2.8 Essential Fish Habitat

Details on EFH impacts are provided in a separate EFH report in [Appendix D](#). A short summary of EFH impacts is provided below.

5.3.2.8.1 Construction/Decommissioning Impacts

During construction, impacts to EFH and EFH species would arise from activities that disturb the seafloor, that alter water quality conditions, and alter physical characteristics of the ocean environment such as noise. Activities that could disturb the seafloor include post lease geotechnical sampling (refer to post lease geotechnical and geophysical sampling procedure details in Section 2.0); installation of the monopile foundations for the WTGs and ESP within the WTG array; placement of seabed scour control

systems at the base of the monopiles; installation of the inner-array cables connecting each WTG to the ESP and installation of the offshore transmission cable system circuits connecting the ESP with the landfall location that use the hydraulic jet-plow embedment technology, associated anchoring required for cable installation barge positioning; and activities related to construction of a temporary cofferdam associated with HDD installation methods.

Construction activities that could alter water quality include post lease geological and geophysical sampling, installation of the monopile foundations for the WTGs and ESP and barge activities associated with this aspect construction; installation of seabed scour control systems at the base of the monopiles; installation of inner-array cables and the offshore transmission cable system circuits that connect the proposed action and landfall location that use hydraulic jet-plow embedment technology and associated barge anchoring, pontoon and anchor line sweep effects; and construction of a temporary cofferdam associated with HDD installation methodology.

Construction activities or proposed action features that could alter the physical characteristics of the marine environment include installation of the monopile foundations, which introduce hard, vertical substrate areas, and introduction of seabed scour control systems.

An additional potential impact to early lifestages of some EFH species is entrainment along with water that is used by construction vessels for engine cooling or for operation of the jet plow during cable burial. Entrainment of eggs and larvae, as well as zooplankton that are food for juveniles and adults of species such as herring, alewife, and shad, would result in the loss of individuals to these species local populations. The water withdrawn for the jet plow is injected into the sediments under high pressure. Survival of entrained eggs, larvae, and zooplankton can be assumed to be essentially zero, because of the pressure and mechanical forces that these organisms would experience. However, unlike a fixed point withdrawal, such as for cooling water at a power plant, the jet plow would typically advance at 3 to 5 miles (4.8 to 8.0 km) per day such that no portion of the water column would be affected for very long. Thus, the dispersed nature of this impact is likely to only have a minor affect on EFH species.

During decommissioning, impacts to EFH would arise from activities that disturb the seafloor, that alter water quality conditions, and alter physical characteristics such as noise. These activities would be similar to the construction phase described above, except no pile driving would occur and no HDD activities would take place. In addition, the monopiles as substrate for a fouling community would be removed, and fish associated with these small reef-like settings would disperse.

Impacts to Benthic EFH

The potential impacts to benthic EFH are described based on the anticipated duration of the impact. While the total area of the seafloor encompassed within the boundaries of the proposed action is large, there are extensive areas that would not be impacted by the proposed action activities and there is an even smaller area that would be impacted in a long term manner. For example, while more than 80 miles (129 km) of cable jetting are proposed in order to bury the cables, these areas would be temporarily disturbed, whereas each of the monopile locations represent a long term alteration of the benthic habitat.

The total permanent direct area of benthic habitat disturbance from construction activities is summarized in [Table 5.3.2-2](#). Permanent benthic habitat loss would result from installation of the WTG and ESP monopile foundations. This permanent loss due to occupation of structures would be approximately 0.67 acres (0.003 km²) or 0.0042 percent of the total proposed action area (see [Table 5.3.2-2](#)). Similar habitat conditions are present in areas adjacent to the site of the proposed action.

The installation of the scour control, inner-array cables, and the offshore transmission cable system would physically displace sediment at specific locations. The total temporary direct area of benthic habitat disturbance from construction activities is summarized in [Table 5.3.2-2](#).

Temporary impacts to benthic habitat would result from jet plow embedment of the inner-array cables, jet plow embedment of the two circuits comprising the 115 kV offshore transmission cable system, and installation of the scour protection devices, as well as from vessel positioning, anchoring, and anchor cable sweep associated with construction (see [Table 5.3.2-2](#)). This temporary disturbance could total up to approximately 812 acres (3.3 km²) (5.1 percent of the total proposed action area) with scour protection mats or 866 acres (3.5 km²) (5.4 percent of the total proposed action area) with rock armoring (see [Table 5.3.2-2](#)). Decommissioning-related impacts would be short-term and localized and are expected to be similar to impacts during construction (see Section 5.3.2.5.1).

The temporary benthic habitat disturbance of between 812 and 866 acres (3.3 to 3.5 km²) from construction could result in the temporary loss of functions and values provided by the benthic EFH. Impacts during construction are temporary, occur over small areas, and the benthic habitat is expected to recover thus restoring the functions and values to EFH and EFH fish species.

The impact from jet plow embedment of the inner-array cables and the offshore transmission cable system would be temporary, with suspended sediments anticipated to settle and refill cable trenches and areas immediately surrounding the cable trenches shortly after embedment (see Section 5.3.1.1). Impacts associated with cable installation barge positioning, anchoring, anchor line sweep, and the pontoons on the jet plow device would also be localized and temporary. Impacts from anchor line sweep has the greatest areal impact, but would primarily affect the sediments to a depth of between 3 and 6 inches (7.6 and 15.2 cm) (Algonquin Gas Transmission Company, 2000) and impacts would be minimized through the use of mid-line buoys. Anchoring locations would have disturbances to the sediment to a depth of 4 to 6 ft (1.2 to 1.8 m) at each anchor deployment, leaving a temporary irregularity to the seafloor with localized mortality of infauna. While numerous anchor re-positionings would occur, the cumulative area is still small (see Section 5.3.2.5). Jet plow embedment would directly disturb sediments to a depth of approximately 8 ft (2.4 m), deeper than the anchoring or anchor line sweep depth disturbances.

Modeling was used (see Section 5.3.1.1) to estimate seabed scar recovery from jet plow cable burial operations. Using the assumption that 3 percent of the sediments in the jetted cross section could be injected back into the water column and that the coarse sediment volume is returned to the trench, it was estimated that the dimensions of the scar left along the cable routes would be 6 ft (1.8 m) wide and from 0.75 to 1.7 ft (0.23 to 0.53 m) deep. Information from a number of relevant studies at similar sites was reviewed, and by applying those findings to site specific conditions for Nantucket Sound and Horseshoe Shoal, approximate recovery times were estimated for the trench scars. The methodology of van Rijn (1993) was used to calculate bedload sediment flux at core locations along the proposed 115kV cable outside the Horseshoe Shoal area. Bedload transport rates at the core locations range from 0.18 to 25 ft³/day per foot (0.017 to 2.3 m³/day per meter) of seabed. Together the flux rates from Horseshoe Shoal and the rates calculated using the method of van Rijn represent the range of sediment flux throughout Nantucket Sound. Based on these transport rates, recovery rates for jetting scars along the cable route are estimated to be between 0.2 and 38 days. Recovery of jetting scars on Horseshoe Shoal is anticipated to occur within a few days. Areas of low wave and tidal current energy and a predominately mud bottom such as Lewis Bay are typically dominated by suspended sediment load. In these areas it is likely that seabed scars from cable burial would last months or until a major storm (hurricane or major nor'easter) occurs. Deposition rates in estuaries in southern New England typically range from 0.079 to 0.79 in/yr (0.2 to 2.0 cm/yr) (King, 2005). Refer to Section 5.3.2.5 for further details on benthic substrate recovery.

Egg and larval stages of demersal EFH species would be temporarily affected by benthic habitat disturbance if present during the time of year of construction. EFH species with pelagic eggs and larvae would be less affected by temporary benthic habitat disturbance. The temporary displacement of benthic habitat would also likely result in the mortality and/or dispersal of some benthic organisms (i.e., prey for some EFH species) in the footprints of the construction activities, thereby temporarily disrupting feeding for some benthic-oriented juvenile and adult EFH species in the area. Pelagic-oriented juveniles and adult EFH species would be less affected by permanent and temporary benthic habitat loss. The greatest areal impacts to surficial benthic habitat and therefore to early demersal life stages and benthic prey species of demersal adults and juvenile EFH species would occur from anchor positioning and anchor line sweep. As discussed in Section 5.3.2.5, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 4.2 percent of the total proposed action area. Therefore, sufficient food base is expected to be available for foraging fish species. In fact, during actual construction disturbance activities affecting the benthos, injured or displaced benthic invertebrates may provide a short-term opportunity for increased feeding by fish.

In the nearshore Lewis Bay environment, benthic EFH could be directly affected by the HDD borehole end dredging activities within Lewis Bay; however, dredging would be limited to a volume of 840 yd³ (642.2 m³) and would be contained within the cofferdam. The area enclosed by the cofferdam would be approximately 2,925 ft² (272 m²), a minimal area compared to surrounding habitat in Lewis Bay. The dredged sediments from within the cofferdam pit would be temporarily removed and replaced upon completion of the offshore transmission cable system. Due to the limited and contained nature of the HDD installation activities within the cofferdam and the limited area affected by the backfilling of the dredged material, no substantial impacts to benthic EFH are expected. These activities would not be required during decommissioning. See Section 2.3.6 for additional information on HDD construction and installation methodologies.

Disturbance of the benthic environment from construction would be short-term and localized because many benthic invertebrate species are capable of opportunistically recolonizing benthic sediments after disturbance (Hynes, 1970; Rosenberg and Resh, 1993; Rhoads et al., 1978; Howes et al., 1997). It has been found that benthic communities that are adapted for survival in high-energy environments would recover more quickly following disturbance (Dernie et al., 2003). The naturally dynamic environment of the proposed action area is already subject to fluctuations in suspended sediment concentrations at the seabed/water interface as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoal areas. Consequently, benthic organisms in the proposed action area are adapted to relatively wide fluctuations in water column suspended sediment concentrations and are not expected to be substantially impacted by short-term sediment resuspension associated with construction and decommissioning. Therefore, affected benthic invertebrate populations are expected to recover as quickly as they are capable of reproducing. Many shellfish species generally spawn on an annual basis; however, depending on the water temperature and time of year, shellfish may spawn more than once per year. Therefore, benthic invertebrate populations at the proposed action's site are expected to fully recover within a time period of 1 to 2 years (Byrnes et al., 2004; C-CORE, 1995; Hall, 1994; Newell et al., 1998; Rhoads and Germano, 1986; Rhoads et al., 1978; Whitlatch et al., 1998).

In addition, because benthic habitats similar to those in the proposed action area are present in Nantucket Sound, similar benthic communities (i.e., prey organisms) would be located in many areas and EFH species would be able to find suitable prey in areas adjacent to the proposed action area and other regions of the Sound. Pelagic species are likely to be able to occupy the water column in other parts of the Sound. As disturbed benthic habitat is recolonized by benthos, as discussed above, EFH species would resume foraging in those areas as prey items become more abundant. Therefore, impacts to EFH species from mortality or displacement of prey species would be expected to be negligible to minor.

During decommissioning activities, benthic EFH would be disturbed once again. Temporary impacts to that habitat would be similar to those described above. In addition, benthic communities that have recolonized sediments initially disturbed during construction, such as along the inner-array cable and the offshore transmission cable system and over the filled-in scour control mats, would be disturbed once again. Post-decommissioning recolonization is expected, and in the interim, EFH species in the proposed action area are likely to be able to find similar prey items in adjacent areas or in other areas of the Sound, and impacts would be expected to be negligible to minor.

Potential for Sediment Contamination of Benthic EFH

Recent studies indicate that sediments in the proposed action area are predominantly sand, and that chemical constituent concentrations are below established thresholds in applicable reference sediment guidelines. Specifically, all of the chemical constituents detected in sediment core samples obtained from the proposed WTG array site and along the offshore transmission cables system, route had concentrations below ER-L and ER-M marine sediment quality guidelines (Long et al., 1995) (see Section 4.1.6.3). Therefore, the temporary and localized disturbance and suspension of these sediments during construction and decommissioning is not likely to result in increased incorporation of contaminants in the benthic substrate or at low trophic levels. EFH species are thus unlikely to experience increased bioaccumulation of contaminants via consumption of prey items or exposure to benthic substrate classified as EFH.

During the near shore installation in Lewis Bay, the HDD operation would be designed to include a drilling fluid fracture or overburden breakout monitoring program to minimize the potential of drilling fluid breakout into waters of Lewis Bay. The drilling fluid would consist of water (approximately 95 percent) and an inorganic, bentonite clay (approximately 5 percent). Although it is anticipated that drilling depths in the overburden would be sufficiently deep to avoid pressure-induced breakout of drilling fluids through the seafloor bottom, a bentonite monitoring program would be implemented for the detection of possible fluid loss (see Section 2.3). In the unlikely event of drilling fluid release, the bentonite fluid density and composition would cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment; thereby minimizing any long-term impacts to EFH or EFH species. Short-term impacts would consist of the covering of benthic organisms in the immediate area of release. These activities would not be required during decommissioning and thus would not be an associated impact risk. In summary, sediment contamination of benthic EFH is expected to be negligible to minor.

Impacts to Eelgrass Habitat in Lewis Bay

As discussed in Section 4.2.2.4 of this DEIS, one SAV eelgrass bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. To avoid impacts to this habitat which also serves as EFH for several EFH species in the proposed action's area (black sea bass, scup, summer flounder), the offshore transmission cable system would be no closer than 70 ft (21.3 m) from the edge of the eelgrass bed located near Egg Island.

In the area of the eelgrass bed in Lewis Bay, the bottom sediments are relatively coarse. Simulations of sediment transport and deposition from jet plow embedment predict that sediments suspended by the jet plow would fall along the route with bottom deposition predicted to be in the range of 0.04 to 0.1 inches (1.0 to 3.0 millimeters) at the western edge of the eelgrass bed ([Report No. 4.1.1-2](#)). The majority of the eelgrass bed is predicted to experience little or no deposition as a result of the jet plow embedment operations. Suspended sediment concentrations in this area are predicted to be in the range of 50 to 500 mg/L, depending on proximity to the cable route. Suspended sediment concentrations of 10 mg/L are predicted to remain for approximately 9 to 18 hours after the jet plow has passed this point on the route.

At the western end of the eelgrass bed, suspended sediment concentrations of 100 mg/L are predicted to remain for up to 4 hours.

Many sessile or bottom-oriented aquatic organisms (including eelgrass) encounter some level of sedimentation under natural conditions as a result of tidal currents, waves, and storms. As a result, many organisms have morphological, behavioral, and/or physiological means of dealing with exposure to deposited sediments. Regrowth of seagrasses such as eelgrass can occur if sediment deposition only results in a light covering of sediment material and if the rhizome system is not damaged (USACE DOER, 2005). Since the majority of the eelgrass bed is expected to experience little or no deposition as a result of jet plow operations, it is anticipated that the natural means of seagrass adaptation to changing sedimentation conditions would allow the eelgrass bed to withstand the short-term jet plow operations that would pass the eelgrass bed, and impacts would be negligible to minor.

Impacts to Submerged Aquatic Vegetation on Horseshoe Shoal

Potential impacts to SAV on Horseshoe Shoal as a result of the construction and decommissioning of the proposed action are expected to be limited in nature. Section 4.2.2.4 summarizes the extent of SAV within Horseshoe Shoal. Field surveys have shown the proposed action area to include only sparse areas of SAV. Most of the habitat surveyed within Horseshoe Shoal was shown to be bare sand and the areas that did include SAV assemblages were mostly comprised of macro-algae, not eelgrass. Impacts to the limited SAV assemblages in the proposed action area are expected from activities associated with installing the inner-array cables, the offshore transmission system cables, the WTGs, the ESP, and the scour control around the monopile foundations. Overall, these activities are anticipated to impact a total of 678 acres (2.7 km²) of Nantucket Sound although only a fraction of this area has the potential for SAV to occur (see [Table 5.3.2-2](#)).

Impacts to SAV resulting from the above listed activities (including anchor cable sweep) are expected to be temporary and similar to impacts seen during coastal storm events. These impacts would include the damage and/or displacement of SAV found within the specific working areas for these individual components.

The only permanent impacts to SAV anticipated are those associated with the installation of the WTGs, ESP, and the scour control mats. The physical presence of the monopile towers would result in a loss of available habitat within the tower footprint for the duration of the proposed action. Once installed however, the towers themselves would provide a substrate area greater than that being impacted for the attachment and subsequent growth of macro-algae.

Once construction has moved to a new site, natural re-colonization of the disturbed areas, by both eelgrass and macro-algae, should begin immediately. However, complete recolonization of disturbed areas by seagrass may take a decade or longer (Neckles et al., 2005), while macro-algae would recolonize considerably faster due to their reproductive dispersal mechanisms, fast growing nature, and opportunistic growth strategies. Based upon the species composition observed during the ground-truthing field study ([Report No. 4.2.2-2](#)), it is expected that within 12-24 months of installation (Villard-Bohnsack, 2003), macro algae would have significantly re-colonized areas which previously supported these communities, as well as the monopile foundations of the WTGs. As a result, SAV impacts are expected to be minor.

Impacts to Water Column EFH

Impacts to EFH from Degraded Water Quality

Construction activities associated with installing the monopile foundations, scour control mats, and the inner-array cables and the offshore transmission cable system would result in a temporary and

localized increase in suspended sediment concentrations which could affect EFH that is defined as within the water column. Decommissioning-related impacts would be short-term and localized and are expected to be similar to impacts during construction. Elevated TSS can negatively impact the ability of some finfish to navigate, forage, and find shelter. The pile driving hammer and jet plow technology that would be used to install the monopile foundations and the offshore cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Due to the predominant presence of fine to coarse-grained sand in Nantucket Sound, localized turbidity associated with construction or decommissioning is anticipated to be minimal and confined to the area immediately surrounding the monopiles, the inner-array cables, and the offshore transmission cable system circuits. Sediments disturbed by construction or decommissioning activities are expected to settle back to the sea floor within a short period of time (see Section 5.3.1.1). In addition, the proposed action area is situated in a dynamic environment that is subject to naturally high suspended sediment concentrations in near-bottom waters as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoal areas. Therefore, marine organisms, including EFH species, in this area are accustomed to periodic increases in suspended sediments and should not be substantially impacted by a temporary increase in turbidity from construction and decommissioning activities.

Simulations of sediment transport and deposition from jet plow embedment of the offshore transmission cable system and the inner-array cables were performed ([Report 4.1.1-2](#)). These simulations, which used two models (HYDROMAP to calculate currents and SSFATE to calculate suspended sediments in the water column and bottom deposition from the jet plow operations), estimated the suspended sediment concentrations and deposition that could result from jet plow embedment of the cables. The model results demonstrate that concentrations of suspended sediment in the water column resulting from jet plow embedment operations (i.e., concentrations above natural background conditions) are largely below 50 mg/L. The effect of grain size distribution is evident since the finer sediments present in portions of the Lewis Bay area, the area at the southern half of the north-south portion of the route, and the area just northwest of the ESP, remain in suspension longer due to higher silt and clay fraction.

In Lewis Bay, suspended sediments are predicted to remain in suspension considerably longer than in Nantucket Sound as a result of weak tidal currents. As a result, water column concentrations are predicted to build-up rather than quickly disperse. The model results demonstrate that concentrations of suspended sediment in the water column resulting from jet plow embedment operations (i.e., concentrations above natural background conditions) in Lewis Bay are largely below 500 mg/L. Suspended sediment concentrations in excess of 100 mg/L are generally predicted to remain for less than 2 hours with the exception of some sections along the offshore transmission cable system route showing durations at 6 hours. Suspended sediment concentrations in excess of 10 mg/L are generally predicted to remain for less than 24 hours after the jet plow has passed a given point along the route, except near the Yarmouth landfall where concentrations in excess of 10 mg/L are predicted to remain for up to 2 days after the jet plow passes as a result of very weak currents and fine bottom sediments.

These TSS concentrations are still minimal when compared to the active bed load sediment transport known to exist in Nantucket Sound (between 45 and 71 mg/L under natural tidal conditions and up to 1,500 mg/L as a result of trawling operations). Sediment suspension during construction and decommissioning activities are not anticipated to result in long-term or environmentally significant elevations in water column TSS. Demersal eggs and larvae of EFH species in the immediate vicinity of construction and decommissioning activities may experience mortality or injury through burial and smothering. Pelagic eggs and larvae of EFH species may be temporarily affected or displaced from elevated TSS in the immediate vicinity of construction and decommissioning activities. Juvenile and adult EFH species are mobile and capable of moving away from disturbed areas and elevated TSS concentrations. Zooplankton or fish species may be temporarily affected or displaced in the immediate

vicinity of the area of the activity; however, they are likely to rapidly return to these areas once construction in the specific area ceases or is completed. As a result, impacts to EFH resources in the water column are expected to be minor.

Sediment suspension during excavation of the HDD borehole ends in Lewis Bay is expected to be minor since these activities would be partially contained within the cofferdam and the top of the sheet piles for the cofferdam would help contain turbidity associated with dredging for the HDD borehole end transition and subsequent backfilling. Therefore, impacts to EFH species would be minor. These activities would not be required during decommissioning.

EFH Species Mortality/Injury/Displacement

Construction/decommissioning is not expected to result in measurable direct mortality or injury to adult and juvenile pelagic EFH finfish species since these life stages are mobile in the water column, capable of avoiding or moving away from the disturbances associated with construction, and not as closely associated with the bottom as demersal finfish. Adult and juvenile demersal EFH finfish species and adult and juvenile benthic EFH invertebrate species in the direct path of bottom disturbing construction and decommissioning activities may experience some direct mortality or injury. During winter construction periods, demersal finfish may experience higher levels of injury or mortality since avoidance of anchors and anchor cables may be hampered due to sluggish response under cold water conditions. However, no measurable effects on populations would be expected. Displacement of juvenile and adult EFH finfish species is likely to be temporary and localized, as no stressor is likely to extend great distances or for long durations associated with any of the construction activities. Displacement of juvenile and adult EFH finfish species is likely to primarily result from increased turbidity.

Because they lack motility, demersal EFH eggs or larvae that lie within the direct footprint of construction disturbance would likely experience mortality. Demersal EFH eggs and larvae may also experience localized increases in physical abrasion, burial or mortality from elevated suspended sediments during construction. The greatest areal impacts to demersal eggs and larvae would occur from anchor positioning and anchor line sweep during construction. However, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 4.2 percent of the total proposed action area. Larvae in the latter stages of development are capable of some motility, which may allow for movement from the construction area. Pelagic EFH eggs and larvae are likely to be less affected than demersal early life stages since they are not as closely associated with the bottom; however, those in the immediate area of construction could experience some injury or mortality. Eggs within the water column would be transported by prevailing currents, with larvae being transported to a lesser degree. Predatory fish species, which may feed on larvae, may be temporarily displaced from the area as a result of disturbance during construction or decommissioning activities. Decommissioning-related impacts are expected to be similar to impacts during construction.

Potential Impacts from Impingement/Entrainment of Fish Eggs/Larvae from Vessel Water Withdrawals/Water Withdrawals Associated with Cable Jetting

Vessel water withdrawals during jet plow embedment of the offshore cable systems are anticipated to be minimal, consisting only of periodic withdrawal of near-surface water for ballast water exchange and for engine cooling. Such vessel water withdrawals would also occur during decommissioning activities and during operation when any maintenance activities would be required. Construction vessels withdrawing surface water for ballast water exchange would be required to adhere to all USCG regulations and requirements for water withdrawal and discharge. This process of withdrawing water for ballast water exchange is commonly practiced and is no different than the processes practiced by other vessels already operating in the area. Water withdrawals associated with engine cooling occur for essentially all motor vessels, and this would be the case for construction vessels, tugs, crew boats, etc.

For vessels underway, the water withdrawals occur along the transit route, and would include entrainment of small marine organisms, which typically occur in a patchy manner throughout the ocean. A certain percentage of these organisms would be injured or suffer mortality as a result of passage through pumps and heat exchangers, both from mechanical forces as well as possibly thermal increases.

The jet plow itself would require additional water withdrawals in order to operate. The intake for the jet plow is expected to be located off of the surface vessel that supports jet plow operations. Water withdrawals for use in the jet plow embedment operation would be withdrawn from the near-surface area. Any early life stages of fish (eggs or larvae) that may be present in the immediate area of water withdrawal have the potential to be entrained during this process. Those eggs or larvae entrained during water withdrawal would likely suffer 100 percent mortality as the water is forcefully injected into the sediments to loosen and liquefy them. Millions of fish eggs and larvae may be present in the withdrawn water, depending on the season. However, given the fecundity of fish, the loss of eggs and larvae only represents a small fraction of equivalent adults of the species that are present. Given that commercial fishing vessels and ferries have traversed Nantucket Sound for years with engine cooling water withdrawals occurring, impacts from the incremental increase from the jetting is short term and minor.

The species that could potentially be impacted by these water withdrawals include those with planktonic egg and/or larval stages at the time of jet plow operation. Early life stages that are benthic or demersal in nature are not expected to be impacted since water withdrawal would occur at or near the water surface. Since the jet plow process is expected to progress relatively rapidly, impacts are expected to be short-term and minimal in any one area. Impacts to these early pelagic life stages that have designated EFH in the proposed action's area would also be limited to those months of the year where jet plow operation coincides with the occurrence of particular life stages in the area. In general impacts from these water withdrawals would be minor.

Acoustical Impact

Information on the hearing thresholds for finfish and potential risk of acoustic disturbance that could result in injury or disturbance to finfish is evaluated below for sounds emitted during monopile construction, other construction, and vessel transit.

Hearing Thresholds for Fish

The hearing threshold is the minimum sound level in a 1/3-octave band that can be perceived by an animal in the absence of significant background noise ([Report No. 5.3.2-2](#)). The hearing bandwidth for an animal is the range of frequencies over which an animal can perceive sound. Finfish have a relatively narrow hearing bandwidth, in the range of 16 to 1,600 Hz, in which their hearing threshold is 80 to 130 dB re 1 μ Pa. Data from nine sources (Nedwell *et. al.*, 2004; Hastings and Popper, 2005) have been combined to produce maximum likelihood estimates of hearing thresholds, summarized in [Table 5.3.2-4](#) for tautog, bass, cod, and Atlantic salmon.

Monopile Pile Driving

The maximum submarine sound generated during offshore construction would occur during installation of the monopile foundations. Sound levels measured during impact pile driving operations at the Utgrunden Wind Park in Sweden were used to model underwater sound expected from installation of the monopiles since the size of the monopiles and the installation techniques proposed are the same as for the Utgrunden Wind Park ([Report No. 4.1.2-1](#)). The Utgrunden data show a maximum sound level of 178 dB at 1,640 ft (500 m). Frequency plots from the Utgrunden data show the peak energy from pile driving occurred between 200 and 1,000 Hz, with underwater sound levels falling below background levels (inaudible) for frequencies below 5 Hz.

In order to determine the actual underwater sound level that is heard by finfish from monopile installation, a hearing threshold sound level (dB_{ht}) was calculated for three fish species for which data were available. The dB_{ht} for a given species is calculated following the method developed by Nedwell and Howell (2004) by passing the frequency spectrum of underwater sound produced by a source through a filter that mimics the frequency-dependent hearing thresholds of that species. The benefit of this approach is that it enables a single number to describe the effects of sound on that species, thereby allowing one to compare acoustic effects among species. The dB_{ht} represents the level of sound perceived by a certain species by taking into account its frequency-dependent hearing thresholds. For estimating the zone of injury for marine species, a sound pressure level of 130 dB_{ht} re 1 μPa (i.e., 130 dB above an animal's hearing threshold) is recommended (Nedwell and Howell, 2004; University of California, 2005). Of the five groups of marine animals considered in the underwater sound analysis, toothed whales (dolphins, porpoises, pilot and minke whales) have the lowest hearing thresholds in the frequency range where construction sounds would occur. Those thresholds are around 50 dB re 1 μPa , and 130 dB above that hearing threshold level is a sound level of 180 dB re 1 μPa , which is the present NMFS guideline for preventing injury or harassment to all marine species (Kurkul, 2002). The 180 dB re 1 μPa sound level guideline is also highly protective to finfish since it is equal to 100 dB_{ht} re 1 μPa (180 minus the 80 dB minimum finfish hearing threshold) and is thus 30 dB below the 130 dB_{ht} re 1 μPa threshold for injury.

Note that since the NMFS 180 dB re 1 μPa guideline is designed to protect all marine species from high sound levels at any point in the frequency spectrum, it is a very conservative criterion. The dB_{ht} calculated for each combination of proposed action activity and marine species is a more accurate measure of acoustic effects than simply comparing the sound level to the NMFS 180 dB criterion because the dB_{ht} method takes into account the frequency distributions of both the sound source and the receiving animal's hearing thresholds.

Research shows significant marine animal avoidance reactions occur and mild behavioral reactions occur at 70 dB_{ht} re 1 μPa (Nedwell and Howell, 2004; Nedwell et al., 2004). Using the hearing threshold data from [Table No. 5.3.2-4](#), dB_{ht} sound levels were calculated for finfish for the proposed action's loudest construction noise (pile driving) and the results are provided in [Table 5.3.2-6](#). Construction noise results are given for the NMFS safety radius of 1,640 ft (500 m) and two closer distances, 1,050 ft (320 m) and 98 ft (30 m), where source measurements were made at the Utgruden wind park ([Report No. 4.1.2-1](#)). Pile driving sound levels cannot be reliably estimated for distances closer than 30 m (98 ft) due to near-field effects. The 1,640 ft (500 m) safety radius is based on a condition in the USACE Permit granted to the applicant for construction and operation of a SMDS [Permit No. 199902477]. The condition requires that sound level monitoring during pile driving procedures be conducted at an initial safety zone radius of 1,640 ft (500 m) to determine compliance with the 180-dBL NMFS threshold. A similar safety radius was established by NMFS for pile installation at the San Francisco-Oakland Bay Bridge (Illingworth & Rodkin, Inc. 2001; SRS Technologies, 2004).

The results of this dB_{ht} analysis ([Report No. 5.3.2-2](#)) show that no injury to finfish are predicted if an individual were to approach as close as 98 ft (30 m) to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB re 1 μPa . Fish that remain in immediate proximity to the monopile 0 to 30 feet (0 to 9 m) have a greater likelihood of injury at the start of pile driving.

The dB_{ht} data presented in [Table 5.3.2-6](#) were then used to calculate the zone of behavioral response for pile driving at the proposed action site. These results, summarized in [Table 5.3.2-7](#), give the distance from the monopile where a significant avoidance reaction would occur for each species, i.e., where $dB_{ht} = 90$ dB re 1 μPa . Avoidance by a minority of individuals would be expected at lower levels and hence at slightly greater distances than those listed in [Table 5.3.2-7](#). If finfish are in the proposed action's construction area, they are likely to temporarily avoid the zone of behavioral response around the

monopile being driven. [Table 5.2.3-7](#) reveals that behavioral effects (avoidance) would occur at a range of 60 to 350 m (197 to 1,148 ft) by finfish.

Acoustical impacts to fish within 1,640 ft (500 m) would be minimized by using a “soft start” of the pile driving equipment (use of a low energy start) to allow fish to move away from the area in response to construction sound. Avoidance effects are temporary, limited to a relatively small area around the one monopile being driven at any one time, and avoidance effects disappear only hours after pile driving ceases. Only two pieces of pile driving equipment would be present at any one time, and they are unlikely to be operating simultaneously in close proximity to each other.

As an added protection measure, underwater sound monitoring would be performed during initial monopile construction (the first three monopiles - as was done to ensure protection of marine mammals during the installation of the SMDS foundation piles). Underwater sound pressure level measurements would be made at an Initial Safety Zone radius of 1,640 ft (500 m) to determine compliance with the 180 dB NMFS threshold. Hydrophone measurements would use the Lmax RMS “fast” setting, and data would be analyzed on a real-time basis to ensure continuing compliance. The SMDS permit stipulated that if measured levels exceeded the threshold, a site-specific Safety Zone radius corresponding to the 180dB threshold would be established and the NMFS approved observer would be advised of the expanded action area for observation of marine mammals. Similar measures would be followed for the installation of the monopiles. These measures would also have benefits to any finfish species in the vicinity of the proposed action. During installation of the SMDS, measured sound levels did not exceed the 180dB threshold at or beyond the initial Safety Zone radius.

Effects of pile driving noise on marine invertebrates are expected to be negligible. An evaluation of the BATHOLITHS airgun seismic surveys off the coast of British Columbia predicted only minor, short-term, sub-local and insignificant impacts on invertebrates (LGL Ltd. and JASCO Research Ltd., 2006). It should be noted that airguns produce some of the loudest peak human-made underwater noises (NMFS) and are designed to penetrate to great depths; therefore predicted impacts to invertebrates from local monopile driving are expected to be much less than that anticipated from the BATHOLITHS program.

Other Construction Sounds

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. No substantial underwater sound would be generated during HDD operations used to transition the offshore transmission cable system to the upland cable system in Lewis Bay. Due to the sound-insulating qualities of saturated sediments, and the fact that the drilling would take place through unconsolidated material, the HDD transition is not anticipated to transmit vibration from the sediment to the water (i.e., it would not add appreciable sound into the water column). The installation of sheet steel for the cofferdam would utilize a low-noise vibratory method and would not use impact pile driving.

Vessel Sounds

Construction would result in increased vessel traffic between the WTG array site, the transmission cable system route, and Quonset, RI (where construction laydown is planned to occur). The sound source level for a tug and barge traveling at low speed, the typical construction vessels for the proposed action is 162 dB re 1 μ Pa @ 1 m (3.3 ft) (Malme et al., 1989). Using the reported sound source level for tugs and barges, the maximum perceived underwater sound level was evaluated at 10 ft (3 m) for finfish using the hearing-threshold data presented in [Table 5.3.2-4](#). The maximum hearing-threshold sound level (dB_{ht} re 1 μ Pa) for finfish at a distance of 10 ft (3 m) from a vessel was calculated as 73 dB_{ht} re 1 μ Pa. Finfish would be able to hear the vessel but the sound levels are safely below the 130 dB_{ht} re 1 μ Pa threshold for

preventing injury or harassment. Therefore, vessels that are 10 ft (3 m) or greater from finfish should not cause physical harm. The 73 dBht re 1 μ Pa sound level at 10 ft (3 m) is above the 70 dBht re 1 μ Pa threshold for avoidance by the most sensitive finfish individual, and thus finfish in the vicinity may display avoidance behaviors to vessels. These behaviors, however, would be short-term and would likely be similar to the behaviors observed during activities that regularly occur in Nantucket Sound such as pleasure boat use, ferry traffic, and fishing. Decommissioning-related impacts would be short-term and localized and are expected to be similar to or less than impacts during construction. Vessel traffic generated by proposed action activities is not expected to have a significant effect on the early life stages of fish species, as it would be typical of vessel traffic already occurring in Nantucket Sound.

Conclusion

Post lease geotechnical and geophysical sampling, and construction/decommissioning activities, are expected to have negligible to minor impacts on EFH. The applicant and MMS would continue to work with NOAA Fisheries and MassDMF to ensure that impacts to EFH and EFH species are minimized and mitigated if necessary. Mitigation being considered at this time includes performing surveys to delineate eelgrass beds, avoidance of anchoring in locations with eelgrass beds and developing a Before After Control Impact (BACI) plan. More discussion of mitigation is provided in Section 9.0.

5.3.2.8.2 Operational Impacts

During operation of the proposed action, impacts to EFH and EFH species would arise from activities that disturb or alter the seafloor, that alter water quality conditions, and alter physical characteristics such as noise. Such activities may include cable repairs, maintenance of scour protection, and associated vessel activity where water withdrawals and discharges occur and noise is produced. Other impacts include the continued presence of a vertical structure which would alter the benthic environment and habitat in the area.

Unplanned and accidental events have the potential to adversely affect EFH and EFH species. Vessel collisions and collapse of a monopile would necessitate repair and/or replacement activities, including mobilization of similar vessels and equipment used to construct a WTG. Oil spills could occur if a monopile collapses or the storage containers on the ESP are ruptured. Small spills could occur during handling of lubricants and fuels during maintenance activities. In general, the low probability of these events occurring results in a negligible potential for impact on EFH and EFH species.

Impacts to Benthic/Demersal EFH

Impacts from Creation of Vertical Structure

Research on the potential effect of the monopile foundations on fish species, including those with designated EFH in the area, was conducted. This research included in-depth discussion of possible fish aggregation, reef effects, and spacing considerations for the monopiles. The vertical structure that would be created from the installation of wind turbine towers is not anticipated to result in adverse impacts to the ecology of the immediate proposed action area or to Nantucket Sound. Although the walls of the towers represent a source of new hard substrate with a vertical orientation in an area that has a limited amount of such habitat, this new substrate is not favorable for colonization or reef formation due to its low complexity and rugosity (CARPG, 1998).

Despite the anticipated utilization of the monopile structures by certain fouling and hard-bottom benthic organisms (see Section 5.1.5.11), the individual monopiles are not expected to serve as true artificial reef structures that would serve to significantly alter the benthic or finfish communities within Nantucket Sound. Historical and recent research conducted on the design of artificial reefs indicates that

the major design features that affect the function of artificial reefs are complexity and rugosity (the material used and roughness), as well as surface area, profile, shape, orientation and size (CARPG, 1998). The quantity and nature of interstitial spaces in reef structures are important in determining the degree and complexity of the biological community developing on and around the reef. Adequate interstitial spaces are necessary to establish a rich diversity of motile invertebrates as well as numerous cryptic fish species (CARPG, 1998). The monopiles would not have any interstitial space and given the wide spacing between the individual monopiles (0.39 to 0.63 miles (629 to 1,000 m) apart), there would not be creation of interstitial space among the monopiles collectively at a scale that would be beneficial to benthic organisms or most fish.

The proposed monopile structures would provide a high profile but cylindrical structure of poor complexity and low rugosity. Thus, fish attraction to the monopile structures is not expected to be as marked as that for planned artificial reefs or complex steel structures such as oil and gas platforms (Wilson et al., 2003) which have a high profile, open latticework structure. Certain demersal EFH species in Nantucket Sound that show territorial or reef-obligate life histories may be attracted to the monopiles including, but not limited to: Atlantic cod, black sea bass, and scup. In addition, it should be noted that the distance between the monopile structures is within the sensory range for flatfish. Flatfish such as flounder, sole and dab have been shown to be attracted to submarine structures at distances of 1,969 ft (600 m) and flounder have been shown to move between 2 reef structures at a distance of 2,953 ft (900 m) (Grove et al., 1989). Because of their relatively high mobility between underwater structures, these species may become more vulnerable to fisheries, increasing the exploitable biomass. In addition, flatfish species have been found to be attracted to artificial reefs (Polovina and Sakai, 1989), although it is believed that they visit the reefs primarily to forage.

In general, it is not likely that the addition of new hardened structures in Nantucket Sound would introduce species that aren't currently there, because artificial hard substrate can already be found throughout the harbor and port areas within the Sound in the form of pilings associated with wharfs and breakwaters. Some studies have shown that artificial reefs simply redistribute the resources without increasing the biomass (Polovina & Sakai, 1989). A conclusion more specific to wind parks may be drawn from research done in support of the Horns Rev windmill park in Denmark. A study was conducted to describe the possible artificial reef impact on fish of the monopile foundations of the planned marine windmills (DIFR, 2000). The Horns Rev project is on a smaller scale than the proposed action, being only 80 units forming an 8 x 10 grid, 1,804 ft (550 m) apart. However the two projects are similar enough to draw conclusions on potential reef effect impacts. The Horns Rev project concluded that "Considering the hydrography and material and design of the Horns Rev structures, there is no indication that the windmill foundations would provide a significant food-chain basis" even though monopiles at the Horn's Rev wind farm were found to be colonized by bryozoans, sea anemone, sea squirts, starfish and the common mussels (*Mytilus edulis*) within 5 months of its construction (S.E Ltd., 2002). Based on the design similarities of the proposed action and the Horns Rev project, it would be reasonable to conclude that the proposed action, a comparable project, would not have significant impact on the food-chain or the ecology of Nantucket Sound.

In addition, several isolated rocks and areas of coarse glacial till do exist in shoal areas throughout Nantucket Sound, and are likely to support benthic communities similar to those that may become established on the WTGs. Although the monopile foundations would create additional attachment sites for benthic organisms that require fixed (non-sand) substrates, the additional amount of surface area being introduced (approximately 1,200 ft² (0.03 acre or 111 m²)) per tower, assuming an average water depth of 30 ft (9.1 m)) would be a minor addition to the hard substrate that is already present. Therefore, it is likely that these isolated structures would generate a relatively small amount of additional patch reef type habitat, common in the Sound, further supporting the conclusion that the monopiles would have a minor impact on the fish community or ecology of Nantucket Sound. Other types of similar artificial hard

substrate can be found throughout harbor and port areas within the Sound that have pilings associated with wharfs and breakwaters constructed over the decades for the protection of anchorages and harbors.

Removal of the monopiles would eliminate the vertical structure-oriented habitat offered by the monopiles that some species prefer and may cause these species to disperse elsewhere. If any of these fish species were subject to increased fishing pressure during the life of the proposed action, removal of the monopiles may allow subsequent dispersal of the aggregated fish, thereby reducing fishing pressure on these species in the area.

Impacts to Benthic EFH from Repair of Submarine Cable

In the unlikely event a submarine cable has to be repaired, a segment of the cable would have to be excavated, repaired and then backfilled again (See construction procedures for repairs at Section 2.4.6). Impacts associated with submarine cable repair work would be similar to those benthic EFH impacts described above for installation of the submarine cable in Section 5.3.2.8.1. Such impacts are expected include disturbance to the seafloor and benthos, which would be localized, temporary, and result in negligible to minor impacts.

Impacts to Benthic EFH during Maintenance Work

Maintenance work on the WTGs would require vessels to operate in the area to deliver maintenance workers and or supplies to the WTGs. This work would result in anchoring of vessels that would cause temporary and localized disturbance to the benthic EFH, which would result in minor impacts. Maintenance of scour mats and or riprap if needed, would result in temporary and localized impacts to benthic resources in the vicinity of the work, and such impacts would be minor.

Impacts from Underwater Electromagnetic Fields (EMF)

Potential impacts to fish species, including those with designated EFH in the proposed action area, from electromagnetic/thermal emissions during the normal operation of the inner-array cables and the offshore transmission cable system circuits are expected to be negligible. The cable system (for both the inner-array cables and the offshore transmission cable system circuits) is a three-core solid dielectric AC cable design. The proposed inner-array and offshore transmission cable systems would contain grounded metallic shielding that effectively blocks any electric field generated by voltages on the conductors within the cable systems. Since the electric field would be completely contained within those shields, impacts are limited to those related to the magnetic field emitted from the offshore transmission cable system and inner-array cables. As described in [Report No. 5.3.2-3](#), the magnetic fields associated with the operation of the inner-array cables or the offshore transmission cable system are anticipated to result in negligible impacts to marine organisms, including EFH species and their prey.

Water Column Impacts

Impacts from Suspended Sediments

In the event a cable repair is required, impacts to the water column would be similar to those experienced during installation of the cable as described above in Section 5.3.2.8.1. Impacts would include temporary turbidity as a result of suspended sediments caused from excavation of the cable and or backfilling of the cable, plus anchoring impacts and anchor line sweep impacts. Marine organisms, including EFH species, in the water column are accustomed to periodic increases in suspended sediments and should not be substantially impacted by a temporary increase in turbidity that could be caused by repair work or other maintenance work, and thus impacts to the water column as a result of suspended sediments are expected to be negligible to minor.

Acoustical Impacts

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Acoustic modeling of underwater operational sound at the offshore proposed action area was performed for the design wind condition (see Section 4.1.2.3). Baseline underwater sound levels under the design wind condition are 107.2 dB re 1 μ Pa (see Section 4.1.2.3 for more information on baseline sound data). The predicted sound level from operation of a WTG is 109.1 dB re 1 μ Pa at 65.6 ft (20 m) from the monopile (i.e., only 1.9 dB re 1 μ Pa above the baseline sound level), and this total sound level falls off to 107.5 dB re 1 μ Pa at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 361 ft (110 m). Since the WTGs would be spaced farther apart than 361 ft (110 m), cumulative impacts from the operation of the 130 WTGs are not anticipated.

In order to determine the actual underwater sound level that is heard by finfish during operation, a dB_{ht} was calculated. Using the hearing threshold data from [Table 5.3.2-4](#), dB_{ht} sound levels were calculated for proposed action's operation. Operation sound results are given for the two distances where source measurements were made in the Utgruden and Gotland wind parks, 65.6 ft (20 m) and 328 ft (100 m) ([Report 4.1.2-1](#)). Operation sound levels cannot be reliably estimated for distances closer than 65.6 ft (20 m) due to near-field effects. The results indicate that at 328 ft (100 m) and 65.6 ft (20 m), perceived operational sound levels for finfish were 7 dB_{ht} re 1 μ Pa and 21 dB_{ht} re 1 μ Pa, respectively. Since operational sound would be only barely audible to finfish at the extremely close distance of 65.6 ft (20 m), it is also unlikely to have any adverse effect on fish eggs or larvae.

The results of this dB_{ht} analysis ([Report No. 5.3.2-2](#)) show that no injury or behavioral effects to EFH finfish species are predicted even if an individual were to approach as close as 66 ft (20 m) to a monopile when the proposed action is operating at the design wind speed because all dB_{ht} values at this minimum distance are well below 130 and 90 dB re 1 μ Pa. Operational sounds would only be slightly audible to finfish at the extremely close distance of 66 ft (20 m). Research conducted at offshore wind farms in Europe suggest that the very low vibration from wind turbines does not impact fishes in the region (AMEC, 2002). At the Näsrevet Windfarm in Sweden, Westerberg (1999) reported that the normal operational sounds of a wind farm did not greatly impact the migration of eels.

Based on the dB_{ht} analysis and observations from offshore wind farms in Europe (Vella, 2002; Westerberg, 1999), underwater sound levels from the WTGs for the proposed action are not anticipated to cause physical harm or behavioral changes to finfish, including those with designated EFH in the area.

Impacts to EFH from Rotor Shadows

As fish swim into the area affected by rotor shadow, they are unlikely to be startled because they would be able to see the periodic motion of the shadows ahead of time. Furthermore, shadows cast by wind turbine blades are unlikely to be perceived by fish as rapidly growing shapes, which is the primary cause of their startling (Webb, 1982) since this does occur with avian predation. Rather, the shadow shape should remain fairly constant at any given point in the water, even as the blades spin. When the blades are not spinning, the shadow would be relatively static. As the blades spin faster, the shadows of each individual rotor blade would become less distinct and harder to perceive. Additionally, the speed of the rotor shadow, as perceived by finfish, would remain fairly constant over short periods of time. This should preclude a sense of shadow acceleration (the looming threshold), as might be expected with avian predation from above (Paglianti and Domenici, 2006). As such, the number of energy-intensive predator evasion responses due to rotor shadow movement is expected to be minimal, and impacts from rotor shadows on EFH species would be negligible.

In addition, the fact that water is denser than air causes light to be refracted toward the water surface. Because the surface of marine water is inevitably wavy, this leads to a dappling effect of light and dark

through the water column and on the seafloor. Marine fishes are accustomed to these shifting patterns of light from above—in fact, many fish species (e.g., whale shark and lanternfish) have developed camouflage that mimics these patterns (Harcourt and Stanley, 2007; Shedd, Aquarium 2007). Therefore, the relatively thin, shifting shadows cast by wind turbine rotors are not expected to significantly contribute to a sense of top-water predation.

Impacts to EFH as a result of Spills and Accidental Releases of Potential Contaminants

The WTGs have been configured to contain any fluid leakage and prevent overboard discharges. Well-maintained equipment and training of personnel would help prevent any spills from occurring. However, in the case of a spill, all service vessels would be equipped with spill handling equipment to minimize and mitigate any impacts. In addition, waste collection systems would be installed on board each WTG. The waste would be separated for proper disposal once the containers are off-loaded at the dock.

The ESP would have sealed, leak-proof decks, which would serve as fluid containment. In addition, spill containment kits would be available near all equipment. Furthermore, the applicant would develop a SPCC Plan in accordance with MMS regulations.

Oil would be stored in greater quantities than any other potential contaminant. To address this, a comprehensive OSRP is under development. The OSRP is likely to provide finfish with a level of protection that is equal to or greater than marine mammals or sea turtles. This follows from the fact that, in the unlikely case of an oil spill, finfish are generally less likely than marine mammals and sea turtles to surface and come into direct contact with the spill. Unlike marine mammals and sea turtles, finfish do not surface in order to breathe and many marine finfish species never surface during the free-swimming stages of their life history.

The areal extent of an oil spill associated with the wind turbines or maintenance vessels would be small such that a significant ecological impact would be unlikely. The only significant source of oil is associated with the ESP. If an oil spill were to occur within the proposed action area, including a mineral oil spill from the ESP, juvenile and adult finfish would be likely to avoid the area directly affected by oil spills, thereby minimizing direct mortality from contact with oil. Some commercial finfish species have floating egg and larval life stages, which are more susceptible to injury or mortality from oil spills than the free-swimming juvenile and adult stages. However, these species also typically spawn over large areas and produce hundreds of thousands to millions of eggs per fish each season. Therefore, a small oil spill from the turbines, maintenance vessels or the ESP in Nantucket Sound would be unlikely to have a significant impact on recruitment from early life stages. Finfish with demersal eggs and larvae are even less likely to be affected by oil spills.

Conclusion

Wind turbine operations are expected to have negligible to minor impacts on EFH, other than the very low probability occurrence of an accidental scenario, such as a commercial oil transport vessel colliding with a monopile and spilling a large quantity of cargo.

Species Specific Impact Summary

Potential impacts discussed above that may affect the benthic and pelagic fish and invertebrate species with designated EFH in the proposed action area are summarized in [Tables 5.3.2-8](#) through [5.3.2-10](#). In order to assess impacts more efficiently, target species were grouped into four categories: early life stages (eggs and larvae) of benthic-oriented species ([Table 5.3.2-8](#)), early life stages of pelagic-oriented species ([Table 5.3.2-8](#)), older life stages (juveniles and adults) of benthic-oriented species ([Table](#)

5.3.2-9) and older life stages of pelagic-oriented species (Table 5.3.2-9). Since potential impacts to all species is highly dependent on the time of year that activities occur, Tables 5.3.2-8 and 5.3.2-9 also describe the potential season(s) when these life stages may be present in Nantucket Sound. Potential impacts to species with designated EFH in the proposed action area are summarized by the four categories described above in Table 5.3.2-10. This table describes the level of impact to each category using the MMS definitions of impact levels and provides a brief description of the potential impact. This table serves to address impacts to the fish and invertebrate species with designated EFH by categorizing them into four groups for comparison. As can be seen in Table 5.3.2-10, all impacts are projected to be minor or negligible.

5.3.2.9 Threatened and Endangered Species

This section provides an overview of the impacts on threatened and endangered species protected under the ESA that have the potential to occur in the site of the proposed action as well as two candidate species, the red knot and the eastern cottontail rabbit.

5.3.2.9.1 Construction/Decommissioning Impacts

Sea Turtle Species

The ESA/MESA protected sea turtle species may be impacted by a number of activities associated with proposed action construction, operation/maintenance and decommissioning.

Acoustical Harassment

Noise measurements and modeling are discussed in Section 5.3.2.6.1, which was done to help with the impact assessment of both marine mammals and sea turtles. Little published data were available regarding the hearing threshold for sea turtles. Unpublished data from the Office of Naval Research regarding a hearing threshold study being done at New England Aquarium on Green Turtles were obtained and combined with other available information in order to develop a hearing threshold for sea turtles. The hearing bandwidth is relatively narrow, ranging from 50 to 1,000 Hz, with a maximum sensitivity at around 200 Hz. The hearing threshold is very high, over 100 dB in the low frequencies where construction noise occurs.

A dB_{ht} was calculated for sea turtles to determine the actual underwater sound level that is heard by sea turtles from monopile installation at different distances from construction activities. The results of the dB_{ht} analysis show that no injury to sea turtles are predicted, if an individual were to approach as close as 30 m to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB re 1 μ Pa. In fact, sea turtles were found to be the least sensitive to noise of all the species evaluated.

A maximum sea turtle hearing thresholds for vessels was calculated for a distance of 100 ft (30.5 m). A level of only 17 dB_{ht} was calculated, well below the injury threshold of 130 dB_{ht} and the harassment threshold of 90 dB_{ht} . The animal would be able to hear the vessel, but no physical harm or behavioral effects would occur.

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound would be generated during HDD.

Any sea turtles are likely to temporarily avoid a given area around the construction, and, given the known areas that the sea turtles inhabit within Nantucket Sound, only minor impacts would be anticipated

due to proposed action construction generated noises. Any noise should not affect the migration, nursing/breeding, feeding/sheltering, or communication of sea turtles.

Noise produced by the decommissioning of the proposed action is expected to be similar to those produced during construction. Proposed action decommissioning would not require pile driving activities, which cause the highest sound levels of any activities associated with any phase of the proposed action.

In addition to pile driving noise, the post lease G&G investigation would result in noise associated with vibracores and drilling of bore holes to acquire subsurface geological information on the sea bottom. The vibracores would be accomplished via a small gasoline motor and the drilling of cores would be accomplished via a truck mounted drill rig on a barge. Both of these activities would be very short term, and these devices generate sound levels that are much lower than sound levels associated with pile driving. Sound levels from a small gasoline motor would be comparable to that associated with a small motorized boat. Sound levels from a truck mounted drill rig would be comparable to those on a small ship or large boat. These types of sounds occur regularly in the area. Thus noise impacts on T&E species are expected to be negligible with respect to G&G activity.

Increased Vessel Traffic

The proposed action would temporarily increase the number of vessels within the vicinity of the construction/decommissioning work areas, especially in the route between Quonset, Rhode Island and the area of the proposed action. Several shipping lanes and two navigational channels exist within the vicinity of the area of the proposed action. During construction activities, especially during pile driving activities, it is estimated that 4-6 stationary or slow moving vessels would be present in the general vicinity of the pile installation. Vessels delivering construction materials or crews to the site would also be present in the area between the mainland and the site of the proposed action. The post lease G&G field investigation would also require the use of vessels in the area (see Section 2.7). The barges, tugs and vessels delivering construction materials would be limited to speeds below 10 knots (5.1 m/s) and may range in size from 90 to 400 ft (27.4 to 122 m), while the vessels carrying construction crews would be traveling at a maximum speed of 21 knots (10.8 m/s) and would typically be 50 ft (15.2 m) in length. The additional traffic from construction vessels may increase the chance of a strike or harassment of sea turtles.

Prey and Habitat Reduction

Activities related to construction may cause a temporary and local reduction of available habitat for sea turtles within the greater area of the proposed action. The main anticipated impact would be avoidance of work areas around WTGs. Proposed action construction is not anticipated to result in permanent changes in sea turtle prey abundance or distribution. Some temporary displacement may occur during periods of noise or elevated suspended sediment concentrations, such as near the cable jetting, but this would be limited to areas directly surrounding the given activities, causing both prey species and sea turtles to move away. Benthic habitat disturbance due to construction activities may cause mortality to benthic organisms in the disturbed area, but similar benthic communities are found throughout Nantucket Sound, enabling sea turtles to find suitable prey in other areas, and the effect is temporary as the disturbed areas would become recolonized.

Habitat Shift (Non-structure Oriented to Structure)

The presence of 130 monopile foundations, 6 ESP piles and their associated scour control mats in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from a soft sediment, open water habitat system to a structure-oriented system with a hard substrate fouling

community, with potential localized changes in use of the area by benthic feeding sea turtles. The WTG monopile foundations would represent a source of new substrate with vertical orientation in an area that has a limited amount of such habitat, and as such may attract fish and benthic organisms, potentially affecting sea turtles by causing changes to prey distribution and/or abundance. While the aggregation of fish around the monopiles would not attract sea turtles, loggerhead and Kemp's ridley turtles may be attracted to the WTGs for the fouling community and epifauna that may colonize the monopiles as an additional food source. All four species may be attracted to the monopiles for shelter, especially loggerheads that have reported to commonly occupy areas around oil platforms (NRC, 1996).

Habitat Shift (Structure to Non-structure Oriented)

Removal of the WTG monopile foundations and ESP piles at the time of decommissioning would result in a localized shift from a structure-oriented habitat near the WTGs and ESP to the original shoal-oriented habitat present prior to construction. However, as the addition of the monopiles would be a minor addition to the hard substrate that was present prior to construction of the proposed action facilities, the removal of the WTGs and ESPs would not cause a great impact in the overall habitat structure. Therefore, sea turtle populations that consume colonizing benthic invertebrate prey are not likely to increase due solely to the presence of the monopiles and hence would not be greatly affected by their removal.

Turbidity and Total Suspended Solids

An increase in the TSS within the water can impact the foraging abilities of the sea turtles, decreasing the visibility of prey species. The suspension of sediments produced by proposed action construction is expected to be temporary and localized, as pile driving does not generate much suspended sediments and jet plow technology in sandy sediments results in minimal sediment release. The post lease G&G field investigation would also result in negligible sediment disturbance associated with the taking of vibracores and drilling of boreholes. Further, the physical composition of the sands and the physical characteristics of the sound environment provide reason to assume that any localized turbidity would settle back to the sea floor within a short period of time (one to two tidal cycles). Simulations of sediment transport and deposition for the proposed action demonstrate that jet plow embedment operations would result in a sediment plume below 50 mg/L, and would settle in less than 2 to 3 hours. Within Lewis Bay, suspended sediments are expected to remain in suspension for longer periods due to the weak tidal currents, with a plume in excess of 100 mg/L remaining for 2 to 6 hours depending on location and period of cycle. Decommissioning-related impacts would be short-term and localized and are expected to be similar to or less than impacts during construction.

Sea turtles that forage within the area of Nantucket Sound are naturally accustomed to substantial amounts of suspended sediment on a regular basis, from storms and strong tidal currents, and should be minimally impacted by a temporary increase in turbidity from proposed action activities, including the sea turtles that may inhabit or forage within Lewis Bay. Further, sea turtles are mobile and can move away from any disturbance, including any increases in suspended sediments. The impacts of increased turbidity on the foraging abilities of sea turtles are expected to be minor.

Cetaceans

Potential impacts to endangered and threatened cetaceans are described in more detail in [Appendix C](#) and will be covered in the Biological Assessment. In addition, impacts to endangered and threatened cetaceans are in many instances similar to those described for MMPA marine mammals (see Section 5.3.2.6). Vessel strike, underwater noise, and habitat shift are some of the potential adverse impacts that could occur during and after construction.

Vessel Traffic and Strikes

According to a recently published large whale ship strike database based on public information collected by NOAA Fisheries from 1975 to 2002 (Jensen and Silber, 2003) for the western North Atlantic, finback whales are the most often reported species hit by ships (75 records of strike) followed by humpback (44 records), North Atlantic right (38 records), gray (24 records), minke (19 records), southern right (15 records), and sperm whales (17 records).

As discussed above in the species descriptions for humpback, fin, and right whales, respectively, each of these species are known to seasonally migrate between their fall/winter mating, birthing, and nursing grounds in the southern waters of the West Indies and the mid- and south-Atlantic states (including the Carolinas, Georgia, and Florida), and their spring/summer feeding grounds in the western North Atlantic (Clapham 1992; Baraff and Weinrich 1993; Waring et al., 2006; NMFS 2005; CeTAP 1982; USEPA Region 1, 1988). Therefore, whales are only expected to be within the vicinity of New England waters during the spring and summer feeding seasons.

Although vessel collisions are a primary cause of large whale mortality in the western North Atlantic, the proposed action is not expected to put whales at increased risk for vessel collisions. Vessels moving at slower speeds (less than 14 knots [26 km/h]), such as the construction vessels to be used, are less likely to cause collisions (Laist et al., 2001). In addition, the vessel routes proposed to be used do not occur in areas where there have been high concentrations of whale sightings. Based upon the underdevelopment of whale prey species in Nantucket Sound, it is highly unlikely that whales would be migrating through, nursing, or feeding in Nantucket Sound. Therefore, the physical presence of vessels associated with the construction, operation, and decommissioning of the proposed action will not contribute to the harassment of migrating, nursing, or feeding humpback, fin, or right whales. Therefore, overall the impacts of increased vessel traffic should have minor impacts on listed whales.

Noise

The maximum submarine sound generated during construction will occur during installation of the monopile foundations. Sound levels measured during impact pile driving operations at the Utgrunden Wind Park in Sweden were used to model underwater sound expected from installation of the monopiles since the size of the monopiles and the installation techniques proposed for the proposed action are the same as for the Utgrunden Wind Park ([Report No. 4.1.2-1](#)). The Utgrunden data show a maximum (L_{max}) sound level of 178 dBL at 1,640 ft (500 m). Frequency plots from the Utgrunden data show the peak energy from pile driving occurred between 200 and 1,000 Hz, with underwater sound levels falling below background levels (inaudible) for frequencies below 5 Hz.

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge will produce sound typical of vessel traffic already occurring in Nantucket Sound. No substantial underwater sound will be generated during horizontal directional drilling (HDD) operations used to transition the offshore transmission cable system to the upland cable system in Lewis Bay. Due to the sound-insulating qualities of earthen materials (the sediment), and the fact that the drilling would take place through unconsolidated material, the HDD transition is not anticipated to transmit vibration from the sediment to the water (i.e., it would not add appreciable sound into the water column).

The sound source level for a tug and barge traveling at low speed, typical construction vessels, is 162 dB re 1 μ Pa @ 1 m (Malme et al., 1989).

In general, toothed whales have a hearing bandwidth of 100 Hz to over 100 kHz, with the most sensitive hearing in the high frequency range of 10 kHz to 65 kHz where their hearing threshold is 40 to

60 dB (Richardson et al., 1995). Baleen whales react primarily to sounds at low frequencies below 1 kHz, which is consistent with the fact these whales usually communicate at frequencies in the 20 Hz to 500 Hz range (Richardson et al., 1995). The hearing threshold for baleen whales ranges from 82 dB at 500 Hz to 88 dB at 20 Hz (Nedwell et al., 2004).

A dB_{ht} was calculated for several species of whales to determine the actual underwater sound level that is heard by whales from monopile installation at different distances from construction activities. The results of the dB_{ht} analysis, provided in Table 6 in [Report 5.3.2-1](#) of the DEIS, show that no injury to whales are predicted if an individual were to approach as close as 30 m to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB.

Maximum whale hearing thresholds for vessels were calculated for a distance of 100 ft (30.5 m). Levels of 42 dB_{ht} and 45 dB_{ht} were calculated for whales and for toothed whales, respectively. These levels are well below the injury threshold of 130 dB_{ht} and the harassment threshold of 90 dB_{ht} . The animal would be able to hear the vessel, but no physical harm or behavioral effects would occur.

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge will produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound will be generated during horizontal directional drilling.

Any whales are likely to temporarily avoid a given area around the construction, and only minor impacts would be anticipated due to construction generated noises. Any noise should not affect the migration, nursing/breeding, feeding/sheltering or communication of whales.

Noise produced by the decommissioning is expected to be similar to those produced during construction. However, decommissioning will not require pile driving activities, which cause the highest sound levels of any activities associated with construction.

Habitat Shift or Alteration

Activities related to construction may cause a temporary reduced availability of habitat for whales in the vicinity of the proposed action. The main anticipated impact would be avoidance of areas of high traffic. However, as under normal conditions the whales are exposed to high volumes of vessel traffic due to commercial and recreational ships within Nantucket Sound, the increase in traffic is not anticipated to displace whales for long periods of time. Some avoidance may also occur during construction activities due to acoustical harassment, as mentioned previously, however this disturbance will be temporary and will not result in any major effects on the listed whales.

Construction and decommissioning are not anticipated to result in changes in whale prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this will be limited to areas directly surrounding the given activities, causing both prey species and whales moving to an undisturbed area. Pelagic prey tends to be highly variable and animals foraging on these sources move with the food source, as seen with many whales and their prey species. Any temporary disturbance to pelagic prey is likely to mimic typical temporal and spatial variability, and is likely available in other areas of Nantucket Sound and surrounding waters for foraging by whales.

Red Knot

The red knot is not a listed threatened or endangered species, but since it is a Candidate species and there is a possibility that it may be listed as one in the near future, it has been included in this section to allow for full consideration of impacts.

In North America, the red knot breeds in arctic zones of Alaska and Canada. The red knot does not breed in Massachusetts; however it occurs as a migrant at stop-over locations, and some individuals over-winter in Massachusetts. Staging areas are known to occur along the mainland shores of Cape Cod during migration, however patterns of activity in Nantucket Sound are poorly understood. The preferred foraging habitat of red knot is associated with inlets to estuaries and bays and in proximity to salt marshes. The closest known staging area in the general vicinity of the proposed action is Monomoy Island, approximately 20 miles (12 km) east of HSS (USFWS, 2006).

The red knot spring migration occurs from mid-February to mid-June. Fall migration occurs from mid-July to mid-November. Red knot peak occurrence in the region during the spring is mid-May, and mid-July in the fall, when the birds may occur at staging locations after long distance, non-stop flights from breeding or wintering grounds. The birds would remain at coastal stop-over locations for a few weeks to build up their fat reserves before resuming their dispersal (O'Brien et al., 2006).

The red knot may occur over areas of Nantucket Sound during migration. One red knot was observed during one boat survey during the 2002 to 2006 survey periods. No other individuals were observed in the study area during aerial or boat surveys conducted by the applicant or by MAS.

The potential impacts to red knot during construction and decommissioning include habitat loss or modification and disturbances associated with increased vessel activity.

Changes in sediment drift and deposition processes caused by construction may affect inter-tidal habitat structure and prey bases onshore. Any type of sediment removal, or disruption of normal coastal erosion and redeposition processes, may impact suitable habitat available within and adjacent to the area of the proposed action. Since it is only the offshore transmission cable system that would be constructed near shore, and it would be buried beneath the seabed, it is unlikely that a measurable change in coastal erosion or deposition processes due to construction activities would occur.

Habitat loss or Modification

The shoreline where the offshore transmission cable system would make landfall is primarily artificial shoreline, comprised of concrete and stone with minimal sandy areas. Habitat loss for the red knot is not expected because the inter-tidal area directly impacted by the offshore transmission cable system landfall in Yarmouth would be drilled under for installation of the cables. This area is not likely to provide habitat for red knot during migration and/or wintering periods. The beach habitat on Great Island represent the closest potential stopover habitat near the cable landfall construction area, and these beaches are not expected to be impacted by any of the construction or decommissioning activities as the shoreline would be drilled under for cable installation. These beaches occur in a developed area and experience high human activity.

The landfall site of the offshore transmission cable system in Lewis Bay is not known to provide stopover or wintering habitat for red knot. Specific construction techniques, including horizontal drilling, would minimize the impact of the proposed action on the inter-tidal community within the vicinity of the landfall site. The laying of submarine cables in Lewis bay and near the inlet of the bay are not expected to cause long term changes in inter-tidal habitat structure or prey availability. The increase in suspended solids and the relocation of sandy sediments would be temporary and would result in no lasting changes in the coastal areas of interior Lewis Bay, or the beaches on either side of the inlet.

Because of the inherent dynamic nature of all marine environments within the area of the proposed action, including the inter-tidal zone, disturbances created during construction and decommissioning are

not expected to cause lasting or harmful effects. Small mortality events of infaunal organisms are likely to occur, but effects on local inter-tidal assemblages would be negligible. Disturbance of the sea floor within Lewis Bay may provide for opportunistic colonization by disturbance tolerant benthos after construction, and similarly after decommissioning activities; however, these changes are not expected to influence inter-tidal areas. Impacts associated with changes in inter-tidal habitat during installation of the offshore transmission cable system in Lewis Bay are anticipated to be negligible.

Vessel Traffic

There would be an increase in vessel activity associated with construction and decommissioning activities. A large vessel(s) would be used to transport and install the monopiles, towers, nacelles, hubs, and blades during construction and decommissioning. The vessel would be loaded in Quonset, Rhode Island, and would be anchored near the monopiles that are undergoing construction. During installation and decommissioning of the WTGs, the large vessel would make several trips from Quonset to the area of the proposed action. Additionally, smaller support vessels would make regular trips from nearby ports to HSS during the construction period.

A study investigating shorebird roost site selection at an important shorebird staging and overwintering site in South Carolina indicated that out of 8 species studied, red knots were relatively sensitive to vessel traffic. The authors determined that red knots avoided roosting at sites that experienced high average boat activity, and red knots responded to boat activity within 1,000 m (Peters and Otis, 2007). Disturbances associated with increased boat traffic could deplete red knot energy reserves during critical pre-migratory periods. However, boat and other construction activities would mainly occur at offshore locations greater than 5 miles (8 km) from potential staging habitats along the mainland coast or along island shores. The closest distance of the offshore transmission cable system to potential staging habitat on the seaward side of Great Island is 0.8 miles (1.3 km). Near shore construction activities in Lewis Bay would be temporary and would occur outside of the known 1000 m vessel disturbance distance.

Therefore, construction and decommissioning vessel activity is expected to have negligible impacts to red knot.

Piping Plover

The following provides a summary of the proposed action construction and decommissioning impacts on the Piping Plover. Federally Threatened piping plover breed along the mainland and island shores of Nantucket Sound. Potential impacts to piping plover associated with construction and operation of the proposed action may include loss of habitat, disturbances associated with the presence or activity of construction or decommissioning equipment, disturbances such as barriers to flight paths due to the presence of the turbines, and risk of collision. Additional sources of impact include oil spills and disturbances associated with submarine cable repair.

Habitat Loss or Alteration

Habitat loss or alteration associated with construction/decommissioning or operation is not anticipated. The proposed WTGs would be located offshore, at least 5 mi (8 km) from the nearest nesting or staging habitat (Figure 5.3.2-4). The proposed landfall of the offshore transmission cable system would not occur within breeding habitat. The proposed action would not impact critical habitat as there are no designations in Massachusetts.

The proposed location of the landfall of the offshore transmission cable system is on the northeastern side of Lewis Bay at the end of New Hampshire Avenue in Yarmouth. Neither the proposed cable nor landfall would cross piping plover breeding habitat. The closest nesting location to the proposed landfall

is approximately 1.5 mi (2.4 km) at Kalmar Beach/Dunbar Point in Hyannis. The closest distance of the offshore transmission cable system to the nearest piping plover nest site on the seaward side of Great Island is 0.8 mi (1.3 km) (Figure 5.3.2-4). The buried cables at their closest point would occur approximately 820 ft (250 m) from Kalmar Point/Dunbar Beach and approximately 1,210 ft (369 m) from Great Island. In addition, since the shoreline would be drilled under for cable placement, there would be no disturbance of beach areas.

Disturbance

High disturbance levels around nest sites can result in the abandonment of nests, and ultimately, decreased breeding success. Causing parents or juveniles to flush while foraging may stress juveniles enough to negatively influence critical growth and development. Potential disturbances during construction and decommissioning associated with increased human activity, the presence and operation of large equipment, and increased boat traffic offshore of nesting sites located closest to the proposed landfall, would be temporary and are not anticipated to impact breeding piping plover. It is possible that a tracking system consisting of a wire, for the operation of the drill head may be placed across the beach. This would be a minor, temporary activity that would not disturb the area more than a person walking on the beach.

Available data on disturbance distances suggest that flushing distances of incubating birds vary among sites and individuals. Disturbances resulting in flushing occurred as far away from nests as 689 ft (210 m), 984 ft (300 m), and 571 ft (174 m) at Nova Scotia, Virginia, and Maryland beaches, respectively (USFWS, 1996). The recommended disturbance buffer around nest sites is typically a 164 ft (50 m) buffer; however, at Maryland sites it is 738 ft (225 m) (USFWS, 1996). The mean flushing distance at Massachusetts nest sites is 24 m (USFWS, 1996). For non-incubating birds, the maximum disturbance distances reported for pedestrian, vehicles, pets, and kites are 197 ft (60 m), 230 ft (70 m), 328 ft (100 m), and 394 ft (120 m), respectively (USFWS, 1996).

Due to the 820 ft (250 m) (or greater) separation of the offshore transmission cable system from the nearest nesting beaches, disturbances associated with offshore construction or operation activities are not anticipated for nesting piping plover. In addition, since the shoreline would be drilled under for cable placement, there would be no disturbance of beach areas. The placement of a wire on the beach (and seafloor) to help guide and track the drill head would result in disturbance essentially equal to a person walking on the beach. The proposed landfall site is 1.5 mi (2.4 km) from the nearest nesting beach and, therefore, onshore construction or decommissioning activities are not anticipated to impact nesting piping plover.

Roseate Tern

The following provides a summary of proposed action construction and decommissioning impacts on the roseate tern. For a detailed analysis, refer to [Appendix C](#), which provides information on T&E species and potential effects to T&E species. The potential impacts associated with the proposed action construction, and decommissioning include loss of habitat, habitat modification or prey displacement during construction, barriers to flight paths due to the presence of WTGs, collisions with proposed action structures, increased predation, and/or disturbances associated with increased vessel traffic during construction and decommissioning.

Habitat Loss or Modification

Terns traveling or foraging in the proposed action area could potentially be impacted by habitat loss or modification during construction and decommissioning activities. Some species of birds are more sensitive to disturbances than others and can be displaced up to hundreds of meters from the source of the

activity (Gill 2005). Breeding terns would be most sensitive to construction and operation disturbances during the breeding season when they have increased energy demands.

There is no available breeding habitat within or in close proximity to the proposed action area boundary, and the offshore transmission cable system and proposed landfall would not cross breeding locations. All points along the transmission cable would be greater than 15 mi (24 km) to the nearest breeding location in Nantucket Sound on Monomoy Island. The center of the turbine array in HSS would be greater than 19.8 mi (31.8 km) to Monomoy Island and 11.5 mi (18.5 km) from the closest potential breeding habitat on Muskeget Island. Therefore, construction and decommissioning activities would not result in the loss of breeding habitat. However, terns travel substantial distances (16 to 19 mi [25.8 to 30.6 km]) from their breeding locations to access foraging habitat and terns may be affected as they travel or forage in the vicinity of the proposed action area. Because of the small footprint of the actual development area (individual WTGs and the ESP), minimal habitat loss is anticipated during proposed action construction and decommissioning activities.

Construction and decommissioning activities could directly deter roseate terns or their prey from the proposed action area resulting in the temporary or permanent loss of habitat. Baseline surveys conducted in Nantucket Sound, documented minimal tern use of the HSS area in relation to other locations in the Sound. Most terns were observed traveling, fewer were seen actively foraging. Terns are known to regularly forage near recreational fishing boats, ships, and other man-made structures. Terns and gulls are among species of birds that have been observed in the vicinity of operating turbines at European offshore facilities (Everaert and Stienen, 2006; Petersen et al., 2006; Pettersson, 2005). Roseate terns would likely continue to forage and travel in the vicinity of construction activities, assuming that their food sources are not displaced. Impacts associated with displacement of prey fish during construction are anticipated to be minimal and temporary. The natural benthic substrate and prey fish communities would be maintained following a period of recovery from the construction or decommissioning disturbances.

Vibrations from pile-driving could startle and temporarily displace prey fish from the proposed action area. Increases in turbidity from offshore cable trenching could temporarily impede fish foraging and navigation in disturbed areas (Jarvis, 2005). Construction activities could affect fish and benthic communities up to 328 ft (100 m) from the activity (Nedwell et al., 2004 *as cited by* Gill, 2005). However, impacts to foraging habitat are anticipated to be minimal as construction activities would be temporary and localized. A jack-up barge with a crane would be used to install the monopiles. There would be a total of two pile driving rams used to fix the 130 monopile structures into the seabed and it is unlikely that both rams would be used simultaneously. The hollow monopiles are expected to trap the majority of sediment displaced during pile driving.

Sediment suspended by trenching during offshore cable installation is expected to be localized (20 milligrams/liter within 1,500 feet [457 m] from the trench) and is expected to quickly resettle (within minutes or up to a few hours) ([Report No. 4.1.1-2](#)). Jet plow embedment would allow for simultaneous plowing and cable-laying to minimize impacts. As a result of disturbances to sediment during trenching and pile driving, small benthic organisms would be stirred up and prey fish may be attracted to the area to forage. This in turn could attract roseate terns to forage. However, this is likely to be a very localized event and is unlikely to represent anything more than a minor potential benefit for foraging terns.

Vessel Traffic

Increases in vessel traffic could result in impacts to roseate terns during the construction, operation, and decommissioning phases. A large vessel(s) would be used to transport and install the monopiles, towers, nacelles, hubs, and blades during construction and decommissioning. The vessel would be loaded in Quonset, Rhode Island, and would be anchored near the monopiles that are undergoing construction.

During installation and decommissioning of the WTGs, the large vessel would make several trips from Quonset to the proposed action area. Additionally, small vessels from Falmouth, Massachusetts, and a maintenance support vessel from New Bedford would make regular trips to HSS during the construction period. While the proposed turbines are in operation, there would be regular vessel trips made from Falmouth and New Bedford harbors to the proposed action area. The expected maintenance schedule would be approximately 2 vessel trips per day for 252 days per year (5 maintenance days per turbine per year) (see Section 2 of the DEIS for a description of maintenance activities).

During high surf conditions, workers may be transported by helicopter to the platform on the ESP. There may also be occasional helicopter landings at the ESP in association with some regular maintenance activities. An increase in recreational fishing may occur around the WTGs if fish populations aggregate around foundations. The arrival of vessels and helicopters could temporarily displace terns from localized areas within the larger proposed action area. This type of disturbance already occurs to some extent within and adjacent to the proposed action area due to existing levels of vessel activity, and the temporary incremental increase is likely to have only a minor affect on roseate tern use of the construction areas.

New England Cottontail

Small populations of New England cottontails were observed in Barnstable County during a 2000 - 2003 survey (MDFW, 2003). The upland work associated with the installation of the underground cable would be located within either streets or an existing previously disturbed utility ROW. As such, construction impacts to eastern cottontail rabbits are expected to be negligible. Construction of the WTGs would not have an impact on New England cottontails as the WTGs would be located far offshore.

Conclusion

The overall impacts from construction and decommissioning activities associated with sea turtle species, cetacean species and the red knot are expected to range from negligible to minor as these impacts would be for the most part confined to the duration of the proposed action and the area of the proposed action activities. Impacts associated with the piping plover would be negligible to minor, and impacts associated with the roseate tern would be minor. These impacts are principally related to habitat disturbance, vessel movement and construction activities. Some mitigation measures being considered at this time include construction techniques, requiring a NMFS-approved observer on-site during all pile driving activities, the use of a bubble curtain, and restricting construction to less sensitive periods. Construction impacts associated with the New England cottontails are expected to be negligible since upland work associated with the installation of the underground cable would take place in streets or an existing utility ROW.

5.3.2.9.2 Operational/Maintenance Impacts

Sea Turtle Species

Vessel Harassment/Strikes

The proposed action operation and maintenance activities are expected to require two vessel trips per working day for 252 days of the year. The vessels are anticipated to consist of small crew boats and slower moving supply vessels, similar to the smaller vessels to be used during proposed action construction.

As previously discussed, sea turtles do not appear to be exceedingly disturbed by the physical presence and sound produced by vessels, and the vessel traffic itself (NMFS, 2001; NMFS, 2002). Sea

turtles should be able to detect and move away from any proposed action vessel by diving into deeper waters. Any impact would be limited to temporary avoidance of an area; however, this is unexpected due to the high volumes of vessel traffic that normally travel the waters of Nantucket Sound. Therefore, the impacts of increased vessel traffic should have minor impacts on listed sea turtles. One exception to this is that if the loggerhead and Kemp's Ridley sea turtles selectively feed around the monopiles, they may interact with the maintenance vessels. However, as the maintenance vessels approach the monopile, they would be at very low speeds and unlikely to strike a sea turtle.

Acoustical Harassment

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Existing underwater sound levels for the design condition are 107.2 dB. The calculated sound level from operation of a WTG is 109.1 dB at 20 m from the monopile (i.e., only 1.9 dB above the baseline sound level), and this total falls off to 107.5 dB at 50 m and declines to the baseline level at a relatively short distance of 110 m.

An analysis of predicted underwater sound levels perceived by sea turtles from proposed action operation show that no injury or harassment to sea turtles are predicted, even if an individual were to approach as close as 20 m to a monopile. When the proposed action is operating at the design wind speed as all dB_{ht} values at this minimum distance are well below 90 dB. In fact, proposed action operation would be inaudible for sea turtles.

Electromagnetic Fields

Potential impacts to sea turtles during the normal operation of the inner-array cables and the offshore transmission cable system circuits are expected to be minor, as the electric field would be mainly contained within the shields surrounding the cables. The magnetic fields associated with the operation of the cables are not anticipated to result in an adverse impact to sea turtles or their prey. The burial depth of 6 ft (1.8 m) below the seabed would also minimize potential thermal impacts from the operation of the cables. Therefore, it is anticipated impacts to sea turtles or their prey species during the normal operation of the cable systems are expected to be minor.

Pollution/Potential Spills

While improbable, an oil spill would have minor to moderate impacts on sea turtles within Nantucket Sound. The type of oil, length of exposure, condition of the oil in terms of weathering and life stage at which the sea turtle is exposed to the spill would all play a role in the impact on the animal. While some oil products would be present within the proposed action structures, the relatively small amount of oil being used would tend to produce a small plume in the event of a spill.

Sea turtles are vulnerable at all life stages, with the most vulnerable stages being the eggs, embryos and hatchlings, which do not occur in Nantucket Sound or in the Northeast. Adult sea turtles are also extremely vulnerable to oil spills. Sea turtles can be harmed if they surface in an oil slick to breathe. Oil can affect their eyes and damage airways or lungs, can be absorbed through their skin and can be ingested through contaminated foods. Sea turtles also seem unable to distinguish between food and tar balls, and show no avoidance behavior when encountering oil slicks ([Report No. 5.2.1-1](#)). Of the species that may occur within the vicinity of the area of the proposed action, Kemp's ridley sea turtles may be most impacted by an oil spill, as it has a small population size and limited nesting distribution. However, the overall potential for an oil spill from the proposed action is very low, and the amount of oil being used and the distance to shore would lead to less severe impacts in any case of oil spill from proposed action facilities.

The exception to this is in the event of a commercial oil transport vessel collision with a WTG, should a cargo container rupture. In such an event, tens of thousands of gallons of oil could be released. Recent experience with the *Bouchard No. 120* grounding in Buzzards Bay provides an example of the extent of dispersal that can occur. However, the low probability of such an event would suggest that the potential for harm or injury to sea turtles would be minor.

Turbidity and Total Suspended Solids

During operation, there are potential impacts related to turbidity and total suspended solids that could occur in the unlikely event of a cable repair. Such impacts would include temporary turbidity and some localized deposition of sediments during the repair process. Turbidity would be caused by the jetting of sediments to uncover the damaged portion of the cable, hoisting of the cable after it is cut, laying the cable back down, and then jetting of sediments for reburial of the repaired cable. Cable repair procedures are discussed more thoroughly in Section 2.4.6. Impacts on listed sea turtle species as a result of cable repair would be minor because of the temporary and localized water quality effects.

Cetacean Species

The impacts from proposed action operations on endangered and threatened cetaceans are essentially the same as those described for MMPA marine mammals in Section 5.3.2.6.

Wind Turbine Operational Noise

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Acoustic modeling of underwater operational sound at the Wind Park was performed for the design wind condition (see Section 3.13 of ESS, 2007). Baseline underwater sound levels under the design wind condition are 107.2 dB re 1 μ Pa. The predicted sound level from operation of a WTG is 109.1 dB re 1 μ Pa at 65.6 ft (20 m) from the monopile (i.e., only 1.9 dB re 1 μ Pa above the baseline sound level), and this total sound level falls off to 107.5 dB re 1 μ Pa at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 110 m (361 feet). Since the WTGs will be spaced farther apart than 360 ft (110 m) (approximately 629 to 1,000 m or 0.39 to 0.63 miles apart), no cumulative impacts from the operation of the 130 WTGs in the Wind Park are anticipated.

An analysis of predicted underwater sound levels perceived by whales during operations show that no injury or harassment to whales are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the turbines are operating at the design wind speed as all dB_{ht} values at this minimum distance are well below 90 dB. In fact, operation sounds will be inaudible for toothed whales, and only slightly audible to baleen whales at the extremely close distance of 65.6 ft (20 m). Therefore, no behavioral effects to whales are anticipated even if an individual were to approach within 65.6 ft (20 m) of the structures.

Habitat Shift

The presence of 130 monopile foundations, 6 ESP piles and their associated scour control mats or rock armor in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from soft sediment, open water habitat system to a structure-oriented system, with minor effects to whales.

Unplanned and Accidental Events

Accidental and unexpected events associated with the proposed action could impact whales. Such impacts would primarily be the result of oil spills, but may also relate to cable repair, collapse of a monopile, and vessel collision with a project structure.

Oil spills could occur either as a release from the ESP storage tank or from a vessel collision with a monopile. Little species-specific information is available regarding the effects of oil spills on whales. Past studies suggest that large whale species do not seem to be particularly sensitive to oil spills. Because they rely on blubber for insulation, whales are less vulnerable to oil spills than fur-coated marine mammals which can die from hypothermia when coated in oil. In addition, humpback whales, fin whales and right whales are all migratory which may limit their exposure to a persistent oil slick in a small geographic area. Although most research suggests that whales do not appear to be especially sensitive to spills, other studies have shown that there are negative long-term effects to whales from exposure to oil. When surfacing, oil may irritate whale's eyes and skin and they may breathe in harmful fumes. Other symptoms of acute exposure to oil include lethargy, poor coordination and difficulty breathing which can lead to drowning (Hammond et al., 2001).

Many of the types of disturbances that would occur during cable repair activities are smaller and shorter duration, but of similar type, to those that would occur during cable installation. A relatively short distance along the sea floor would be disturbed by the jetting process used to uncover the cable and allow it to be cut so that the ends could be retrieved to the surface. In addition to the temporary loss of some benthic organisms, there would be increased turbidity for a short period, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. Given the small area, short duration, and infrequency of occurrence of listed whales in the proposed action area, potential adverse impacts from cable repair activities on the listed whales would be negligible.

The extent of potential impacts that could result from a vessel collision with a monopile largely depends on the extent of damage to the monopile or vessel, as well as the nature of the vessel. Some smaller vessels would merely strike a glancing blow and suffer some hull damage but not sink. Other vessels may suffer enough damage to sink, causing a small release of fuel and debris. A larger vessel, such as an oil tanker, would most likely cause a collapse of the monopile, also resulting in a small release of lubricating fluid. If oil being transported were to be released, then depending upon the quantity released, an oil spill that escapes Nantucket Sound could directly affect listed whales (see section 5.2.1.1). Repair of a damaged or collapsed monopile would create short term and localized disturbances to the benthos, water column, and pelagic organisms similar to the construction and decommissioning of a single monopile, albeit in reverse order and combined in a single event. Since these disturbances are localized to the monopile they are unlikely to adversely affect listed whale species, and therefore potential adverse impacts resulting from a vessel collision with a monopile and the associated repair activities on the listed whales would be negligible.

Red Knot

The potential impacts to red knot during proposed action operation may include impacts associated with disturbance from vessel activity during any necessary cable repair, impacts associated with oil spills or WTG structure or ESP fluid spills, and the risk of collision of migrant red knots with WTG structures.

Vessel Traffic

There would be an increase in vessel activity within the Horseshoe Shoal area associated with maintenance of the WTGs during the operational period. During operation, maintenance vessels would mainly operate out of Hyannis or similar Cape Cod ports. These ports have adequate facilities for

berthing and loading of the maintenance vessels. These ports occur in developed areas and currently experience similar uses. There are no known important staging areas in the vicinity of these ports; therefore, the increase in vessel activity in these areas is anticipated to result in negligible impacts to red knot.

There may be an increase in vessel activity associated with offshore cable repair during the operation phase. However, the cable is designed under normal conditions to last the life of the project. The closest distance of the offshore transmission cable system to potential staging habitat on the seaward side of Great Island is 0.8 miles (1.3 km). Near shore construction activities in Lewis Bay would be temporary and would occur outside of the 1000 m vessel disturbance distance for red knot. Therefore, vessel disturbances associated with cable repairs are anticipated to result in negligible impacts to red knot

Oil Spills

The presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions and possibly oil spills. Oil spills may result in the release of contaminants from vessels or from the WTG or ESP foundations themselves. Depending on the location and the size of a spill, red knots may be impacted. If the feathers of birds become coated with oil, birds lose their ability to repel water and to insulate, and in some instances, lose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2003). Shorebird habitat was impacted by the oil spill, particularly at Barney's Joy, Dartmouth, and shorebird mortality was a resulting impact.

Monopile collapse, vessel collisions, or storm damage to the ESP or WTG structures could result in oil or other fluid contamination. The total maximum oil storage on the ESP is expected to be approximately 42,000 gallons at any given time. The total oil storage at each WTG is expected to be approximately 214 gallons at any given time (27,820 gallons for all 130 WTGs). In the unlikely event that an oil spill was to occur, the oil is most likely to travel toward the south shore of Cape Cod and the eastern shore of Martha's Vineyard (20 percent to 30 percent). It has a 90 percent chance of impacting any shoreline in the area.

The potential impacts of oil spills associated with the operation of the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the mortality of red knot if staging areas were to be impacted. Oil spills that occur outside of dispersal, staging periods, or wintering periods could result in no impacts to red knot. Due to the distance between the WTG area and the closest known red knot migratory and wintering habitat on Monomoy, the potential for impacts are reduced, and when the probability is considered, oil spills should be considered to represent a minor impact.

Risk of Collision

There is the potential for red knot collisions with the proposed WTGs. The risk of collision is dependent on the frequency of occurrence of red knots within the site of the proposed action, visibility during potential red knot encounters with WTGs, and the flight behaviors of red knots within the area of the proposed action.

Red knots may occur with the area of the proposed action during migration, however, no red knots were observed in HSS during aerial and boat surveys conducted during 2002 to 2006. One individual was observed during one of the applicant's boat surveys near Cape Poge off of Martha's Vineyard on September 13, 2002. The individual was in a mixed flock of sandpipers and was observed flying low over the water.

Red knots undertake one of the longest known migrations and may travel thousands of kilometers without stopping (Harrington, 2001). Departure for migration for most shorebirds, including red knots, tends to occur on sunny days in the few hours before twilight (Harrington, 2001). Red knots tend to occur in larger flocks than most other shorebirds with flock sizes at over one hundred individuals; the average size of red knot flocks consisted of roughly 50 individuals at one study location (Harrington, 2001). Observations suggest red knots fly in v-formations, and mixed flocks eventually segregate according to species after departure from beaches (Harrington, 2001). Flocks observed departing for migration, gained altitudes at relatively high rate of 0.91 m/s compared to 7 other species observed (Harrington, 2001). Limited migration behavior information suggests that red knots mainly migrate during periods of good visibility and that they may travel at relatively high altitudes. These behaviors may put red knot at a low risk of collision with the proposed turbines, however, more site specific information is required to assess their risk.

Red knot are known to occur regularly during migration on Monomoy Island (USFWS, 2006), especially during the late summer and early fall. Migration paths and flight altitudes used to access Monomoy are not known. The observation of one individual near Cape Poge off of Martha's Vineyard may indicate that red knots also utilize beach and inter-tidal areas associated with the islands of Nantucket Sound, or that some individuals may pass Martha's Vineyard while accessing staging habitat. No other individuals were observed in the study areas and no individuals were observed within HSS during the 2002 to 2006 boat and aerial surveys. However, aerial and boat surveys were conducted during the day, and therefore it is not known whether red knot may cross HSS during nighttime migration movements. Additionally, there are limitations to visual observations of shorebirds flying near the surface of the water from aerial surveys, as well as visual observations of high flying shorebirds from the surface of the water during boat surveys. More information is needed to access red knot occurrence and flight behavior in HSS during the day and at night, during a variety of weather conditions. However, the results of available surveys indicate a low chance of occurrence of red knot in the area of the proposed action. The risk of collision is low and therefore, collision mortality associated with the proposed action is anticipated to result in negligible impacts to red knot.

Piping Plover

Minor adverse impacts to piping plover are anticipated during operation of the proposed action. The site of the proposed action does not occur within breeding or staging habitat, or within a known migration or movement corridor. Therefore, the effects of loss of habitat or habitat modification would be negligible. There are no features that would funnel piping plover across the site of the proposed action if their movements were to result in crossings of Nantucket Sound during the breeding season or migration season. Therefore, the presence and operation of the WTGs is not expected to present a major barrier to the flight paths of transient plovers. Piping plover that encounter turbines during crossings of the Sound are generally expected to avoid collisions with WTG structures depending on visibility. These avoidance behaviors are expected to result in minor changes to piping plover flight behavior and minimal increases in energy expenditure. Therefore, the presence of WTGs in HSS may affect piping plover, but minor adverse impacts are anticipated.

WTG Presence and Rotor Movement

During the breeding season, piping plover remain in close proximity to nests as they forage on invertebrates in the inter-tidal zone near nest sites. During this period, plovers mainly travel by walking or running between foraging and nearby breeding sites. Their regular daily movements would not result in crossings of the proposed action area. However, there have been some observations of plovers during the breeding season departing land and heading for the horizon. There are no known flight corridors for plovers over the Sound during the breeding season. There are no topographical features such as shortest crossings that would direct occasional flights over the Sound into HSS. Therefore, the presence and operation of turbines is not anticipated to present a major barrier to the flight paths of piping plover.

Other unusual crossings of Nantucket Sound during the breeding season could include the crossings of failed breeders or unpaired birds seeking alternate habitat or a mate. However, aerial and boat surveys conducted in 2002, 2003 and 2004 in Nantucket Sound did not detect such movements in any of the study areas. There is no data available that suggest piping plover would cross HSS during such movements; therefore, the WTGs are not anticipated to create a major barrier to the flight paths of piping plover.

The majority of Atlantic Coast piping plover migratory movements is believed to take place along the outer beaches of the coastline (USFWS, 1996). Most movements are believed to occur along a narrow flight corridor, and offshore and inland observations are rare (USFWS, 1996). Some birds may occur inland or offshore if blown off course by weather events. The birds that breed or stop-over on islands in Nantucket Sound and Vineyard Sound would make over-water crossings while accessing these locations. Therefore, there is a potential that piping plover could occur in the proposed action area during migratory or post-breeding dispersal movements. However, there are no topographical features that would funnel piping plover through HSS. Therefore, the presence of the WTGs is not expected to present a major barrier to the flight path of migrating piping plover.

Risk of Collision

Piping plover cross areas of Nantucket Sound to access breeding locations during migration or dispersal, and may sporadically cross the Sound during the breeding period. However, the flight paths of piping plover through the Sound are not known. The migration flight paths of piping plover along the Atlantic Coast are expected to occur within a narrow corridor along the coast but some birds may occur offshore or inland. Piping plover migrate both day and night and could travel during periods of inclement weather when visibility is reduced. However, studies suggest that migration of birds is reduced during periods of inclement weather (Petersen et al., 2006). Birds have demonstrated turbine avoidance behaviors both during the day and at night. If piping plover were to occur within the area of the proposed action, they would generally be expected to visually detect and avoid collisions due to FAA lighting on the nacelles as well as sources of natural lighting. More information is required to assess the effects of refracted light during periods of rain or fog to traveling piping plover. There are no topographical features that would funnel piping plover through HSS, therefore, crossings of the site of the proposed action are expected to be few in relation to the number of birds that could potentially cross Nantucket Sound over the course of a year.

Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) estimated the number of piping plover turbine encounters per crossing of the wind turbine array, assuming all turbines were aligned perpendicular to each bird's path, based on three different flight height scenarios: If all individuals fly below 30 m, the expected encounters per crossing would be 0.07; if all birds fly in the rotor swept zone (75.5 to 440 ft [23 to 134 m]), there would be 0.67 encounters; and if flights are evenly distributed from 30 to 600 m then there would be 0.13 encounters. The authors suggest that, based on high avoidance rates estimated for other species, the likelihood of collision resulting from encounters is low (see Collision Probability

Modeling for description of avoidance rates). The authors assume that all encounters with stationary monopiles would be avoided.

Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) used the Band Collision Risk Model to estimate a 91 to 99 percent plover turbine avoidance rate based a range of known avoidance rates calculated for other species. These avoidance rates are consistent with rates calculated at a few existing wind farms in the U.S. where mainly geese and raptor species were estimated to have avoidance rates greater than 95 percent. Fernley et al., (2006) calculated the avoidance rates of geese at four operating land-based wind farms in the U.S. using the Band Collision Risk Model. The avoidance rates calculated at the four facilities ranged from 99.82 percent to 100 percent despite high usage by geese at these wind farm sites. Whitfield and Madders (2006) used the Band Collision Risk Model to estimate the avoidance rate of hen harriers (*Circus cyaneus*) at eight wind farms in the U.S. Estimates were: 100 percent at 6 sites, 99.8 percent at 1 site, and 93.2 percent at 1 site. Other avoidance rates reported include: 99.62 percent mainly for gull species at Blyth Harbor in Northeast England, 99.5 percent for golden eagle (*Aquila chrysaetos*) at a U.S. facility, and 99.98 percent for passerines at the Oosterbierum wind farm in the Netherlands (Chamberlain et al., 2006). There are, however, limitations to the Band Collision Risk Model, as it does not account for differences among bird activities and behaviors under a range of conditions, and because avoidance rates exhibited by a range of species are understudied (Chamberlain et al., 2006).

Chamberlain et al., (2006) warned against the inaccuracies that can result in collision models that are based on the avoidance rates calculated for other species. Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) provided an estimate of the number of plover crossings of the proposed action area per year. This estimate was based on the number of breeding plovers from Massachusetts northwards, including the Atlantic Canada population. It was estimated that 2,458 plovers cross the Massachusetts coastline over the course of a year (based on adults in spring and fall, and fledglings). MassWildlife suggested that less than 200 piping plover would cross HSS in a year ([Report No. 5.3.2-1](#)). This figure was applied to the model with varying scenarios of flight height and collision probability. Based on an avoidance rate of 98 percent, if all flights occurred in the rotor zone, one piping plover collision would occur in 5.5 years; if all flew below 98 ft (30 m), there would be one collision in 50 years; if flight heights were distributed between 98 to 1,968 ft (30 to 600 m), there would be one collision in 28 years. Using the avoidance rate of 91 percent, there would be 1.2 collisions per year if birds flew exclusively in the rotor zone, 1 collision in 12 years if all birds flew below 98 ft (30 m), and 1 collision in 6 years if flight heights were distributed between 98 and 1,968 (30 and 600 m). The authors emphasize the uncertainties surrounding the model including the lack of information regarding piping plover occurrence and flight behavior in HSS, as well as the lack of a species-specific avoidance rate.

A population viability analysis (PVA) was developed by Brault (2007) ([Report No. 5.3.2-4](#)) using the most recent breeding population trends of both the Atlantic Canada and New England population. The model estimated a range of mortality associated with the proposed action that could be tolerated by the population without increased risk of extinction or decreased probability of recovery goals (the author used 600 breeding pairs for New England, although the current recovery goal is 625 pairs; the correct recovery goal of 400 pairs was used as the Atlantic Canada threshold). The author modeled varying kill rates with no growth and intermediate growth scenarios. It was estimated that a take of up to 5 piping plover per year would not influence the likelihood of achieving Atlantic Coast recovery goals, or influence the probability of extinction. It was estimated that the increase in the risk of extinction was low over a period of 50 years with wind farm fatalities up to 20 birds per year, given that there are no changes in available breeding and wintering habitat. It was determined that changes in the annual survival rate had 2.25 times the effect on population dynamics than did changes in productivity. The author emphasized that the potential impacts associated with the proposed action are greatly dependent on the level of management efforts. The PVA used a New England recovery goal of 600 breeding pairs instead of the actual 625

breeding pairs. This discrepancy in 25 birds is likely an insignificant factor to the wide range of parameters factored into the model; however, it represents a flaw in the model.

Assuming the estimated worst case scenario of 1.2 wind farm-related piping plover fatalities per year with the low turbine avoidance rate of 91 percent, calculated by Hatch and Brault (2007) (Report No. 5.3.2-1), the recent PVA model suggests that the proposed action would not significantly impact the probability of achieving recovery goals or the influence the probability of extinction. However, there is a large range of uncertainty surrounding the collision mortality estimate. The actual number of crossings of the proposed action area per year, the average height of flight during crossings, and the turbine avoidance rates specific to piping plover are not known. The estimate of 1.2 wind farm-related fatalities is conservative because it assumed that piping plover exhibit a low turbine avoidance rate and that all birds fly through HSS at rotor height. The assumption that all piping plover would cross the proposed action area at rotor height is likely inaccurate; however, it is appropriate to be conservative until more data is available.

Non-Routine, Unplanned and Accidental Events

Piping plover may be impacted by oil spills, monopile collapse, cable repair, and pre-construction geotechnical and geophysical investigations. Depending on the season, and the size and location of the area affected by an oil spill, a spill in Nantucket Sound could result in the decreased breeding success or mortality of piping plovers. However, an oil spill is an unlikely event and due to the distance of the area of the proposed action from the major breeding areas, negligible impacts are anticipated to result from oil spills. Furthermore, if a spill were quickly detected and contained, negative impacts could be minimized or avoided. Most potential affects from monopile collapse would occur offshore and not affect shoreline areas used by the piping plover.

The presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions, and possibly oil spills. Contamination may result from the release of fluids from vessels, or from the WTG or EPS structures themselves. Depending on the size and location of an area impacted by an oil spill, spills could result in the direct mortality or decreased breeding success of piping plovers. If the feathers become coated with oil, birds lose their ability to repel water and to insulate (Jarvis, 2005). Potential impacts include mortality from heat loss, starvation, or drowning. Some birds may lose their ability to fly. Mortality can result if toxins are ingested through water or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2003). Piping plover were impacted by the oil spill, particularly at Barney's Joy, Dartmouth. Two piping plover were reported dead as a result of oil slicking. However, overall nesting success that year was not believed to be adversely impacted (BBNEP, 2003).

The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the loss of piping plover adults or could lead to decreased nesting success. Oil spills that occur outside of the breeding or dispersal periods could result in no impact to piping plover. Due to the distance between the WTG area and the closest piping plover nesting location (approximately 5 miles [8 km]), as well as the low probability of occurrence, the potential for impacts from an oil spill are minor.

The disturbances associated with cable repair activities are expected to be of a similar type but shorter and less extensive than during cable construction. Regular maintenance activities are not anticipated for the submarine cables. Due to the 250 m (or greater) buffer of the offshore transmission cable system from the nearest nesting beaches, disturbances including increased human presence and vessel traffic associated with offshore maintenance activities are not anticipated for nesting or foraging piping plover, and overall cable repairs would have a negligible affect on piping plover.

Roseate Tern

The Federally Endangered roseate tern breeds at limited colony locations within Buzzards Bay and Nantucket Sound (see [Appendix C](#), which provides information on T&E species and potential effects to T&E species). The potential impacts associated with proposed action operation include habitat loss or modification, barriers to flight paths due to the presence of WTGs, collisions with proposed action structures, increased predation, and/or disturbances associated with increased vessel traffic. Additional sources of proposed action impacts include oil spills, monopile collapse, cable repair, and geotechnical and geophysical investigations.

Habitat Loss or Modification

There is no available breeding habitat within or in close proximity to the proposed action area boundary, and the offshore transmission cable system and proposed landfall would not cross breeding locations. All points along the transmission cable would be greater than 15 mi (24 km) to the nearest breeding location in Nantucket Sound on Monomoy Island. The center of the turbine array in HSS would be greater than 19.8 mi (31.8 km) to Monomoy Island and 11.5 mi (18.5 km) from the closest potential breeding habitat on Muskeget Island. Therefore, operation of the project would not result in the loss of breeding habitat. However, terns travel substantial distances (16 to 19 mi [25.8 to 30.6 km]) from their breeding locations to access foraging habitat and terns may be affected as they travel or forage in the vicinity of the proposed action area.

Operation theoretically could directly deter roseate terns or their prey from the proposed action area resulting in the temporary or permanent loss of habitat. Baseline surveys conducted in Nantucket Sound, documented minimal tern use of the HSS area in relation to other locations in the Sound. Most terns were observed traveling, fewer were seen actively foraging. Terns are known to regularly forage near recreational fishing boats, ships, and other man-made structures. Terns and gulls are among species of birds that have been observed in the vicinity of operating turbines at European offshore facilities (Everaert and Stienen, 2006; Petersen et al., 2006; Pettersson, 2005). Roseate terns would likely continue to forage and travel in the vicinity of operating WTGs, assuming that their food sources are not displaced.

The boundary of the proposed action area would include approximately 25 square miles (6474 hectares) of WTGs and ESP (electrical service platform) foundations, and 5.89 acres (2.4 hectares) of transmission cable. The total area represents 11 percent of Nantucket Sound (Jarvis, 2005). However, the total area of seabed that would permanently be disturbed would be less than 1 percent of the total wind farm area including approximately 1 acre (0.4 hectares) for the 130 turbines, 100 by 200 ft (30.5 to 61 m) for the ESP platform, and over 45 acres (18 hectare) for rock scour protection (Jarvis, 2005). The additional amount of surface area (approximately 1,200 square feet [111 square meters] per tower would result in a minor addition to the substrate that is currently available. Due to the small amount of additional surface area in relation to the total proposed action area in Nantucket Sound, and the spacing between WTGs, the proposed structures are not expected to have a significant affect on the benthic community, the presence of prey fish, or foraging terns.

WTG Presence and Rotor Movement

The presence of wind turbines and the spinning of the blades could present barriers to the flight paths of birds and could potentially affect or restrict access to breeding, staging, or foraging habitat. A wind farm could potentially lead to significant impacts if it were to occur in an area of high use by birds (Drewitt and Langston 2006). Barriers can result in increases in energy expenditure if birds are forced to travel greater distances while accessing foraging habitats or while undertaking migration movements. However, there are no known situations where a wind farm has created a 'barrier effect' resulting in an avian population level impact (Drewitt and Langston 2006).

Terns have been observed to continue to use WTG areas at existing offshore facilities during both migration and breeding periods. Post-construction radar studies during migration at the Nysted and Horns Rev wind farms in Denmark indicate that, although the greatest levels of movement occurred outside of the wind farms, terns continued to migrate through the wind farm areas (Petersen et al., 2006). The facility is located 8.7 mi (14 km) offshore and is comprised of 80 turbines with a rotor zone of 98 to 360 ft (30 to 110 m). The turbines are spaced 1,640 ft (500 m) apart, half the distance of the proposed turbines. Visual data collected at the Nysted and Horns Rev facility indicate that the majority of terns generally avoided the direct wind farm area but increased their use of the 1.2 mi (2 km) zone surrounding the facility (Petersen et al., 2006). Terns were observed foraging at the outer edges of the facility around turbine structures. Small flocks flew into the farm, but then exited the area after passing through the second row of turbines (Petersen et al., 2006). Sandwich terns (*S. sandvicensis*) entered the wind farm between two turbines more frequently when one or both of the turbines were not active (Petersen et al., 2006). Common and arctic terns (*S. paradisaea*), observed flying in the vicinity of turbines at a facility in Kalmar Sound, Sweden, flew between turbines or right next to the turbines instead of veering off in wide curves as waterfowl species were observed to do (Pettersson, 2005). The Kalmar facility is located 1.9 to 7.8 mi (3 to 12.5 km) from the shore with 12 turbines spread out over two locations positioned 20 to 30 km apart. The rotor zone is 115 to 328 ft (35 to 100m) above the water surface. The facility is located along a major migration corridor for water birds. Most birds were observed making slight alterations to their flight paths while traveling past turbines to avoid approaching individual turbines. It was estimated that the presence of the turbines resulted in a minor increase (0.2 to 0.5 percent) to the overall distance traveled by most birds during migration (Pettersson, 2005).

A more local tern-turbine interaction study was conducted at the MMA campus turbine. The MMA turbine has a maximum height of 74 m (243 ft) (85 to 243 ft [26 to 74 m] rotor zone) and is located at the western entrance of the Cape Cod Canal. The turbine is situated 328 ft (100 m) from the water's edge on a landmass adjacent to a popular common and roseate tern foraging location, the Mashnee Flats Shoal located 5.3 mi (9 km) from one of the largest roseate tern breeding colonies, Bird Island. Visual surveys and mortality searches were conducted from April 24 to November 30, 2006, during the breeding, staging, and fall migration periods (see Section 5.3.2 Risk of Collision for information regarding mortality searches). Terns were most abundant in the area during the post-breeding period when they were foraging in large, mixed-species flocks. Terns were most abundant in the turbine airspace (within 164 ft [50 m] of turbine tower, rotor, and blades) during the chick-rearing period and least abundant during the nesting period. The average flight height of terns in the turbine airspace was 83 ft (25.3 m) and the mean flight height was 50 ft (15 m). The one positively identified roseate tern observed in the turbine airspace flew at 26 ft (8 m). In summary, of the terns observed in the 164 ft (50 m) airspace surrounding the turbine: 17 percent flew within, 74 percent flew below, and 9 percent flew above the rotor zone. The study demonstrated that terns continued to use the 50 m [164 ft] airspace around the turbine while traveling between foraging locations (Vlietstra, 2007). However, the operating rotors and spinning blades were observed to deter terns from flying directly within the rotor zone of the turbine when the rotor velocity was greater than 1 rpm. Under these conditions, terns were found to be 4 to 5 times less abundant in the turbine airspace. Therefore, it was assumed that the terns visually and acoustically

detected the spinning blades when the rotor was operating (Vlietstra, 2007). Despite the turbine's location in between foraging locations, terns continued to use the area and their access to habitat was not evidently restricted.

Risk of Collision

As terns are known to travel and forage in the vicinity of other man-made structures, including wind turbines, it is likely that roseate terns would continue to use the area of the proposed action after construction. Although the majority of terns are expected to avoid the direct WTG rotor swept area, it is anticipated that terns would continue to travel and forage in the vicinity of the turbine array. Tern surveys in HSS documented minimal use of the area of the proposed action, therefore, the proposed action is not anticipated to present a major barrier to the flight paths of terns. The proposed action is not expected to substantially increase energy expenditure as terns travel around the direct area of WTGs. Also, because turbines would be widely spaced (0.39 to 0.63 miles [0.63 to 1.0 km] apart), it is anticipated that some terns would occur between turbines while traveling or foraging as they have been observed to do at existing offshore facilities with smaller spacing between turbines. Therefore, the presence of the turbines may affect roseate tern behavior to some extent, but is not anticipated to adversely affect the population of roseate terns.

Roseate terns are anticipated to continue minimal foraging and traveling activities in the vicinity of the proposed action with a low risk of collision given the turbine-avoidance behavior exhibited by terns at the majority of existing offshore and near-shore facilities. The exception is the high collision mortality observed at the Belgium facility located adjacent to a tern colony where terns exhibited high risk flight behaviors and frequent flights through the turbines which put them at a greater risk of collision. Because no colony is located adjacent to HSS, this data is not particularly relevant to the proposed action's potential impacts. Roseate terns would be expected to make direct flights while traveling through HSS to access foraging or breeding locations. The majority of flight heights observed in the area of the proposed action occurred below the rotor zone. During conditions of good visibility, roseate terns would be expected to visually detect and react to turbine structures. Roseate terns are not expected to frequent the area of the proposed action during those periods of inclement weather or at night, however, surveys have not been conducted under these conditions and therefore the potential for collision under these conditions can not be ruled out. However, if flying into strong headwinds, terns would be expected to fly closer to the water's surface. If flying at night, they would be expected to avoid encountering the proposed turbines due to FAA lighting mounted on turbine nacelles as natural sources of lighting, based on the observed turbine avoidance behavior observed by other waterbirds at night. These factors decrease the risk of roseate tern collisions with proposed action structures.

Hatch and Brault (2007) ([Report No. 5.3.2-1](#)) calculated a median value of 0.8 roseate tern fatalities per year as a result of collision with the proposed turbines. Arnold (2007) ([Report No. 5.3.2-5](#)) developed a PVA to demonstrate the range of mortality that the Northeast population of breeding roseate terns (excluding the Canada population) could tolerate without an increased risk of extinction. Under the most updated survival and productivity parameters at the time of modeling, it was determined that there is a 95 percent chance that the population would fall below the threshold of 500 males after 50 years in the absence of additional mortality resulting from the proposed action (the risk of extinction at 15 and 25 years without additional proposed action associated mortality is 9 percent and 42 percent, respectively). The results of the population viability analysis indicate that a take of 0.8 individuals per year would lead to a minimal increase in the risk of population extinction. For a 20 year operational period, the take of the maximum uncertainty parameter of 8.2 individuals per year after 15, 25, and 50 years would result in the risk of population extinction of 11 to 12 percent, 46 to 50 percent, and 95 to 96 percent, respectively. These extinction probabilities are only slightly higher than the probability of extinction in the absence of the wind farm. The PVA suggests that the proposed action would result in a minimal increase in the risk

of population extinction. Therefore, the potential for collision may result in minor adverse impacts to roseate terns, but is not anticipated to jeopardize the population.

While the collision probability model and the PVA suggest that the development of the proposed action would result in minor adverse impacts to the population of roseate terns, there is uncertainty surrounding the collision risk probability model because the actual number of roseate terns that occur in the area of the proposed action each year and the turbine-avoidance rates for roseate terns factored into the model are estimates only. There is uncertainty surrounding the population viability analysis because of the unpredictability of stochastic events. However, these models are based on the most current life history data and were developed in consultation with roseate tern experts.

Increased Predation

It is unlikely that development of the proposed action would result in additional hunting habitat for predatory species. Peregrine falcons aerial and perch hunt, and are known to take species of tern although this is much more likely to happen in proximity to land than around Horseshoe Shoals and their seasonal occurrence in the area of the proposed action does not overlap with roseate terns. Additionally, proposed action structures would be equipped with perch deterrents and modern tubular towers do not provide perch habitat as do older, outdated lattice towers common at some land based projects. Therefore, there is a negligible chance that increased predation due to the presence of proposed action facilities may adversely effect roseate terns.

Vessel Activity

Terns appear to be less sensitive to human disturbances than other species of birds, and are also thought to be attracted to some areas of human activity (Borberg et al., 2005; Drewitt and Langston, 2006; Sadoti et al., 2005a). Terns are known to habituate to some levels of human presence and disturbance. Terns are regularly observed traveling and foraging in the vicinity of vessels and other man-made structures. The major northeast roseate tern breeding colonies on Ram and Bird Islands in Buzzards Bay are located near the entrance of the Cape Cod Canal which receives frequent recreational boating and commercial shipping activity, yet terns continue to colonize these islands. Biologists frequently visit the large roseate tern colonies on the Atlantic Coast and consequently, roseate terns have become habituated to their presence and their handling of eggs, chicks, and adults (Nisbet et al., 1999). An increase in the presence of terns and gulls observed in areas around the Horns Rev offshore facility in Denmark was believed to be associated with increased boat activity for maintenance activities (Petersen et al., 2006). Therefore, roseate terns are expected to continue their traveling and foraging activities despite the presence of increased boat traffic and the few anticipated helicopter landings in HSS. Terns would be expected to return to the area after the departure of the vessels.

Roseate terns are expected to be among those species of bird that would habituate to the presence of increased boat traffic associated with maintenance activities. Therefore disturbances associated with the operation of the facility are anticipated to have minimal effects on roseate terns.

Unplanned and Accidental Events

Roseate terns may also be impacted by oil spills, monopile collapse, cable repair, and pre-construction geotechnical and geophysical investigations. The presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions and possibly oil spills. Because terns forage at the water's surface, they are among those species of birds that are particularly vulnerable to oil spills (Jarvis, 2005). If the feathers become coated with oil, birds lose their ability to repel water and to insulate, and in some instances, lose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water

or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005). The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the loss of roseate tern adults or could lead to decreased nesting success. Oil spills could directly impact roseate tern colonies, as the Ram Island colony was impacted in 2003. However, due to the distance of the proposed action from nesting colonies, oil spills associated with the proposed action are unlikely to impact nesting colonies. Therefore, potential oil spills are anticipated to result in minor adverse impacts to roseate terns.

Cable repair activities would be similar to cable installation activities, but would occur for a short period in a small discrete location. Cable jetting, splicing, and re-jetting would result in minor and temporary increases in suspended sediments and would temporarily disturb benthos. Tern foraging in areas of elevated suspended sediments would be reduced. In both instances the habitat and species would recover and no impacts to roseate terns are anticipated from cable repair activities.

In the event of a monopile collapse, recovery and replacement activities would be similar to decommissioning and construction of a single WTG. A very minor amount of benthic habitat would be disturbed with a short term and localized increase in suspended sediments. Foraging opportunities for terns would be reduced in areas of elevated suspended sediments. Some lubricating fluid would likely leak from the submerged nacelle, but would rapidly disperse given the small quantity involved. However, should a tern dive for fish within this small plume, it could be harmed. There is a low likelihood of this occurrence and low probability of it occurring coincidentally with tern use of the immediate area. Potential impacts to roseate tern in the event of a monopile collapse would therefore be negligible.

The geotechnical investigation methods such as borings would result in negligible effects on benthos and water column characteristics, and these activities would be localized and short term, such that no effects on roseate tern habitat or use of the proposed action area are anticipated, even though much of this activity will be focused on the Horseshoe Shoal area. Geophysical investigation methods, such as sidescan sonar, are even less intrusive and have less habitat altering capabilities, and would, therefore, also have no adverse effects on roseate terns.

New England Cottontail

Small populations of New England cottontails were observed in Barnstable County during a 2000-2003 survey (MDFW, 2003). The upland portion of the underground cable would be located within streets and an existing previously disturbed utility ROW, which would be allowed to revegetate after construction. As such, operation of the underground cable would have negligible impacts on the New England Cottontails. Operation of the WTGs would not have an impact on New England Cottontails as the WTGs would be located far offshore.

Conclusion

The operation of the proposed action is expected to have negligible to minor impacts on T&E species of sea turtles, cetaceans, and the red knot (not yet listed as a T&E species but likely). With respect to the piping plover, the results suggest that collision mortality associated with the proposed action would result in a moderate adverse impact. Although the level of collision mortality associated with the proposed action is anticipated to be low, there is great uncertainty surrounding piping plover use of the proposed action area. However, impacts are not anticipated to jeopardize the Atlantic coast population. With respect to the roseate tern, available data suggest a low level of risk of collision with WTG structures. However, there is uncertainty surrounding the available data. The loss of a single breeding individual would be detrimental to the regional population; therefore, a moderate adverse effect on the roseate tern population is anticipated. This impact, however, is not anticipated to jeopardize the Atlantic coast

population. Consultations with other Federal agencies through the Section 7 ESA and MMPA authorization processes are being conducted in order to confirm the potential for impact, and to confirm the appropriate mitigation measures to minimize potential impacts. Some mitigation measures may include restricting speeds of crew vessels, utilizing trained marine observers, and monitoring underwater acoustical levels. Operation of the underground cable would have negligible impacts on the New England Cottontails as the cable would be installed in streets and an existing ROW.

5.3.3 Socioeconomic Resources and Land Use

Socioeconomic data provided to describe socioeconomic impacts in this section came from the United States census unless otherwise noted (<http://factfinder.census.gov>). The most recent available U.S. Census community data for Barnstable County, Massachusetts and Washington County, Rhode Island came from 2005 estimates, and the most recent available community data for Nantucket County, Dukes County, and Bristol County, Massachusetts came from the 2000 census (U.S. Census, 2005 and U.S. Census, 2000).

There would be few and minor adverse impacts on socioeconomics from the construction and operation of the proposed action. In addition, the proposed action would create jobs and require the purchase of goods and services which could benefit the local and regional economies. The applicant would implement a variety of mitigation measure to address impacts on socioeconomics, in which are discussed in Section 9.0.

5.3.3.1 Urban and Suburban Infrastructure

5.3.3.1.1 Construction/Decommissioning Impacts

Housing

The increase in the number of workers to fill the construction requirements of the proposed action would be modest: 391 full-time jobs during the 27-month period, consisting of 316 for the manufacturing and assembly activities (79 and 237 of which would be from Massachusetts and Rhode Island, respectively) and 75 for construction and installation activities (56 and 19 of which would be from Massachusetts and Rhode Island, respectively). Fewer workers would be required to decommission the proposed action as manufacture and assembly activities would not be required. It is unlikely that this level of employment would require significant migration of workers from outside of the ROI. However, as shown in the existing conditions discussion, the Barnstable County communities of Barnstable and Yarmouth had over 10,000 vacant housing units in the year 2000. Even considering that 89 percent of those vacant units are considered to be seasonal or recreational in nature, there would still be approximately 1,200 housing units available in Barnstable/Yarmouth to accommodate the new residents. As a result, the proposed action would have a negligible impact on housing in the area. In addition, the relatively small number of workers required relative to the population of Barnstable County indicates that workers coming to live in the area during construction and or operation would have a negligible impact on public services (i.e., school system enrollment, water use, sewer demands, emergency services, etc.). The manufacture and assembly operations slated for Quonset, Rhode Island would also have negligible impact on housing and public services given the relatively small number of employees relative to the number of vacant homes in Washington County.

Construction and Manufacturing Industries

The proposed action would have minor impacts on Barnstable and Washington counties through the resulting temporary increase in construction employment, and associated hirings and purchases that

would benefit the construction and manufacturing industries. Refer to Section 5.3.3.2 for further information on economic impacts of the proposed action.

Service Industries

The proposed action would have a minor impact on Barnstable and Washington counties through the temporary increase in demand for service industries during construction (i.e., restaurants, hotels/motel use, hardware, and etc.). Refer to Section 5.3.3.2 for further information on the economic impacts associated with the proposed action.

Waste Disposal and Transit Facilities

The only impact on the Barnstable and Washington county transit facilities would consist of normal work day waste produced by workers who load and unload from boats in Falmouth, and small anticipated small quantities of waste associated with manufacture and assembly in Quonset. This waste disposal would have negligible impact on the area.

Military Activity and Energy Industry

The proposed action is not anticipated to have an effect on the military activity in the area or the energy industry during its construction/decommissioning phase. Refer to discussion of these issues with respect to operational impacts at 5.3.3.7.

Conclusions

The proposed action is expected to have negligible to minor impacts (both positive and negative) during construction/decommissioning on urban and suburban infrastructure (i.e., impacts on housing, construction and manufacturing industries, service industries, waste disposal, and military activity). This is because the construction workforce required is relatively small relative to the work force in the area, and there is ample availability of necessary housing stock and other infrastructure to accommodate the construction activity.

5.3.3.1.2 Operational Impacts

Housing, Construction and Manufacturing Industries, Service Industries, Waste Disposal

Only 50 workers are required to operate and maintain the facility. These workers would access the site via work boats from Falmouth with a maintenance supply vessel coming from New Bedford, Massachusetts. As the level of employment for operations and maintenance is very small, there will be no significant in-migration of workers from outside of the ROI, and impacts on housing, municipal services and infrastructure in the area would be negligible. The proposed action, once in operation would also have a negligible impact on construction and manufacturing industries and service industries due to the small number of workers required and negligible amount of supplies needed to be purchased to run the facility. Once in operation, the facility would generate a negligible amount of solid waste and thus there would be negligible impact with respect to waste disposal requirements.

Military Activity

Concerns have been raised as to how the proposed action would impact the PAVE PAWS early warning radar site. However, in a memo dated March 21, 2004, the U.S. Air Force stated, "Our experts have reviewed the proposed locations for the Wind Power Plant near Cape Cod AFS and have determined it poses no threat to the operation of the PAVE PAWS radar at Cape Cod AFS. At the nearest proposed location, the main radar beam would clear the towers by more than 4,500 ft (1,372 m)" (Refer to Air Force Letter and PAVE PAWS Report in [Appendix E](#)).

Energy Industries

Electrical Generating Capacity, Base and Surge Load Servicing, and Transmission and Relay System

The proposed action represents a new source of generating capacity, which would provide electricity to the region and contribute to the state of Massachusetts's alternative energy portfolio. The electricity from the proposed action would most likely be consumed in the area of the facility (i.e., Cape Cod and the Islands). The proposed action's expected production of 182 MW of electricity in average wind conditions would meet three quarters of the 230 MW average demand of Cape Cod and the Islands, and thus have a substantial positive impact on electrical generating capacity. Negligible impacts are anticipated to base and surge load servicing, as the ISO-NE manages the electrical system to create built in redundancy to address planned and unplanned outages. With respect to transmission cable system impacts, the proposed action has undergone a system impact study by NSTAR and with NSTAR's recommended system upgrades, the proposed action was found to not have an adverse impact on the NEPOOL transmission system and "would improve the Cape area transmission performance particularly when the power plant is producing power" (Tourian, 2005a and Tourian, 2005b).

Conclusion

The proposed action is expected to have a negligible impact during operations on urban and suburban infrastructure (i.e., impacts on housing, construction and manufacturing industries, service industries, waste disposal, and military activity). This is because once the proposed action is in operation it would only require a very small workforce and minor services from the local area, and generate a negligible amount of solid waste. The socioeconomic impact on the energy industry during the operational period would be moderate as the proposed action would result in a substantial contribution to the Commonwealth of Massachusetts' alternative energy portfolio standards.

5.3.3.2 Population and Economics

5.3.3.2.1 Construction/Decommissioning

Impacts on Demographics

Construction would require a small number of workers relative to the population of the area, most of whom would commute to the area (an annual average of 391 full-time jobs during the 27-month period, consisting of 316 for the manufacturing and assembly activities (likely in Quonset Rhode Island), and 75 for construction and installation activities in Barnstable, Massachusetts. As such the proposed action is expected to have a negligible impact on population, as well as other demographic factors including age, race and ethnic composition, and education.

Impacts on Economics

The direct economic impacts in the Region of Impact (ROI) and Massachusetts during manufacture and assembly and construction and installation would consist of the hiring of manufacture, assembly, and construction and installation workers and the purchase of non-labor goods and services. Most of the specialized components of the WTGs, such as the nacelles (i.e., the portion of the WTGs that contain the drive train and the electromotive generating systems), and the rotors would be purchased outside the ROI and very likely outside of Massachusetts ([Report No. 5.3.3-1](#)). Other non-labor goods and services would be bought in Massachusetts or Rhode Island such as concrete, steel, and barge services. The temporary increase in economic activity within the ROI and Massachusetts during the manufacture and assembly and construction and installation phase would be the sum of the: (1) direct economic impacts – hiring of manufacture and assembly and construction and installation workers and purchases of non-labor goods

and services; (2) indirect effects – the additional demands for goods and services, such as replacing inventory, from the industries that sell goods and services directly to the project; and (3) induced effects – the increases in employment, income, etc. generated by the expenditure of disposable income of the newly hired manufacture and assembly and construction and installation workers. The size of the temporary increase in economic activity in the ROI and Massachusetts during manufacture and assembly and construction and installation and operation would depend on the proportion of direct expenditures that take place within these regions. Once the proposed action begins operating, the direct, indirect and induced economic effects would be permanent changes to the state and ROI economies.

Impacts on Employment

Based on the estimate of total person-months of manufacture and assembly and construction and installation phases labor required, it is estimated that a total of 880 person-years of labor would be required during the manufacture, assembly, construction, and installation phase, 711 for manufacture and assembly operations and 169 for construction and installation activities. Assuming a 27-month manufacture and assembly and construction and installation phase, this translates into an annual average of 391 full-time jobs during the 27-month period, consisting of 316 for the manufacturing and assembly activities (79 and 237 of which would be from Massachusetts and Rhode Island, respectively) and 75 for construction and installation activities (56 and 19 of which would be from Massachusetts and Rhode Island, respectively). However, in actuality the manufacture and assembly and construction and installation activities would not be evenly distributed across the manufacture and assembly and construction and installation phases, but would instead peak during year 2 when the maximum temporary employment at the two locations at one time would be about 600 workers. Given the size of the regional manufacture and assembly and construction and installation labor market, and proximity of manufacture and assembly and construction and installation phase operations to both the Boston and Providence Metropolitan Statistical Areas (MSA), it is estimated that 75 percent of the construction and installation workers would be from Massachusetts, while 25 percent of the manufacture and assembly workers would be from Massachusetts. The latter proportion could rise if some or all of the manufacture and assembly operations are conducted in Fall River, Massachusetts, or possibly southeastern Massachusetts.

In addition to the employment benefits described above, the use of the IMPLAN input/output (I/O) model predicts secondary induced employment benefits resulting in an additional 206 to 622 jobs in Massachusetts and an additional 388 to 1,150 jobs in Rhode Island.

Impacts on Income and Wealth

Impacts on income and wealth would come from new wages associated with construction and operation of the proposed action, as well as purchases of equipment and services locally (i.e., non-labor goods and services). It is estimated that total payments of wages and salaries to Massachusetts' residents hired during the manufacture and assembly and construction and installation phase would be about \$17,158,000. In addition, total payments of wages and salaries to Rhode Island residents hired during the manufacture and assembly and construction and installation phase would be about \$32,445,000 over the 27-month period.

In order to estimate the temporary increase in economic activity during the manufacture and assembly and construction and installation phase, the IMPLAN input/output (I/O) model was used for Massachusetts. A discussion of the model is provided in [Report No. 5.3.3-1](#). Approximately 20 percent of the Project's total capital cost of \$700 million would be needed for labor, while 80 percent would be required for non-labor goods and services, including the WTG components; electric equipment including transmission lines; environmental studies and licensing costs; materials; legal service; construction materials, such as steel; and transportation services. The 80 percent share for non-labor costs means that the temporary increase in economic activity in the ROI and Massachusetts, and even in New England,

during the manufacture and assembly and construction and installation-phases would depend primarily on the value of non-labor items purchased within these regions. Based on the location of likely suppliers for the WTG components, it is estimated that between \$150 million and \$250 million in purchases on non-labor goods and services would occur in Massachusetts during the manufacture and assembly and construction and installation phases. Total output in Massachusetts would increase by between \$85.0 million and \$137.4 million annually, while the annual increase in value added would range between \$43.9 million and \$71.0 million ([Report No. 5.3.3-1](#)). Total output in Rhode Island would increase by between \$180.6 million and \$292.0 million annually, while the annual increase in value added would range between \$93.3 million and \$151.0 million. In addition, between \$360 million and \$410 million in purchases on non-labor goods and services would occur in Rhode Island during the manufacture and assembly and construction and installation phases.

Other MA property income, comprised of rent, dividends and interest, and corporate profits, would rise by between \$9.2 million and \$14.8 million annually, producing an annual increase in corporate income taxes of between \$434,900 and \$702,200 if half of the increase were taxable corporate net income. The total increase in corporate income tax revenues during the manufacture and assembly and construction and installation phases could range between \$1.304 million and \$2.106 million.

Other Rhode Island property income, comprised of rent, dividends and interest, and corporate profits, would rise by between \$19.6 million and \$31.5 million annually, producing an annual increase in corporate income taxes of between \$924,000 and \$1.5 million, if half of the increase were taxable corporate net income. The total increase in corporate income tax revenues during the manufacture and assembly and construction and installation phases could range between \$2.8 million and \$4.5 million.

Impacts on Business Activity by Industrial Sector

The main impacts of the proposed action would be on the construction sector as a result of construction related job hires and purchase or lease of offshore construction vessels and equipment and related supplies, as described above. Accordingly, the proposed action is expected to have a minor to moderate positive impact on the construction industry in the area.

Conclusion

The proposed action is expected to have a minor impact on population and economics during its construction/decommissioning. The proposed action would generate construction jobs (391 full time, temporary jobs) and generate revenues resulting from construction jobs (approximately \$50 million to be spent on construction wages) as well as contribute to the economy via the purchase of materials and supplies, and secondary induced economic effects from construction.

5.3.3.2.2 Operational Impacts

Impacts on Demographics and Employment

Approximately 50 workers would be required to maintain the facility during operation, with approximately \$2.64 million spent on salaries. The use of multipliers indicates that as many as another approximately 104 additional indirect jobs may result from the proposed action's operation ([Report No. 5.3.3-1](#)). Impacts from operation on demographics and employment would be negligible given the small number of operational workers relative to the area workforce and size of the economy.

Impacts on Income and Wealth

Once the facility begins operation, an estimate of the annual operation and maintenance (O&M) purchases is approximately \$16 million to maintain the facility. The annual purchase of O&M services

would generate additional permanent increases in economic activity in the ROIs. The combination of the direct, indirect and induced effects as described above would generate an annual increase in Massachusetts' personal income tax revenues of \$346,500, while the rise in corporate income tax revenues would be approximately \$113,900.

It is estimated that the on-land improvements of the transmission line and related facilities located in Barnstable and Yarmouth would have an assessed value of \$26.25 million, and generate annual property tax revenues of \$62,500 in Barnstable and \$217,200 in Yarmouth. Approximately 25 percent of the onshore transmission facilities would be located in Barnstable and 75 percent would be located in Yarmouth.

The resultant employment and tax revenues would have a minor to moderate positive impact on the tax revenues for the Towns of Barnstable and Yarmouth, but negligible impact when measured against the larger economy of Massachusetts. The resultant employment and tax revenues associated with the maintenance operation out of New Bedford would have a negligible impact when measured against the local economy.

Impacts on Property Values

Currently available information does not support any firm conclusion with respect to the wind facility's effect on property values. A potential purchaser of a piece of property would make an offer to purchase based on his or her own values and sense of aesthetics, which may or may not be affected positively or negatively by the proposed action. A U.S. Government funded study published in 2003 entitled "The Effect of Wind Development on Local Property Values" examined 25,000 real estate transactions within five miles (8.0 km) of ten of the larger wind farms built in the United States between 1998 and 2001. The study found no adverse effect of views of wind turbines on nearby real estate values. Similarly, in 2006 a study entitled "Impacts of Windmill Visibility on Property Values in Madison County, New York" found no negative impact on real estate values from a wind farm there. Thus, there is evidence that some wind projects may not affect property values, though impacts are likely to vary on a proposed action specific basis, and based on the person or persons own interpretation of whether they like or dislike the wind farm.

Impacts on Business Activity by Industrial Sector

Impacts on the ROI during operations of the proposed action would be limited to employment of a small crew for maintenance of the proposed action. This small amount of new employees would have a negligible impact on overall business activity and the local economy.

Public Perception

Many comments were received both in favor and against the proposed action. A recent contingent evaluation study (Seltzer, 2006) concluded that in general people were willing to pay \$164.41 per year for a policy that would allow Nantucket Sound to be used for the proposed action. The study attempted to measure peoples attitudes toward the development and included the presentation of visual simulations to help show what the proposed action would look like. Thus, the study attempted to incorporate peoples' attitudes to aesthetic impacts as well as other factors. Yet, contingent valuation studies can be prone to errors depending on how they are carried out, and one review of the study concluded that it was not reliable because the methodology did not follow professional standards for contingent valuation studies (Ward and Niemi, 2007).

Health Impacts

The proposed action would have negligible impacts on public health as its operation would comply with environmental standards to protect public health and the facility would not generate air or water pollution that could affect public health.

Tourism and Recreation

Comments were received on the MMS public notice that the proposed action would have a negative impact on tourism and recreation due to visual impacts, and other comments were received that the proposed action would have a positive impact on tourism and recreation due to the desire of persons to visit the WTGs via boat tours and the potential for additional recreational fishing opportunities as a result of the added hard bottom structure associated with the monopiles. It is difficult to predict the economic impact of the proposed action on tourism and recreation. However, as discussed in the visual section at 5.3.3.4.2, the visual impacts of the proposed action are unlikely to affect the viability of the recreational areas upon which tourism is strongly based (i.e., the general public is not expected to stop using the recreational areas around Nantucket Sound, Cape Cod and the Islands for summer enjoyment including activities like sitting on the beach, viewing the expanse of Nantucket Sound, swimming, fishing, sailing, and other recreational activities). In general, direct impacts to recreation from the WTGs to recreation such as boating and fishing are minor and discussed further in Section 5.3.3.6.

Conclusion

The proposed action is expected to have a minor impact on population and economics during its operation through its operation and maintenance expenditures, tax payments, and the small increase in jobs related to operation. The applicant has provided further economic benefits including payments to the Town of Yarmouth of \$350,000 annually or \$7,000,000 over twenty years of operation for the on land portion of the interconnection line. Discussion of any mitigation measures proposed by the applicant or being required by MMS is provided in Section 9.0.

5.3.3.3 Environmental Justice

A socioeconomic analysis was conducted and showed that the counties within the ROI (Barnstable County, Nantucket County, Dukes County, Washington County, and Bristol County) had a lower percent minorities than the rest of the State, and a lower percentage of people living under the poverty level than the rest of the state and thus the ROI in a broad sense is not within an environmental justice population (refer to Section 4.3.3.3.1).

Although the statistics for Barnstable County as a whole indicate that the area is not an environmental justice area of concern, the Massachusetts Environmental Justice GIS Map shows that there is a smaller census block group in and around Hyannis, Massachusetts that is an Environmental Justice Population (refer to [Figure 4.3.3-1](#)). The on-land cable portion of the proposed action is located outside of this area, but the existing substation where the cable connects is located within this area. The location of the existing substation is outside the population center of Hyannis and work at the substation is expected to be minor with negligible environmental impact.

As discussed in Section 4.3.3, Wampanoag tribes are located in the ROI in the Town of Aquinnah (Gay Head) and in the village of Mashpee, Massachusetts and constitute an environmental justice population. These are discussed below.

5.3.3.3.1 Construction/Decommissioning Impacts

The onshore cable portion of the proposed action would be constructed in streets and in an existing ROW, and thus would result in negligible to minor environmental impacts. Only the area of the cable interconnection with an existing substation is within a State GIS designated environmental justice population area, and the work at this location would be minor and at an existing substation. Construction work is not located near Wampanoag tribal lands and would not affect these areas, though economic benefits including construction jobs, and economic revenues (refer to Section 5.3.3.2.1) could have a minor positive impact on environmental justice populations including the Wampanoag's.

Conclusion

Construction/decommissioning impacts are not expected to result in a disproportionately high adverse environmental and/or health impact on low income or minority populations in the ROI.

5.3.3.3.2 Operational Impacts

The potential visual impact of the proposed action on the Wampanoag Tribe of Gay Head/Aquinnah was raised as a concern during government to government consultations about the proposed action between the MMS and the Tribal Historic Preservation Office.

To address the concern of visual impacts from this location, three line-of-sight profiles were created along transects originating at the approximate highest ground elevation in Gay Head/Aquinnah and extending northeasterly to the maximum height of the nearest proposed WTG along the profile. The three profiles were oriented to represent potential views of the landscape that a person standing at the Gay Head location would see when facing toward the left, middle and right (south side) of the WTG array. The locations of the three profiles (or transects) are shown on [Figure 5.3.3-1](#). Profiles A, B and C are presented in [Figures 5.3.3-2](#) through [5.3.3-4](#).

The transect lines on each figure are color coded to indicate areas along each profile that would be visible (green) to the person at Gay Head, based only upon screening afforded by the specific Martha's Vineyard topography along that profile. This type of line-of-sight profile does not take into account the additional screening effects of vegetation or intervening structures, if present. Areas not visible to the viewer, again based upon topography only, are indicated in red. As shown in the figures, the profiles indicate that no portions of the offshore turbines in the array would be visible to the viewers at Gay Head/Aquinnah.

The land associated with the Wampanoag tribe of Mashpee is well inland from the coast line, and given the wooded vegetation, and fairly level topography, there would not be a view from this location.

Due to the distances of these two Indian tribal lands from the offshore proposed action site, (Gay Head Wampanoag Tribal Land is 24 miles [38.6 km] away and Mashpee Wampanoag Tribal Land is more than 10 miles [16.1 km] away) no other source of environmental impacts on these areas is associated with the proposed action. During government to government consultations between MMS and the tribes, there was concern expressed that the proposed action would interfere with the tribes' subsistence fishing. However, the proposed action would not preclude fishing from the area around the proposed action and the spacing of the turbines would not have a significant affect on fish populations or trawling and other types of fishing activities at the site of the proposed action. Therefore, environmental justice impacts are expected to be negligible.

Conclusion

In conclusion, operational impacts are not expected to result in a disproportionately high adverse environmental and/or health impact on low income or minority populations in the ROI.

5.3.3.4 Visual Resources

5.3.3.4.1 Construction/Decommissioning Impacts

Visual impacts during construction and decommissioning would be limited to vessels working out in Nantucket Sound and traveling back and forth between Barnstable (for worker staging/supplies) and Quonset, Rhode Island (for manufacturing/assembly). Equipment for installation and decommissioning of the monopiles would require the use of jack-up barges and cranes. The installation of the monopiles is expected to take 8 months and installation of the WTGs is expected to take approximately 9 months. A crane and barge would also be required for near shore dredging work associated with construction of the exit hole associated with the horizontal directional drill operation for the landfall of the offshore transmission cable system. Utility line construction equipment would also be required on land to install the onshore transmission cable system. The onshore portion of the work is expected to take approximately 10 months. Decommissioning is expected to require similar equipment and time requirements. The larger construction/decommissioning vessels would be a visible feature within the area viewshed, more so from boats in proximity to Horseshoe Shoals than from land. And while most construction is expected to occur during daylight hours, these vessels would have nighttime lights in accordance with USCG regulations. In addition, during dawn and dusk periods, particularly on cloudy days, work lights may be required for worker safety as well as to improve visibility on construction vessels. Work lights are generally downward directed lights and would not typically be oriented horizontally where their visibility on shore would be increased.

Conclusion

Visual Impacts associated with construction/decommissioning would be limited to construction equipment and partially built structures depending on phase of construction. Such impacts in general would be minor as construction equipment would only be in use temporarily during the construction and the decommissioning period.

5.3.3.4.2 Operational Impacts

Major Visual Components of the Proposed Action

The proposed action is a 468 MW offshore wind-powered electric generating facility, with associated offshore and onshore transmission cable system. As currently proposed, the proposed action includes 130 3.6 MW GE offshore wind turbines, each mounted on 257 ft tall tubular steel monopile towers. The 3-bladed rotors have a diameter of approximately 364 ft (111 m) and would reach a maximum height of approximately 440 ft (134.1 m) above sea level. Each tower has a service platform located approximately 30 ft (9.1 m) above the water surface. The turbines are arranged in a grid pattern with an approximate separation distance of 0.3 to 0.5 miles (0.6 to 0.9 km).

The 50 perimeter WTGs and the eight WTGs located directly adjacent to the ESP would be lit at night. Every corner would be marked with a medium intensity red light (similar in intensity to FAA L-864) at night with no more than 1.7 miles (2.8 km) between medium intensity lights. The remaining perimeter WTG would be marked with low intensity light fixtures (similar in intensity to FAA L-810), visible from approximately 1.15 miles (1.9 km). The eight interior WTGs adjacent to the ESP would have the low intensity lights. All other interior WTGs would not be lit by red lights at night. The red lights on the perimeter WTGs would be synchronized to flash in unison rather than randomly as

previously proposed. The red lighting would flash on for one second, with no lighting for two seconds, for a total of 20 FPM. This lighting design complies with the new FAA guidelines. The FAA lights would be visible from land.

Three USCG amber navigation warning lights would be also installed on the access platforms of each tower approximately 32 ft (9.8 m) above the water's surface. The USCG access platform lights would not be visible from land.

Other visible components of the proposed action include a 20 x 26 ft service platform, which is topped with an FAA aviation warning light. The ESP is an enclosed structure, 100 ft (30.5 m) tall, by 200 ft (61 m) wide, by 100 ft (30.5 m) long, which houses transformers and electrical switching equipment. It is sided with metal panels and supported by cross-braced tubular steel legs, approximately 40 ft (12.2 m) above the water surface. No FAA lights are required on the ESP; USCG lighting would be installed, as described above. Helicopter warning lights would be remotely activated on the helipad as needed. All built components of the facility are proposed to be painted a marine gray color.

The turbine array would be located 13.8 miles (22.2 km) from Nantucket, 9 miles (14.5 km) from Edgartown, 9.3 miles (15.0 km) from Oak Bluffs, 5.6 miles (9.0 km) from Cotuit, 6.5 miles (10.5 km) from Craigsville Beach, and 5.2 miles (8.4 km) from Point Gammon.

Visual Impacts to Historic Structures - Assessment of Effects

The ACHP regulations at 36 CFR 800.5(a) require the MMS to apply the criteria of adverse effect to historic properties within the APEs, which are discussed in Section 4.3.4 and summarized in [Table 5.3.3-1](#). The visual simulation views also are noted in Section 4.3.4 and in [Table 4.3.4-1](#). Three categories of effect are considered for each property identified: adverse effect, no adverse effect, and no effect.

According to 36 CFR Part 800.5(a)(1), “an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association.” Accordingly, for an effect to be considered adverse, it must alter a qualifying characteristic of the property, or “diminish the integrity of the property’s significant historic features” (36 CFR Part 800.5(a)(2)(v)).

A finding of no adverse effect is made when there is an effect on the property due to the undertaking, but that visual change in setting does not diminish the property’s integrity, and therefore does not negatively affect its historic significance and hence its eligibility for listing in the National Register. In such cases, the change in the setting created by the undertaking does not diminish the integrity of the property’s significant historic features that make it eligible for the National Register.

A finding of no effect is made when a clear view of the undertaking from historic properties within the undertaking’s APE is not present.

The ocean is an important component of the setting for all of the historic properties within the APE, since many of them were designed as seasonal resort communities to take advantage of the coastal setting, or light houses, designed to warn watercraft of hazards. However, being able to view the WTGs from these properties does not rise to the level of altering a qualifying characteristic of these historic properties in most cases. While the view from some vantage points within these properties may be altered under certain conditions, in many cases this alteration is not such that the property’s significant historic features have suffered a loss of integrity. In such cases, there is no adverse effect. In cases where the setting of the property is impacted in such a way as to diminish the integrity of the property’s significant historic

features, the proposed action is considered to have an adverse effect on the historic property. [Table 5.3.3-1](#) summarizes the assessment of effects considerations for the properties located within the proposed action's APE.

Conclusions on Visual Impacts to Historic Structures during Operation

Based on an analysis of visual effects undertaken in the visual impact assessment, which included both daytime and nighttime visual simulations, MMS concludes that the proposed action would have an adverse effect on one National Historic Landmark (NHL) property (the Kennedy Compound) and two individual historic properties (Wianno Club and Cape Poge Lighthouse). The visual alteration that the WTGs would entail to the setting of these properties, particularly the relatively close, unobstructed views to the WTGs from nearly any vantage point within the properties, would diminish the integrity of these properties' significant historic features.

The proposed action would have no adverse effect on one NHL (Nantucket Historic District), four historic districts (Cotuit Historic District, Wianno Historic District, Hyannis Port Historic District, and Edgartown Village Historic District), and seven individual properties (Col. Charles Codman Estate, Monomoy Point Lighthouse, West Chop Light Station, East Chop Lighthouse, Tucker Cottage, Edgartown Harbor Lighthouse, and Nantucket/Great Point Lighthouse).

The proposed action would have no effect on two NHL properties (the Martha's Vineyard Campground Historic District/Wesleyan Grove-Martha's Vineyard Camp Meeting Association NHL), one historic district (Wouldiam Street Historic District), and four individual properties (the Nobska Point Light Station, the Ritter House, the Arcade, and the Oak Bluffs Christian Union Chapel). These properties are generally within the visual APE defined as 300 ft (91.4 m) from the shoreline, but are screened from water views by intervening structures, vegetation and/or topography, or the view of the WTGs is nearly invisible on the horizon.

At present, the MMS is continuing the Section 106 process, and would continue consultation per 36 CFR 800 to evaluate strategies to mitigate adverse effects and to consider appropriate mitigation measures to minimize impacts.

Visual Resource Impacts to Recreational Areas (Non Historical)

The visual impacts from development of the proposed action on onshore recreational resources would be essentially the same as those described for onshore historic sites. Refer to simulation photographs in [Figures 5.3.3-5](#) and [5.3.3-6](#). The same daytime and nighttime visual simulations are used to assess the degree of these impacts.

Nantucket Sound beaches along the southern shore of Cape Cod in the Towns of Falmouth, Mashpee, Barnstable, Yarmouth, Dennis, Harwich, and Chatham would have open views of the visible structures. The visual simulations indicate the greatest proposed action visibility would be between Cotuit (VP 5 at 6.4 miles [10.3 km] distance) and Hyannis Port (VP 8 at 6.2 miles [10 km] distant), including Craigville (VP 7 at 7.0 miles [11.3 km] distant). Applying these distances to areas not simulated west of Cotuit and east of Hyannis Port, visual impacts on Cape Cod are expected to be greatest from Great Neck in Mashpee to the mouth of Bass River at the Yarmouth-Dennis town line.

Open views would be available from other recreational resources along the south side of Cape Cod, including the Shining Sea Bike Path in Falmouth, the New Seabury Golf Club's Ocean Course, the Hyannis Port Golf Club, and shorefront conservation areas (see [Table 4.3.4-2](#) and [Figure 5.3.3-5](#)).

Falmouth beachgoers would experience views between those simulated at Nobska (VP 1) and Cotuit (VP 5), depending on their respective distances to the wind turbine array. VP 5 approximates views at Mashpee beaches, including New Seabury and Popponesset, east through Oyster Harbors. Users of the small Town Beach at the eastern end of Sea View Avenue would experience similar views to VP 6. No views toward the water and the proposed action were found in the Village of Osterville. The Craigville simulation (VP 7) approximates proposed action visibility from the Craigville beaches, Long Beach in Centerville, and West Hyannis Port. Because this viewpoint was taken on a bluff at approximate elevation 35 ft (10.7 m) above sea level, the simulation provides somewhat more visibility of the built proposed action than would be experienced at sea level on the beaches.

Views from VP 8 are similar to what would be experienced at Kalmus Park Beach, the large public beach in Hyannis, smaller area public beaches, and the outer areas of Hyannis Harbor. Views from points to the east out to Chatham (VP 26) would be similar, although the structures would be increasingly smaller and less noticeable in the field of view as one proceeds east along the south shore of the Cape and away from the wind turbine array.

On Martha's Vineyard, open views of the proposed action would be available along the beaches and in the immediate vicinity from East Chop at Oak Bluffs south to the Edgartown Lighthouse. VP 21 is similar to what would be experienced under similar conditions at east-facing beaches between Oak Bluffs and Edgartown, as well as portions of Felix Neck Wildlife Sanctuary in Edgartown. Open views would be available from the beaches at Cape Poge on Chappaquiddick Island (VP 19).

On Nantucket, open but distant views of the proposed action would be available from beaches along the entire north shore of Nantucket Island east to Great Point.

Visibility of the proposed action would be affected during the high use season by the degree of haze and fog that develops over the water. According to the U.S. Coast Pilot 2 (NOAA, 2004) for Nantucket Sound "the characteristic advection fog, formed by warm air over cool water, is most frequent from April through August. At this time visibilities drop below 2 miles (3.2 km) 10 to 18 percent of the time. In addition the Coast Pilot provides a climatological table for Nantucket Island which shows that the number of days with fog averages 200 days annually. Thus, there would be a substantial portion of time (at least 10 to 18 percent in the summer months) where the proposed action would not be visible from shorelines.

In addition to the photographic simulations referenced above, daytime photographic renderings from each of the six viewpoints most distant from the proposed action were assessed using two generic waterfront photographs, to try to heighten the contrast and visibility of the WTGs against the sky. These are termed renderings (and each viewpoint is labeled with "B") to differentiate them from the site-specific photographs used to generate the simulations. The six viewpoints are listed below; photo-renderings are shown from each viewpoint respectively in [Figure 5.3.3-7](#), sheets 1 through 6:

- **Viewpoint 1B:** Nobska Lighthouse, Woods Hole in Falmouth, Cape Cod;
- **Viewpoint 26B:** Monomoy Lighthouse, Monomoy Island, Chatham, Cape Cod;
- **Viewpoint 20B:** Lighthouse Beach in Edgartown, Martha's Vineyard;
- **Viewpoint 22B:** Nantucket Cliffs, Nantucket;
- **Viewpoint 23B:** Great Point, Nantucket; and
- **Viewpoint 24B:** Tuckernuck Island, Nantucket.

To develop each rendering, one of the two generic waterfront photographs were selected for each viewpoint, based upon the specific orientation of views toward the proposed action at that viewpoint, and the applicable sun angle that would heighten the visibility of the WTGs to the greatest degree. Both generic photographs were shot into the midday sun, resulting in a light-colored washed-out sky above the horizon. Under these conditions, depending on the orientation of each specific viewpoint toward the wind turbine array, WTGs on the horizon would either be cast into shadow or be strongly front-lit. These lighting conditions heighten the contrast of the WTGs against the sky. The WTGs are front-lit in views from north-facing viewpoints at Nantucket Cliffs and Tuckernuck Island because the sun angles at these locations would rarely back-light the WTGs. The WTGs are shown as back-lit in the remaining far-field viewpoints.

The distances range from almost 9 miles (14.5 km) in Edgartown to approximately 14 miles (22.5 km) at Nobska Lighthouse, Nantucket Cliffs, and Monomoy Lighthouse. Because the WTGs are relatively slim light-colored structures, they are difficult to see at these distances.

Visual impacts at very long distances (15 and 18.8 miles [24.1 and 30.3 km]) were also assessed. These represent distant views of the proposed action that would be experienced by viewers at some shoreline recreational resources, such as beaches and dock areas. For a listing of specific resources at these distances see [Table 4.3.4-2](#) and [Figure 4.3.4-3](#). Both of these photo-renderings represent potential daytime views of the proposed action under clear sky conditions from distant shoreline recreational areas. A visual Simulations has been prepared that shows the proposed action at a distance of 15 miles (24 km), and represents daytime views that would be experienced from south-facing Cape Cod beaches in Dennis Port and Harwich Port, near the border between the two towns (see Sheet 1 of [Figure 5.3.3-8](#)). An additional simulation has been prepared that shows the proposed action at a distance of 18.8 miles (30.3 km), representing daytime views that would be experienced from south-facing beaches in the vicinity of East Harwich and Chatham, and west-facing beaches on the northern portions of Monomoy Island (see Sheet 2 of [Figure 5.3.3-8](#)). The long viewing distances results in the facility structures looking very small, as a result of perspective, atmospheric clarity, and the curvature of the earth's surface.

Visual Impacts from Boats in Close Proximity

The turbines would obviously appear much larger while viewed close up by boaters traveling or recreating near the site. As such, the turbines would be much larger relative to surrounding features and would be more visible under hazy or foggy weather conditions at these distances. [Figures 5.3.3-9](#) and [5.3.3-10](#) shows similar sized features from the Nysted Project in the Baltic Sea off of Denmark. Nysted consists of 72 turbines (2.2 MW Siemens), which are 226 ft high (69 m to hub) with 270 ft (82.4 m) rotors (361 ft) (110.2 m overall height) versus the proposed action which has an overall height of 440 ft (134.1 m). The Nysted turbines are spaced in a grid 2,789 ft by 1,575 ft (850 m by 480 m [or 10.4 rotor diameters by 5.8 rotor diameters]). The proposed action has a spacing of 3,281 ft by 2,064 ft (1,000 m by 629 m). Though these are not the same dimensions as the proposed action, the photographs approximate the type of visual impact a viewer is likely to see up close to the wind turbine array.

Conclusions on Visual Impacts to Recreational Areas During Operation

The proposed action represents a large manmade feature in the natural landscape of Nantucket Sound that would be viewed by many people in numerous shoreline areas used for recreation that surround Nantucket Sound. Conclusions as to the significance of visual impact on the people using recreational areas are difficult, as the interpretation of visual impacts is subjective. Many comment letters were received expressing opinions that the proposed action would cause an unacceptable visual impact, and many other comment letters were received expressing views that the proposed action would be beautiful

to look at.⁵ Visual impacts are important from Cape Cod locations as the proposed action would change the views out to Nantucket Sound from a mostly natural ocean setting, to a setting with manmade features present across a substantial portion of the horizon. Thus, the proposed action would have moderate visual impacts to recreational resources, with major visual impact limited to boaters that are transiting near or within Horseshoe Shoals since they would be located close to the structures. However, the visual impacts are unlikely to affect the viability of the recreational areas (i.e., the general public is not expected to stop using the recreational areas around Nantucket Sound for summer enjoyment including sitting on the beach, viewing the expanse of Nantucket Sound, swimming, fishing, sailing, and other recreational activities). In addition, minimization of visual impacts has occurred through minimization of nighttime lighting, color choice, and facility layout (refer to Section 9.0 for further information on visual impact mitigation).

5.3.3.5 Cultural Resources

5.3.3.5.1 Construction/Decommissioning Impacts

Impacts on Onshore Cultural Resources

Historic

Historic Archaeological Resources

Based on the results of the terrestrial archaeological intensive survey, no significant historic archaeological resources have been identified within the Project's APE for ground disturbance along the onshore transmission cable system route. Therefore, the proposed action is expected to have a negligible impact on onshore historic archaeological sites during construction/decommissioning.

Above-Ground Historic Resources

No known or designated historic structures or districts have been identified within the Project's APE for ground disturbance on land, which consists of paved roadway and cleared NSTAR ROW. There would be no physical impacts to onshore historic structures and districts due to construction/decommissioning. Therefore, impacts are negligible along this portion of the site of the proposed action for historic properties.

Visual impacts to historic properties associated with construction/decommissioning are minor as they are temporary and limited to construction equipment and partially built turbine structures depending on the phase of construction.

Prehistoric

Based on the results of the terrestrial archaeological intensive survey, no significant prehistoric archaeological resources have been identified within the Project's APE for ground disturbance along the onshore transmission cable system route. Thus, construction/decommissioning impacts to prehistoric resources would be negligible.

⁵ A recent contingent evaluation study (Seltzer, 2006) assessed among other things, people's opinions of what the Project would look like. This was performed by showing individuals photo simulations of the Project, and then asking their opinion as to how they think it would look. Overall, the largest group of responders had a neutral opinion toward visual impacts, though a much larger percentage of responders from Cape Cod thought the project would be ugly compared to those questioned who lived in other areas of Massachusetts. Yet, contingent valuation studies can be prone to errors depending on how they are carried out, and one review of the study concluded that this study was not reliable, because the methodology did not follow professional standards for contingent valuation studies (Ward and Niemi, 2007).

Impacts on Offshore Archaeological Resources

Historic

Three targets with moderate probability of representing historic shipwrecks were identified in the vicinity of Horseshoe Shoal. The MMS would require that these three potential shipwreck locations be avoided by all bottom-disturbing activities during all proposed action construction, maintenance and decommissioning activities; therefore, construction/decommissioning impacts are expected to be negligible. If avoidance is not possible, then MMS would require groundtruthing of targets in consultation with MHC and MBUAR. The MBUAR and MHC concurred with these recommendations (see letters dated May 11, 2004 and May 19, 2004, respectively).

Prehistoric

The archaeological analysis of the subbottom profiler and vibracore data collected within the area of the proposed action identified organic material interpreted as paleosols (ancient land surfaces) in limited areas within the easternmost portion of the WTG array. The wind turbine array has been modified to avoid the areas where intact paleosols have been identified. No other areas having a high probability for prehistoric site occurrence were identified from marine remote sensing data collected within the site of the proposed action; therefore, impacts from construction/decommissioning are expected to be negligible.

Conclusion

Based on cultural resource surveys conducted to date and through continued coordination with MBUAR and MHC and compliance with any other future requests for further analysis and or mitigation, the construction/decommissioning impacts are expected to be minor. Should any archaeological resources be encountered during construction/decommissioning, operations would be halted immediately within the area of the discovery and the discovery would be reported to the MMS Regional Director. Mitigation being considered at this time includes avoiding identified sensitive areas, and the development of an Unanticipated Discovery of Cultural Resources and Human Remains Plan.

5.3.3.5.2 Operational Impacts

The Advisory Council on Historic Preservation regulations at 36 CFR 800.5(a) require the MMS to apply the criteria of adverse effect to historic properties within the area of potential effects, which are discussed in Section 4.3.4 and summarized in [Table 5.3.3-1](#). Three categories of effect are considered for each property identified: adverse effect, no adverse effect, and no effect. [Table 5.3.3-1](#) shows that out of the 20 historic places assessed, 3 were identified as having an adverse effect, 12 no adverse effect, and 5 no effect. See Section 5.3.3.4.2 for definitions of these categories.

Operational impacts on cultural resources will be limited to the visual effects of the wind turbine array on onshore Above-Ground Historic Resources. The ocean is an important component of the setting for all of the historic properties within the APE, since many of them were designed as seasonal resort communities to take advantage of the coastal setting, or light houses, designed to warn watercraft of hazards. However, being able to view the WTGs from these properties does not rise to the level of altering a qualifying characteristic of these historic properties in most cases. While the view from some vantage points within these properties may be altered under certain conditions, in many cases this alteration is not such that the property's significant historic features have suffered a loss of integrity. In such cases, there is no adverse effect. In cases where the setting of the property is impacted in such a way as to diminish the integrity of the property's significant historic features, the proposed action is considered to have an adverse effect on the historic property. [Table 5.3.3-1](#) summarizes the assessment of effects considerations for the properties located within the Project's APE.

Conclusions on Visual Impacts to Historic Structures during Operation

See conclusions to Section 5.3.3.4.2 for this assessment. In conclusion, the visual alteration to the historic Nantucket Sound setting caused by the WTGs and related structures would constitute an alteration of the character, setting and viewshed of some historic properties, and MMS would continue to conduct consultation per 36 CFR 800.

5.3.3.6 Recreation and Tourism

This section addresses impacts to recreational activities other than visual impacts. Refer to Section 5.3.3.4 for a discussion of visual impacts to recreational areas.

5.3.3.6.1 Construction /Decommissioning Impacts

Impacts on Tourism

The proposed action is located far offshore and its construction and associated post lease G&G field investigation are not expected to affect tourism, the use of recreational parks, and use of the ocean for recreational activities (Refer to Section 4.3.6 for a presentation of recreational activities of the area). The construction of the onshore cable system would take place during the off season to minimize disruption of the tourist season. Accordingly, impacts to tourism are expected to be negligible during construction. Decommissioning impacts are also expected to be similar to construction impacts; therefore they would also be negligible.

Impacts on Shoreline Activities and Birdwatching

During construction and decommissioning, the noise and activity associated with installation of the onshore cable may temporarily disturb birds that inhabit the area, though this work would occur during the winter months when many migrating birds have vacated the area. In addition, given the altered and developed nature of the shoreline cable crossing location, it is unlikely that this is a high use area for birdwatching or beach recreation. Thus, construction and decommissioning impacts on birdwatching and shoreline use would be negligible.

Impacts on Recreational Boating

Details of the marine-based construction and post lease G&G field investigation would be closely coordinated with the USCG and local Harbor Pilots. During construction and decommissioning, it is likely that temporary vessel access restrictions in the immediate vicinity of construction operations may be required to protect public safety. These restrictions, however, would be limited to small sections of the area of the proposed action as the cable embedment process is completed or around WTG or ESP installation. Notice to Mariners would be posted and called on a daily basis or at intervals required by the USCG. The construction vessels would display the appropriate day shapes and/or lighting, and would monitor VHF Ch. 13 and Ch. 16 during operations. Thus, impacts on recreational boating during construction, the post lease G&G field investigation, and decommissioning would be minor.

Impacts to Recreational Fishing

During construction and decommissioning, it is likely that temporary vessel access restrictions in the immediate vicinity of construction operations may be required to protect public safety. These restrictions, however, would be limited to small sections of the area of the proposed action as the cable embedment process is completed or around WTG or ESP installation. Notice to Mariners would be posted and called on a daily basis or at intervals required by the USCG. The construction vessels would display the appropriate day shapes and/or lighting, and would monitor VHF Ch. 13 and Ch. 16 during operations.

In general, the proposed action would have a minor and localized impact on fishing during construction and decommissioning, as a result of temporary avoidance of disturbed habitat by fish species during these activities. Accordingly, impacts to recreational fishing during operation are expected to be minor.

Conclusion

The proposed action is expected to have a minor impact on recreation during construction/decommissioning. This is primarily because most of the construction and decommissioning activities would be located far from shore and are not expected to significantly impact avian or fish populations (see Section 5.3.2.4 for Avian Impacts and Section 5.3.2.7 for Fishery impacts) or access to these areas by fisherman, birdwatchers, and tourists.

5.3.3.6.2 Operational Impacts

Impacts on Tourism

The proposed action is located far offshore and is not expected to affect tourism and use of recreational parks and use of the ocean for recreational activities. Therefore, there would be negligible impacts to tourism during proposed action operation. Refer to Section 4.3.4 for discussion of how visual impacts could affect use of the area. In fact, there are undocumented reports of increased tourism after some European wind energy projects were constructed.

Impacts on Birdwatching

Since the proposed action would be a minimum of 4.8 miles (7.7 km) from shore and the cable portion of the proposed action onshore would be underground, there would be negligible impacts on recreational birding which primarily occurs along the shorelines of Cape Cod and the Islands.

Impacts on Recreational Boating

The proposed action would impact the Figawi sail boat race that occurs between Hyannis and Nantucket and back every year on Memorial Day. This impact would be moderate, but can be overcome by selecting a race course that does not pass through the site of the proposed action - the overlay of historic race courses shows the race can still be run without crossing the area of the proposed action (refer to [Figure 4.4.3-2](#)).

In addition, sail boaters, and to a lesser extent motor boaters, would be faced with a moderate navigational impact as the proposed action would in general make offshore cruising more difficult as the operator would have to take more care to avoid the structures. Navigation in the area would be more difficult during fog conditions and/or at nighttime. Discussions with boaters revealed that many recreational boaters avoid the shallower portions of Horseshoe Shoal, particularly under wavier conditions when the shoals make the seas more choppy. Refer to Section 5.3.4.3 for a complete discussion of recreational boating impacts and to Section 9.6 for navigational impact mitigation. In some instances boaters may benefit from the WTGs since they represent aids to navigation and could allow someone to navigate through the wind turbine array. Overall, operational impacts on recreational boating would be minor.

Impacts on Recreational Fishing

The majority of recreational anglers surveyed in the MRFSS program from the three counties surrounding Nantucket Sound reported hook and line as gear type used and most recreational anglers reported fishing from a private/personal or rented boat as the type or mode of recreational fishing. Since the WTGs within the array would be spaced 0.39 by 0.63 (629 by 1,000 m) apart, the physical presence of

these structures should not interfere with recreational fishing activity, including maneuvering of recreational vessels (see Section 5.3.2.7 for more detail) or using recreational fishing gear. The presence of the WTG monopile foundations may enhance recreational fishing for certain species, such as Atlantic cod, black sea bass, cunner, tautog, and scup (see Section 5.1.5.11); such phenomena have been documented at oil rigs in the Gulf of Mexico. The proposed action should not affect other modes of recreational fishing, such as fishing from shore since the shoreline would be drilled under and shoreline areas would remain undisturbed.

Although it appears that charter/party boat companies do not frequently visit Horseshoe Shoal, the operation of the proposed action should not interfere with any recreational fishing conducted from charter or party boats in the area of the proposed action, and once constructed, may, in fact, enhance recreational fishing for certain species discussed above.

The NOAA Fisheries Recreational VTR data for charter and party boats indicated that the portion of fishing reported to occur within the area of the proposed action on Horseshoe Shoal only accounted for approximately 2.8 percent of the total federally-reportable charter and party boats over an eleven year period. A survey of commercial and recreational activities ([Report No. 4.2.5-6](#)) indicated that some recreational fishing takes place on Horseshoe Shoal. More specifically, 25 percent of the recreational fishermen surveyed, reported fishing on Horseshoe Shoal some portion of the time.

In summary, the proposed action is not expected to interfere with recreational fishing during operation, as it would not prohibit access or use of existing recreational fishing areas and may in fact enhance fishing as a result of the WTG foundations. Accordingly, impacts to recreational fishing during operation are expected to be minor.

Impacts from Unplanned and Accidental Events

Should a cable failure occur, a Cable Repair Plan would be implemented (see Section 2.4.6 for a description of this plan). Impacts from cable repairs would include localized turbidity around the work area, localized and temporary bottom disturbance from anchoring the work vessels, noise impacts associated with the repair work, and emissions from the work vessels. Overall impacts from cable repair on recreation and tourism would be negligible.

Should an oil spill occur, impacts on recreation and tourism would depend on the location, magnitude, and sea conditions at the time of the spill. The applicant would be required to operate the facilities with an approved OSRP that would be designed to maximize the containment and clean-up of spilled substances. However, should an oil spill reach shoreline areas, there would be a temporary reduction in beach recreation and tourism because of the unpleasant conditions that would be present on the beaches.

Conclusion

The proposed action would have a minor impact on recreation during operation as it is not expected to significantly impact avian or fish populations (see Section 5.3.2.4 for Avian Impacts and Section 5.3.2.7 for Fishery impacts) or access to these areas by fisherman, birdwatchers and tourists. Measures would be implemented to help aid in safe use of the area by recreational boaters such as informing boaters of the proposed action activities in Notice to Mariners and providing the necessary as-built coordinates to allow plotting of the facilities on NOAA nautical charts.

With respect to visual impacts on recreational areas, the proposed action represents a large manmade feature in the natural landscape of Nantucket Sound that would be viewed by many people in numerous

shoreline areas used for recreation that surround Nantucket Sound. Conclusions as to the significance of visual impact on the people using recreational areas are provided in Section 5.3.3.4.

5.3.3.7 Competing Uses in the Vicinity of the Proposed Action

5.3.3.7.1 Construction/Decommissioning Impacts

Other Pipelines and Cables

Although a portion of the proposed offshore transmission cable system would cross over one of the existing submarine cable systems already servicing Nantucket Island from Barnstable (Lewis Bay), the effects of this crossing are expected to be negligible since the crossing is over the top of the existing cable and would likely use some form of manufactured “bridging” that would involve a very narrow linear crossing area where the cables would intersect. This is a routine installation technique that results in temporary and localized effects on the seabed and prevents damage to the other utility line. There are also cables that run from Falmouth out to Martha’s Vineyard, though these are well away from the proposed action location and would not be affected. There are no known bottom-founded structures in the vicinity of the site (other than structures associated with coastal marinas, which are located far from the proposed action area), and there are no pipelines in close vicinity to the proposed action area. The onshore portion of the transmission cable system can be constructed with due care to avoid affecting any existing utilities that may be present in the streets, road shoulders, or the NSTAR ROW.

Navigation Features

Maintenance dredging of nearby channels, if initiated at the same time as the jet plow installation of the cable system, could result in additional concurrent uses of the waterway. However, such concurrent uses would only be temporary, and the area affected at any one time during construction of the proposed action is relatively small and would not have a negative impact on navigation. The applicant and the party undertaking the dredging would have to schedule activities and vessel locations so as not to interfere with each others operations.

Sand Mining and Mineral Extraction

There are no sand mining projects proposed within the area of the proposed action or during the scheduled timeframe of the proposed action construction activities. There would not be any space use conflicts between the proposed action installation and sand mining projects. Furthermore, because there is currently a moratorium on oil and gas leasing along the Atlantic coast, these types of projects are unlikely in the timeframe before or during the installation of the proposed action. Therefore, no space conflicts would occur.

Commercial Fishing and Boating

The proposed action would be constructed in phases, and marine traffic would only be restricted in the immediate vicinity of ongoing construction activities for protection of public safety. The applicant estimates that only a few WTG locations would be worked on at any one time. However, cable jetting operations require that fixed gear not be placed in any cable segment schedule for jetting, since the gear could be damaged or lost. Since this would occur in ever changing locations, only small portions of the available fishing area would be restricted at any one time during cable jetting. The remaining areas of the proposed action would be open to unrestricted navigational access. Information updates including daily broadcasts on marine channel 16 would be provided during construction activities. See Section 9.6 for more navigational impact mitigation.

Recreational Fishing and Boating

The proposed action would be constructed in phases, and marine traffic would only be restricted in the immediate vicinity of ongoing construction activities (estimated to be one to two WTG locations at any one time and along the cable jetting vessel) for protection of public safety. The remaining areas of the proposed action would be open to unrestricted navigational access. Information updates including daily broadcasts on marine channel 16 would be provided during construction activities. See Section 9.6 for more navigational impact mitigation.

Military Training

The MMR conducts military training in the vicinity of the proposed action area. They have confirmed that the proposed action would not impact such training (see letter received from the base, in [Appendix E](#)).

Other OCS Alternative Energy

Currently there is only one tidal energy project proposed in the general area of the proposed action. This is proposed by Cape and Islands Tidal Energy Company and is located in Vineyard Sound. As the tidal energy project is more than 10 miles (16.1 km) away from the proposed action area, it would not result in a competing use of the area. The wind project in Buzzard's Bay proposed by Patriot Renewables, LLC would compete economically with the proposed action, but it is sited more than 17 miles (27.4 km) from the site of the proposed action and would not represent a competing use to the affected area of Nantucket Sound.

Onshore Activities

The construction and decommissioning of the proposed action would only cause temporary use conflicts due to the construction equipment during the installation of the transmission cable system through existing roadways. This conflict would be minor and temporary and would be minimized through implementation of a Traffic Management Plan.

Removal of Monopiles-Decommissioning

See Section 2.5 for a detailed description of the decommissioning process. Impacts from decommissioning would be similar to those during construction, but the end result would be the removal of navigation obstructions and return of the site of the proposed action to near pre-project conditions. All impacts from decommissioning to competing uses would be temporary and localized and would be negligible.

Conclusion

Overall competing use impacts of the proposed action construction and decommissioning on other existing and proposed uses would generally be minor because of the limited activity that currently takes place or is proposed at the site of the proposed action, the limited ways in which the proposed action would impact those activities, and the proposed mitigation measures.

5.3.3.7.2 Operational Impacts

Other Pipelines and Cables

There are currently no proposed pipeline or cable installation projects proposed within the area of the proposed action in the near future. The existing cables are not within Horseshoe Shoal, therefore there are no space use conflicts.

Navigation Features

Most commercial traffic, such as cruise ships and ferries which have deep drafts (13 to 20 ft [4 to 6.1 m]), are restricted by their draft and for safety reasons to the navigation channels marked by the USCG. Accordingly, cruise and ferry ships do not navigate out of the Main Channel and would not be expected to come close to the WTGs. It is also highly unlikely that any dredging projects would be allowed within the area of the proposed action, but if any were proposed, the presence of the WTGs would require restrictions. The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage ground, known as “Anchorage I.” Floats or buoys for marking anchors or moorings in place are allowed in this area. Minor restrictions on anchoring would be caused by the monopile structures and the ESP. Overall, competing use impacts on navigational features would be negligible with respect to the Project’s operation.

Sand Mining and Mineral Extraction

The monopiles and offshore cables of the proposed action would make future plans of sand mining within Horseshoe Shoal and along cable routes difficult, though there are many other locations to choose from that would be available for sand mining. In the event that the moratorium on oil and gas leasing in the Atlantic is lifted, future leasing within Horseshoe Shoal would be restricted by operation of the proposed action.

Commercial Fishing and Boating

Space use conflicts would occur between commercial fishing and the proposed action due to the establishment of the WTGs and ESP. Small areas would be precluded from commercial fisheries while these structures are in place during operation. (Space requirements are discussed in Section 2.2.) However, the 0.39 miles by 0.63 miles (0.63 by 1.0 km) spacing between the WTGs is far wider than the widths of existing channels in the Nantucket Sound area routinely used by commercial vessels (as shown in Table 4.2 of [Report No. 4.4.3-1](#)). Specifically, the existing channel widths in the Nantucket Sound area range from 240 ft in Hyannis Harbor to 700 ft in the Cleveland Ledge Channel. In comparison, the WTG spacing distance is 2,066 ft by 3,281 ft. Mariners are currently able to safely navigate commercial and recreational vessels through these commonly accepted narrow corridors. Therefore, the minimum spacing of 2,066 ft (629.9 m) would not present conditions more restrictive to navigation than presently exist in these channels. Fishing vessels would still be able to trawl within the wind turbine array. However, their operators would have to take the presence of the WTGs into account as they steer their courses. The WTGs on the east side of the array have been relocated to the northwest corner of the array in response to comments received from commercial fishermen who use mobile gear stating that the deep water to the east of Horseshoe Shoal is where they work most (Revised Navigational Risk Assessment, 2006).

The 115 kV offshore transmission cable system is also buried at sufficient depth and would be monitored to avoid upheaval or unburial, such that they would not affect trawling or anchoring in the area. Conflicts with navigation would be mitigated by USCG terms and conditions, such as lighting on the proposed action structures, boating restrictions, and annotated charts with private navigation aids that would be added to the existing network of navigation aids maintained by the USCG.

Analyses and observations of the area of the proposed action indicate Nantucket Shoals is not used by boaters extensively like other near shore areas. Large vessels and commercial vessels would continue to use the channels in the area for safety reasons, and are, thus, not likely to navigate into the area of the proposed action. As such, interruption or change in most vessel traffic patterns as a result of the proposed action would be negligible.

Recreational Fishing and Boating

Space use conflicts would also occur between recreational fishing and boating and the proposed action due to the operation of the Project. Space requirements for proposed action operation are discussed in Section 2.2. Any restrictions that are necessary to protect the safety of mariners would be implemented in coordination with the USCG. Recreational fisherman would also experience aesthetic impacts while fishing within the shoals and in the vicinity of the proposed action during operation. Recreational boaters/fishermen in the waters of Nantucket Sound would experience open views of the visible components of the proposed action during clear days and nights. See Section 5.3.3.6.2 for more recreational fishing impacts. Competing uses associated with recreational motor and sail boating are discussed in detail in the Navigation Section at Section 5.3.4.3.

Military Training

The MMR has indicated that the proposed action would not impact operation of the proposed action (see letter in [Appendix E](#)).

Onshore Activities

The transmission cable system onshore could interfere with or prevent future utility development within the onshore area of the proposed action, but typically this merely requires careful design of new facilities, since more developed areas in and near bigger cities have streets and ROWs with many more buried utilities than would exist along the proposed action route. Therefore, only minor impacts would occur to future uses.

Cable Repair

Should a cable failure occur, a Cable Repair Plan would be implemented (see Section 2.4.6 for a description of this plan). Cable repair requires the addition of a loop of spliced in cable, adding a very short distance of the seafloor that is occupied by the cable system, and would prevent future or other bottom disturbing construction or installations in the area. Overall impacts from cable repair on competing uses would be negligible.

Conclusion

Overall competing use impacts of the proposed action operation on other existing and proposed uses would generally be minor except as noted above (i.e., the Figawi Race) because of the limited activity that currently takes place or is proposed at the site of the proposed action, the limited ways in which the proposed action would impact those activities, and the mitigation measures that would be implemented. Some minimization measures include the spacing between the WTGs, the depth of burial of the cable system, and the navigation aids created by the presence of the WTGs and ESP, which minimizes navigational impacts. The onshore portion of the proposed action is proposed within existing roadways and ROWs and would primarily compete with the installation of other utilities, which can be accommodated with adequate designs.

5.3.4 Navigation and Transportation

5.3.4.1 Overland Transportation

5.3.4.1.1 Construction/Decommissioning Impacts

Impacts on overland transportation would be negligible due to the relatively small number of workers used for construction and operation relative to the surrounding population. Both Barnstable, (the worker staging area) and Quonset Rhode Island (Equipment manufacturing/assembly/loading area), have

roadways in the area to provide access as needed. The majority of activity including transporting material for the construction of the proposed action would take place on barges from a deep water port in Quonset, Rhode Island.

Transportation impacts associated with the installation of onshore transmission cable system facilities would be temporary in nature. Some combination of road detours or lane closures would be required for cable installation within roadways. A detailed Traffic Management Plan would be prepared in coordination with the Town of Barnstable, Town of Yarmouth, and MassHighway to address road detour and/or temporary closure procedures as well as maintenance of access to abutting businesses and residences. This Traffic Management Plan would also include provisions for coordination with driveway access in construction areas.

Conclusion

Overland transportation impacts of the construction of the proposed action would be minor due to the relatively small number of construction workers and would be mitigated via use of a Traffic Management Plan. Mitigation being considered at this time includes the installation of the onshore cable system would occur outside of the height of the summer tourist season to minimize any vehicular disruption; trenchless technologies would be used at major intersections and railroad crossings in order keep traffic disruptions to a minimum. A more detailed discussion of mitigation is provided in Section 9.0.

5.3.4.1.2 Operational Impacts

Operational impacts on overland transportation would be limited to a very small number of workers associated with the operation and maintenance of the facilities. Maintenance workers would access the site via work boats from Falmouth, and the maintenance supply vessel would access the site from New Bedford. As the number of workers required for maintenance and operation would be very small, the overland transportation impacts during operation would be negligible.

5.3.4.2 Airport Facilities and Aviation Traffic

5.3.4.2.1 Construction/Decommissioning Impacts

The FAA has studied the impact of the proposed action on the airport facilities and aviation traffic in the area and has concluded that the original configuration of the proposed action would “have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities” (see correspondence from FAA in [Appendix E](#)). As a result of the reconfiguration of the WTG’s, design changes that had increased rotor height, and the release of new lighting guidelines by the FAA, the applicant had initiated new Aeronautical Surveys by the FAA for each of the proposed turbine locations. This subsequent determination is pending. Based on the above FAA finding, and assuming a subsequent finding from FAA of no substantial adverse effect on aircraft or on operation of air navigation facilities, the potential impacts during construction would start out as negligible and increase to minor as more and more WTGs are erected. During decommissioning, impacts would start out as minor and drop to negligible as more and more WTGs are removed.

5.3.4.2.2 Operational Impacts

As noted above, the FAA has studied the impact of the proposed action on the airport facilities and aviation traffic in the area and has concluded that the original configuration of the proposed action would “have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities” (see correspondence from FAA in [Appendix E](#)). The FAA is reviewing the proposed action modifications and would issue another determination.

In March of 2005 the FAA made public a draft report for marking and lighting of wind turbine farms that was developed jointly with the DOE following 4 years of research and flight evaluations of existing wind farms. The FAA formally issued the guidance document in final form in November 2005 (Development of Obstruction Lighting Standards for Wind turbine Farms; DOT/FAA/AR-TN05/50).

As a result of the new FAA guidance, the following revised lighting plan is proposed for operation of the facility:

- Each Perimeter WTG nacelle would be lighted with one red flashing FAA light fixture equipped with automatic bulb changers.
- Medium intensity lanterns (FAA L-864) would be used at corners/points of direction change with intervals of no more than 1.5 miles (2.4 km) between similar intensity fixtures.
- The balance of perimeter WTG's would be marked with low intensity lanterns (similar in intensity to the FAA L-810 with visibility to approximately 1.15 miles).
- The eight turbines adjacent to the ESP would each have one L-810 flashing red fixture.
- The balance of the interior turbines would not have FAA lighting.
- The turbines would be painted off-white (5 percent grey) and no daytime white lighting would be used.
- All FAA lighting would be synchronized to flash as one at a rate of 20 FPM.

These changes would result in the proposed action design being compliant with FAA guidance while minimizing adverse affects on other environmental resources that occur as a result of WTG and ESP lighting.

As described in Section 4.4.2, within the site of the proposed action, aviators are responsible for safe flight under Visual Flight Rules (VFR). While the WTGs do represent obstacles to flight near the ocean's surface, they would be marked on navigation charts and if unsure of safety, aviators would fly over or around the WTG array. This is consistent with the FAA findings.

Conclusion

Given the above lighting plan, and assuming a subsequent finding from FAA of no substantial adverse effect on aircraft or on operation of air navigation facilities, impacts to aviation are expected to be minor.

5.3.4.3 Port Facilities

5.3.4.3.1 Construction/Decommissioning Impacts

With respect to construction and decommissioning impacts on navigational activity, the proposed action would be constructed in phases, and marine traffic would only be restricted in the immediate vicinity of ongoing construction and decommissioning activities (estimated to be one to two WTG locations at any one time or short segments of the cable system) for protection of public safety. The remaining areas of the proposed action would be open to unrestricted navigational access. The WTG that is closest to the Main Channel is approximately 1,190 ft (362.8 m) from the charted Main Channel edge and approximately 6,900 ft (2103.7 m) east of the Main Channel's narrowest point. The work vessels used to construct or decommission the WTGs are approximately 400 ft (122 m) long. This leaves ample

room for vessels to transit past any ongoing work. These work vessels would not need to occupy or block the Main Channel during construction and decommissioning. Therefore, no restrictions or closures of the Main Channel to transiting vessels are anticipated. The USCG routinely deconflicts waterways and channels around marine construction activities, and it is anticipated that such procedures could be implemented in Nantucket during construction and decommissioning.

The proposed action would not prohibit vessels from entering or operating in the area of the proposed action and the applicant does not intend to establish exclusionary zones. In addition, the WTGs would be constructed in a grid pattern (minimum 0.39 miles by 0.63 miles [0.63 by 1.0 km] spacing), which would help mariners by allowing them to navigate a relatively straight course through the WTG array. In addition, the 0.39 miles by 0.63 miles spacing between the WTGs is far wider than the widths of existing navigation channels in the Nantucket Sound area routinely used by commercial vessels (i.e., Cape Cod Canal is 480 ft [146.3 m] wide), and thus ample room would be provided for navigation (see [Figure 5.3.4-1](#)).

Conclusion on Construction and Decommissioning Impacts

Given the level of navigational impacts discussed above, and proposed mitigation including the lighting of monopiles, lighting of construction vessels, spacing and placement of monopiles to allow for safe navigation, the impacts to vessels navigating in channels during construction and decommissioning would be minor. Note that in the later stages of construction or the early stages of decommissioning, when most of the monopiles are in place, navigational impacts are likely to be the same as those described below in the section on impacts during operations. The USCG has provided Terms and Conditions for the proposed action to help ensure navigational safety of the area during construction and operation (see [Appendix E](#)).

5.3.4.3.2 Operational Impacts

Ship, Container and Bulk Oil Handling Facilities

There are no ship and container handling facilities in ports surrounding Nantucket Sound. Containers are carried on SSA ferries as part of a tractor trailer rig and are on and off loaded by driving the rig onto or off the vessel on its vehicle deck. There are bulk liquid facilities at Vineyard Haven and Nantucket for offloading petroleum products that are transported by the T/V Great Gull and other barges. The largest ship handling facilities are those owned and operated by the SSA and the oil transfer facilities in Vineyard Haven and Nantucket. The referenced facilities are located in harbors far away from the proposed action and as such the proposed action would have negligible impacts on these facilities. Impacts to ferries, oil transport barges and other vessels are discussed below.

Navigational Channels

Due to the characteristics of the waterway, most commercial traffic is restricted by its draft and for safety reasons to the navigation channels marked by the USCG. The area is transected by two named channels but only one major channel that provides a route for medium sized vessels to transit in an east/west direction in an area north of the Nantucket Shoals.

The separation distance between the WTGs and the Main Channel is slightly less than that of the Middelgrunden Wind Farm from a shipping channel in Copenhagen, Denmark. The Middelgrunden Wind Farm is located approximately 1,500 ft (0.29 miles M [0.46 km]) from this shipping channel. According to the Royal Danish Administration of Navigation and Hydrography, between 25,000 and 30,000 ships navigate this shipping channel annually, and there have been no reported incidents of collision of ships in this channel with the WTGs (Nielsen, 2005).

In addition, the proposed action has been reconfigured to further distance WTGs from the referenced channels. Several of the southernmost turbines shown in the 2003 Navigational Risk Assessment have been relocated from sites adjacent to the Main Channel to sites in the northwestern portion of Horseshoe Shoal; an area with significantly less deep draft commercial vessel traffic. This relocation further reduces the chance for deep draft vessel interaction, as the nearest WTG is now sited approximately 1,190 ft (0.23 miles [0.37 km]) from the charted edge of the Main Channel, which represents a separation distance increase of approximately 515 ft (0.09 miles[0.15 km]) from that presented in the applicant's 2003 report.

Cruise Ship Traffic

As discussed above, most commercial traffic, such as cruise ships which have deep drafts (13 to 20 ft [4 to 6.1 m]), are restricted by their draft and for safety reasons to the navigation channels marked by the USCG. Accordingly, cruise ships do not navigate out of the Main Channel, and would not be expected to come close to the WTGs. As a result, navigational impacts to cruise ships are expected to be negligible.

Ferry Operations

Ferry operations between Martha's Vineyard and Woods Hole should not be affected by the proposed action as the ferries come no closer than 8 miles (13.0 km) from the closest WGT for the SSA vessels calling on Oak Bluffs and over 9.2 miles (14.8 km) for vessels calling at Vineyard Haven.

Vessels traveling between Hyannis and Woods Hole to Martha's Vineyard use the North Channel from the Hyannis Sea Buoy (HH) through Red Nun 8 and Green Can 7 to Green Can 11 and pass to the north of Horseshoe Shoals. The closest point of approach to a WGT on the north side of Horseshoe Shoal is in the channel gate between Red Nun 8 and Green Can 7, and is approximately 0.86 miles (1.4 km) away.

The SSA vessels traveling from Hyannis to Nantucket proceed to the Hyannis Sea Buoy (HH) and set on a course of 154°True passing Bishop and Clerks Red Nun 4 to Port, over Broken Ground and Red #2 continuing to Green #17 on the Main Channel. Horseshoe Shoal is passed down the starboard side. The closest point of approach this vessel track takes to a WGT is approximately 1.7 miles (2.8 km) in the vicinity of Half Moon Shoal. Based on SSA published vessel schedules and transit times, it is unlikely that a meeting situation between two SSA ferries would be encountered in the immediate vicinity of a WGT.

Ferries using the Main Channel for transits between Woods Hole and Nantucket and between Martha's Vineyard and Nantucket approach the WGT at a distance of approximately 0.69 miles (1.1 km) from a track line at the center of the channel in the vicinity of Red #20 of the Main Channel. Vessels in a meeting situation with a 500 yard closest point of approach between them could potentially come within 0.4 to .46 miles (0.65 to 0.74 km) from the nearest WGT at the Red #20 and Green #21 Gate.

The SSA stated in a letter to USCG Sector Providence that its captains often use tacking maneuvers on the route between Hyannis and Nantucket to provide a smoother ride and to protect vehicles and cargo on board the ferries. This tacking maneuver is postulated to be a course line set at an angle to the sea to allow the vessel to pitch less in a head sea or to wallow less in a trough. Rather than follow a straight course of 154°True, the master varies his course up to 45 degrees either side of the base course. Actual tacking maneuvers by the SSA have not been documented. However, it appears based on channel width and the WTG array offset from channels, that there is ample room for navigation, and the proposed navigational mitigation would make any such impacts minor.

Marinas and Recreational Boating

Marinas are located along shoreline areas far from the proposed action, and as such, would not be affected by the WTGs. The proposed action would impact the Figawi sail boat race that occurs between Hyannis and Nantucket and back every year on Memorial Day. This impact would be moderate, but can be overcome by selecting a race course that does not pass through the site of the proposed action - the overlay of historic race courses shows the race can still be run without crossing the area of the proposed action (refer to [Figure 4.4.3-2](#)).

The current proposed action design specifications call for a WTG rotor to clear sailing vessels no larger than 47 ft (14.3 m) (mast heights 72 ft [22 m] or less). Barring any custom design, as a general rule, sailing vessels greater than 47 ft (14.3 m) in length would not be able to clear a rotor due to their mast heights exceeding 72 ft (22 m). Sail boats of this size would tend to stay away from the area due to the shallow shoals and inherent risks of navigating, such a large sailing vessel through the WTG array. This would be a moderate impact and would be mitigated as follows: If a vessel with a mast or structure height of 72 ft (22 m) or higher is in distress and drifting toward a WTG, the WTGs in the path of the vessel can be remotely shut down by the applicant upon receipt of a request to do so by the USCG. Shutting down the WTG prior to the distressed vessel coming close to a WTG would eliminate the potential of the vessel being struck by the rotating blade.

Finally, sail boaters, and to a lesser extent motor boaters, would be faced with a minor to moderate navigational impact, depending on the type of navigational impact on board, as the proposed action would in general make offshore cruising more difficult as the operator would have to take more care to avoid the structures. This would be more difficult during fog conditions or at nighttime.

Commercial Fishing

Commercial fishing is not expected to be significantly impacted. The offshore cables are buried at sufficient depth such that they would not be affected to the extent trawling takes place in the area or by anchoring in the area (A detailed assessment of anchor impacts is provided in the *Revised Navigational Risk Assessment* – ([Report No. 4.4.3-1](#)).⁶ In addition, the proposed action WTGs are spaced far apart in a straight grid to allow trawlers to navigate in a relatively straight line without danger of colliding with the WTGs. With respect to proposed action mitigation, the revision to the turbine array has resulted in the relocation of a number of WTGs away from the from deeper water areas along the eastern portion of the array to minimize or avoid impacts to commercial fisherman who use mobile gear in this area. The increased separation distance of the turbine array from this area provides a potential positive impact to marine navigation for commercial fishing when compared to the original turbine array configuration.

Search and Rescue (SAR)

The proposed action is within an area between 41°27' N to 41°32' N and 70°14' W to 70°23' W (a “SAR Study Area” of approximately 46.4 square miles [116 km²]). Analysis of historical SAR data provided by the USCG indicates that there are 94 sortie records in the data within this USCG SAR Study Area. Multiple sorties occurred at the same date and time in many locations in the data, resulting in a total of 50 incidents in the area of the proposed action. These incidents occurred between November 1991 and August 2002. The majority of the incidents occurred during daylight hours, with only 22 percent occurring between sunset and sunrise. The majority (81 percent) of the responses to SAR

⁶ There is generally little commercial use of anchorages in the area of the proposed action given the dangerous shoal waters and the accessibility of nearby harbors. The Steamship Authority’s vessels, work vessels, and cruise ships could potentially anchor in the area, although the likelihood is slim. These types of vessels typically have anchors that would penetrate 3 to 4.5 ft in and around the area of the proposed action. This is 1.5 to 3 ft less than the minimum 6 ft burial depth proposed for the inner array cables and submarine cable interconnection.

incidents in the SAR Study Area were made by sea. Aircraft were only used to respond to 4 incidents in the SAR Study Area during the 10-year study period. In some cases, multiple responders were required for an incident.

The proposed action is not anticipated to have negative effects on SAR operations in the area of Horseshoe Shoal. The wide turbine spacing would allow those USCG vessels that are not restricted by the existing water depths to continue to operate within the proposed action area. A representative of USCG Air Station Cape Cod indicated that USCG aircraft would be able to operate in and around the area of the proposed action during periods of good visibility, including nighttime operations (USCG, 2003). The representative indicated that aircraft would not likely conduct operations in the area during times of very low cloud ceilings or dense fog, and a vessel-based response would be more appropriate during those times. The USCG aircraft responding to incidents south of the area of the proposed action would either cruise over or around the WTG array, depending on their destination, and this would not adversely affect USCG response times (USCG, 2003).

The presence of the WTGs within the proposed action area, as well as some of their design features, can benefit SAR operations in the area, as discussed below.

- Each WTG would be clearly marked with an alphanumeric designation on the tower, and the USCG, other local, states, and Federal agencies would be provided with a plan showing designations for each WTG. This designation could be used by mariners in distress as a primary or additional positional reference to provide to the USCG when requesting assistance. By receiving these additional easily readable positional references from mariners in distress, the USCG would be able to focus its efforts on rescuing the mariner in distress rather than spending time in the search.
- Each WTG would have a safety line with a loop at the end from the platform to the water. While tying up to WTGs under normal circumstances would be prohibited, mariners in distress would be allowed to tie up to a WTG either by their own choice or by direction from the USCG, until assistance arrives. In addition, persons in the water could swim to the WTG and hold on to the safety line until assistance arrives.
- The WTG grid pattern and spacing would provide the USCG with the opportunity to establish air and sea search grids that align with the turbines if desired. The WTGs would provide points of reference to USCG personnel as SAR missions are performed.
- During proposed action operations, proposed action work vessels in the proposed action would be conducting routine monitoring and maintenance during daylight hours when the seas are less than 6 ft (1.8 m). These work vessels would be able to assist vessels in distress within the proposed action during these times, and would do so either upon receipt of a request for assistance from the vessel or from the USCG. Proposed action personnel on these vessels would be trained in first aid, CPR, and marine survival skills.

Ice

There do not appear to be historical records on the frequency of sea ice events in Nantucket Sound. The National Weather Service in Taunton, Massachusetts stated they do not keep sea ice records, and are not aware of other agencies that maintain such records for Nantucket Sound (NWS, 2003). The *Coast Pilot* makes one passing reference to ice in Nantucket Sound, when it mentions that northerly winds keep the north shore of the Sound free from drift ice (NOAA, 1994); this further suggests that sea ice events in Nantucket Sound do not occur with any regular frequency. Anecdotal evidence suggests that large-scale

sea ice events have occurred less frequently in Nantucket Sound during the past decade. However, sea ice was common in Nantucket Sound during the winters of 2002 to 2003, and 2003 to 2004. According to ferry operators and others interviewed, ice does not appear to affect navigation in Nantucket Sound with any regular frequency. The WTG monopiles have been designed to withstand the forces of up to six (6) inch thick ice floes impacting the monopile.

Although rotor blades would have a slick surface for aerodynamic efficiency, which would allow most ice to slide off prior to any significant buildup, ice may collect on the WTG structure and blades under certain meteorological conditions. This ice usually takes the form of a thin sheet as it attaches to WTG surfaces. Temporary icing of a rotor blade would activate vibration sensors causing turbine shutdown in order to prevent rotor damage or hazard to proposed action maintenance staff or others from falling ice. Conditions conducive to icing would be evaluated by continuous monitoring of meteorological conditions and by monitoring the WTGs remotely (via camera). If conditions warrant, manual shut down of the WTGs experiencing icing conditions would be initiated. The ice would remain attached until meteorological conditions allow it to melt. If the WTG is no longer operating due to icing, the melting ice would break apart into fragments in the same manner as ice falls off building. The risk of ice fragments being thrown from a turning rotor and causing injury is relatively small when one considers the unique weather conditions required for icing and the fact that icing can only occur during the winter months when navigation activity within the site of the proposed action is likely reduced to a few vessels other than the maintenance vessels. Accordingly, impacts from icing are expected to be negligible.

Vessel Impact Analysis

An impact analysis was performed to assess the structural ability of the WTGs to withstand vessel strikes ([Report No. 4.4.3-1](#)). The analysis concluded that a drifting vessel of the size that frequents the area of the proposed action would not result in collapse of a WTG after impact. However, it was concluded that the impact of a moving vessel, equal to or larger than a 1,200 metric ton barge, with a WTG could possibly result in collapse of a WTG after impact, and that the impacting vessel and persons onboard could sustain some form of injury. However, such large vessels do not typically operate in the area of Horseshoe Shoals because of inadequate water depths and safety considerations. As well, the mitigation described above reduces the likelihood of such an event from ever occurring.

Conclusion

Impacts related to navigation are expected to be minor with the exception of impacts to sailing vessels which are expected to be moderate in the event of loss of vessel control. Impacts would be minimized through mitigation including lighting of monopiles (see Section 9.0), spacing and placement of monopiles to allow for safe navigation, and the WTG array setback from boating channels. The USCG has provided Terms and Conditions for the proposed action to help ensure navigational safety of the area during construction and operation (These are summarized in section 9.6.2 and attached in [Appendix E](#)). A more detailed discussion of mitigation is provided in Section 9.0.

5.3.4.4 Communications

5.3.4.4.1 Construction/Decommissioning Impacts

There are two primary communication issues that arise with regard to the construction of large-scale wind turbine projects: (1) Temporary use of “itinerant” and shared repeater frequencies, point-to-point frequencies, and cell phones by construction crews can possibly cause some amount of radio traffic congestion for other users, especially cell phone users; and (2) Use of construction cranes that could temporarily cause local re-radiation of Low Frequency and Medium Frequency services. These issues are discussed below.

Temporary Use of Radios by Construction Crews

Temporary use of radios by construction crews is seldom an issue because there is very little (although not zero) overlap of private radio frequencies (RFs) with public safety and marine frequency bands (the primary exception is the use of private frequencies by some public entities in cases where public safety frequencies are completely subscribed). The private frequencies that are generally used by construction crews are in the VHF and UHF ranges, and, if properly licensed and maintained, operate completely outside of the marine and public safety bands.

Of primary concern are the emergency calling frequencies, which require the highest degree of protection, as follows:

(1) VHF

- Channel 16 (156.800 MHz) - Distress, safety and calling
- Channel 13 (156.650 MHz) – Inter-ship navigation (bridge-to-bridge)
- Channel 70 (156.525 MHz) - Digital Selective Calling

(2) HF: HF radiotelephone emergency channel 2182 kHz

Private use of the HF frequencies is virtually nonexistent today, because it represents obsolete technology and the antennas are insufficiently compact. It is far more likely that construction crews would use VHF, UHF, or Super High Frequency (SHF) frequencies. Among these three frequency ranges, marine applications are primarily centered on the VHF channels. Besides protection of the emergency channels listed above, additional frequencies are assigned and licensed by the FCC to marine service on a basis that protects them from interference (refer to [Table 5.3.4-1](#)). Temporary use of radios by construction crews can have minor impact on radio communications to these frequencies. Avoidance of these frequencies would minimize impact.

Temporary Use of Construction Cranes by Construction Crews

Construction cranes would have a local effect primarily upon low and high RFs. This effect would manifest itself as a distortion of the RF around the crane, which would have a magnitude similar to the wind turbine itself. Since the crane would be relatively close to the turbine position, the differential effect is not expected to be significant with respect to long range navigation (LORAN) broadcast, and HF emergency frequencies.

Conclusion

In conclusion, communication issues resulting from construction and decommissioning of the proposed action would be minor and easily mitigated by avoiding close approach and by utilizing properly licensed and maintained two-way radios.

5.3.4.4.2 Operational Impacts

Wind turbines can have impacts on many types of communications. This section addresses the operational impacts with respect to microwave, HF, cell phone, satellite, TV, AM, FM, and LORAN communications.

Frequently, wind turbines located near RF transmitters or receivers can cause one or more modes of RF impact, such as aperture blockage (shadowing, usually caused by the support structure), time-varying occultation (usually caused by the turbine fan), and multipath reception (usually caused by RF “scattering” of the primary signal).

The turbines have an electrical conductor that runs the length of the leading edge of each blade, and which is grounded through the hub connection. As the turbine rotates through an RF field, it results in a time-varying signal that is displaced in time from the primary (incident) signal. Depending upon the sensitivity of the RF receiver, the frequency involved and the strength of the radiated power, it is possible in some cases that interference could be caused to other services.

Impacts associated with Various Communication Devices

Using industry standard procedures and FCC databases for microwave links, a search was conducted to determine the presence of existing microwave paths crossing the subject property, as well as other RF facilities within or adjacent to the identified area. The turbine layout plan was then prepared as an overlay, showing microwave blackout areas and nearby land mobile (2-way) radio facilities. The resulting maps are shown in [Figures 5.3.4-2](#) and [5.3.4-3](#). With respect to broadcast facilities, pertinent TV, FM and AM stations were listed and the estimated impact to broadcast consumers in the turbine area was assessed.

The following is a list of communication devices and information on how they may be affected. [Table 5.3.4-2](#) shows a summary of the frequencies of interest with respect to possible adverse effects due to the proposed action.

Entertainment Satellite

Entertainment satellite equipment depends on a stationary earth receiver. If a turbine blade, which has a metal component, turns in front of the receiver dish, the received video can “freeze” or “pixelate” (turn into small squares). This impact would be minor and only apply to a vessel using an entertainment satellite system in very close proximity to the turbines.

Entertainment Broadcasting Services (AM, FM and TV stations)

The frequency used for entertainment broadcasting services is below 1 GHz. For shipboard analog receivers, such as traditional TV, FM and AM, the main effect of a turbine blade would be a small rhythmic variation in the transmitted signal strength that is generally compensated for by the receiver’s automatic gain control, even when the receiver is quite close to the turbine. The exception to this statement would be if the particular station was quite distant (depending upon the type of service) or used a directional antenna that reduced coverage over the water. It should be noted that some ships occasionally use AM broadcast stations for positioning. The use of these signals is relatively imprecise and may be subject to a small amount of additional uncertainty when near the turbines. For digital entertainment signals, the indicated effects can be slightly greater; in these cases, the 0.5 miles (800-m) limit may be appropriate. While these entertainment style services can be disrupted within the turbine impact area, mitigation should generally not be required because the influence area is small, being primarily confined to a radius of 0.5 miles (800 m) from each turbine (it is true that there is a small residual effect outside of this distance, but it is generally considered to be insignificant). Based upon FCC database information, no significant impact is expected to the reception of FM or AM broadcast facilities. Direct over-the-air reception of full-power TV stations is unlikely in and near the turbine area, being limited to TV sets mounted in watercraft, and due to the paucity of nearby TV transmitters.

Non-emergency Ship-to-Shore Communications (cellular communications and VHF frequencies in the marine band)

To a first order approximation, the same blockage (more precisely, “re-radiation”) effect is experienced by both the receiver and the transmitter of non-emergency ship-to-shore communications, and can disrupt both sides of a conversation or data transfer. A small additional impact is due to antenna

aperture blockage of the very large turbine support structures. These effects are primarily limited to paths that pass through the turning blades within approximately 0.5 miles (800 m) of shipboard radios, even though the angles of interception are lower on the horizon compared to the satellite services. Ship-to-ship communications are subject to the same impacts as the ship-to-shore services, as long as either of the ships is within the impact zone (the subject antenna should be approximately 0.5 miles [800 m] from the nearest turbine).

Navigation and Positioning Services

Navigation and positioning services can be critical to ship safety. They include satellite GPS services, LORAN, and shipboard radar. The satellite GPS signals are subject to the same types of anomalies that affect entertainment satellites. Precise timing is the hallmark of accurate positioning, and the receivers used to calculate the ship's position can be "fooled" by the "multipath signals" created if it is "looking" through a wind turbine. For most ships, the 800 m radius should provide sufficient clearance (subtended angle above the horizon of less than 15 degrees).

The situation for long-range radar requires special consideration. Radar operates by sending out a RF "pulse" in the high-Gigahertz range, and then waiting for an "Echo" from a fixed object or a ship. The time delay of the echo, along with the direction of the reflection, establishes the distance and the bearing of the object, which can be another ship or a land obstruction. The higher the frequency, the better the possible resolution (the ability to distinguish two objects close together). At angles close to the horizon, wind turbines can add "clutter" to the radar's display screen, making it difficult to distinguish small objects, even with high resolution. Depending upon the power and sophistication of the radar system, this effect can extend for 57.5 to 92 miles (92.6 to 148.2 km) from the turbine farm, but would be confined to the general region of the turbines. The primary effect would be to make it difficult to resolve each wind turbine separately.

LORAN

If a ship is within a 0.5 miles (800 m) distance from a turbine there is a possibility that a minor error could be introduced into the LORAN receiver. There are no reasonable mitigation techniques, other than maintaining the required distance.

Safety and Emergency Communications

For nearly all voice and low-speed data applications, the effect of the turbines would be confined to the 800 m radius mentioned previously. For some non-standard applications, such as high-speed data above 10 or 20 Megabits per second, the throughput speed may be reduced if the communications path transverse the turbine area, especially near the center of the path. This effect is not deemed to be critical, because the communications would not be completely disrupted, merely slowed, and the geometry required for adverse effects would be a small fraction of usage, especially since communications at these higher speeds is currently quite rare. Based upon reasonable assumptions, there are no serious instances of impact potential to land mobile or public safety facilities.

Impact of Offshore Cables

The possible radiation from offshore cables is confined to power frequencies (60 to 120 Hz, usually 3-phase). The magnitude of the EMF is proportional to the current flowing in the cable(s). The cables are engineered structures with shielding, and are designed not to radiate and electric field. It should be noted that a wavelength at 120 Hz. is over 1,000 miles (1609.3 km); therefore, a significant difference of potential would not be evident from the proposed action to the shore. Therefore, there would be no significant effect.

Micro Wave Communications - Airports

No microwave links are impacted by the present turbine arrangement. However, if turbines are relocated within the Worst Case Fresnel Zone of any other identified path as shown in [Figure 5.3.4-2](#), those paths should be re-studied. If turbines must be re-located closer to the microwave path, the path should be field-verified by GPS survey.

Conclusion

The proposed action is expected to have a minor impact on the communications systems in the area. In addition, to help ensure minimal impact on communications, the USCG has submitted Terms and Conditions, one of which requires the applicant to submit an analysis before the start of construction, to evaluate whether or not the WTGs as designed would interfere with marine communication or navigation systems or produce any adverse impacts to navigational safety (refer to USCG letter in [Appendix E](#)).

5.4 ALTERNATIVES EVALUATED FURTHER IN DETAIL

Based on the results of the screening process described above, MMS chose the following alternatives to evaluate in further detail. These include:

- Monomoy Shoals;
- South of Tuckernuck Island;
- Smaller Alternative;
- Phased Development Alternative; and
- Condensed Array Alternative.

The locations for each of these alternatives are shown together in [Figure 3.3.5-1](#). This section also reviews the option of taking no action.

5.4.1 South of Tuckernuck Island Alternative

5.4.1.1 Description of the South of Tuckernuck Island Alternative

The South of Tuckernuck Island Alternative is approximately 3.8 miles (6.1 km) southwest of Tuckernuck Island in Federal waters (see [Figure 3.3.5-1](#)). Water depth within the site ranges between 15 ft and 100 ft (4.6 m and 30.5 m) below MLLW, with an estimated average depth of approximately 57 ft (17.5 m). The South of Tuckernuck Island Alternative would be the same generation size as the proposed action (130 WTG's, 3.6 MW machines plus an ESP), but would require an area of approximately 36 square miles (93.2 km²). The proposed turbine spacing for the South of Tuckernuck Island site is a grid arrangement approximately 9.0 rotor diameters (0.63 miles [1.0 km]) by 5.7 rotor diameters (0.39 miles [0.629 km]).

This site would require foundations to be placed in various water depths ranging from approximately 15 to 100 ft (4.6 to 30.5 m), but still benefits from some sheltering effects from open ocean waves due to Nantucket Island to the east. The South of Tuckernuck Island Alternative would likely require three different sized monopiles and a quad-caisson foundation depending on water depth. Water depths between 0 and 30 ft (0 and 9.1 m) would utilize a 16.75 ft (5.1 m) diameter monopile, water depths between 30 and 45 ft (9.1 and 13.7 m) would utilize an 18.0 ft (5.5 m) diameter monopile, and water depths between 45 and 65 ft (13.7 and 19.8 m) would utilize a 19.0 ft (5.8 m) diameter monopile. The quad-caisson foundation, a fabricated steel structure, would be utilized for all WTGs installed at a depth greater than 65 ft (20 m). This structure would consist of four tower foundations that support the tower interface (see [Figure 3.3.5-2](#)). This structure would require more fabrication and installation due to its large size and the more challenging sea conditions off the southern coast of Nantucket Island.

With respect to construction, the South of Tuckernuck Island Alternative is located in a more open ocean setting that presents sea conditions considerably different from the proposed action. Greater precautions for personnel safety would add to the complexity of the construction. The sea conditions would also restrict access to the site for construction and for maintenance to a considerably greater degree than the proposed action as well as some of the other alternatives. Routing for delivery of material to the site from a marshalling area (assumed to be Quonset Rhode Island for purposes of this comparison) would be from south of Martha's Vineyard.

The construction sequencing for this Alternative would be similar to that described for the Nantucket Sound alternatives. However, rather than the mechanical driving of the structure into the seabed as described for the monopiles, the caissons of the deep water foundation would be set on the seabed and then suctioned into place to the appropriate depth.

The 115 kV offshore transmission cable system for the South of Tuckernuck Island Alternative would consist of the same equipment as described in Section 2.3 of this document. The total length of the offshore cable route, from the alternative site of the ESP to the Barnstable Substation, would be 33.4 miles (53.8 km). Of this amount, approximately 14.8 miles (23.8 km) of cable would cross the OCS, 12.7 miles (20.4 km) would cross state submerged lands, and approximately 5.9 miles (9.5 km) of cable would be located in an onshore transmission ROW. The offshore cable would be routed from the ESP in a northwesterly direction for about 6.8 miles (10.9 km) and then turn in a northeasterly for about 20.7 miles (33.3 km) before making landfall.

The location, WTG configuration, and interconnection routing for this alternative are provided in [Figure 3.3.5-3](#).

5.4.1.2 Environmental Resources of the South of Tuckernuck Island Alternative and Comparison with the Proposed Action

5.4.1.2.1 Regional Geologic Setting

Particle analysis of surface grab sediments collected during benthic studies in Nantucket Sound show sand sized particles predominate, derived from relict glacial sediments (Poppe et al., 1989; Theroux and Wigley, 1998). Finer-grained sediments containing silt and clay could be expected south of Tuckernuck Island, which would indicate that depositional sediment environments may occur in some locations. Glacial sediments near the South Tuckernuck Island Alternative site could be about 60 ft (18.3 m) thick (Uchupi et al., 1996).

Approximately 8 to 10 miles (13 to 16 km) west of the South of Tuckernuck Island Alternative, vibracore samples recovered coarse to fine quartz sand and shell fragments in the upper seven ft (2.1 m). At other core locations, sands also contained silt and clay, generally at the base of the vertical section sampled. Borings that were drilled southeast of Nantucket Island encountered approximately 90 ft (27.4 m) of fine sand overlying a silt of unknown thickness (Uchupi et al., 1996). Lenses of gravel to coarse sand and medium to fine silty sand were encountered in another nearby boring. These conditions indicate that alternating sequences of high and low energy sediment deposition during glacial stagnation and retreat occurred.

The geological setting of the South of Tuckernuck Island Alternative is similar to the proposed action with regard to sediment composition (see Section 4.1.1 of this document). Horseshoe Shoal is generally composed of medium sands dominating the shallow water sediments and poorly graded fine and silty

sands located in the deeper shoal waters. The geologic setting at the South of Tuckernuck Island Alternative is comparable and offers no significant environmental advantage over the proposed action.

With respect to coastal geomorphology, the northwest part of the South of Tuckernuck Island Alternative is located south and southeast of Muskeget Channel between Martha's Vineyard and Nantucket. Strong currents in and around this channel and ocean currents continue to shape the geomorphology of the sea bottom in this area. Migrating sand waves and shoals may be present, especially in shallow water on the northwest portion of the alternative site. Coarse-grained armor-type bottom sediments, often encountered in channels swept clean of fine-grained material, can also be expected. The regional geology and coastal morphology of the proposed action and the South of Tuckernuck Island Alternative are similar; however site-specific conditions of the two sites differ (see Section 4.1.1.1 of this document for a discussion of the site-specific conditions at the site of the proposed action). Compared to the proposed action, the geology and coastal morphology of the South Tuckernuck Island Alternative offers no significant environmental advantage over the proposed action with respect to its construction, operation, or decommissioning.

5.4.1.2.2 Noise

The potential impacts from above water and underwater sound related to construction and decommissioning activities at the South of Tuckernuck Island Alternative would be equivalent to the impacts from these activities at the Nantucket Sound Alternative. However, due to the greater number of foundation supports with larger diameters and the greater distance that this site is located offshore, the South of Tuckernuck Island Alternative may require a longer construction timeframe, thereby resulting in longer duration of acoustical impacts during construction and decommissioning compared to the other offshore alternative sites.

The potential impacts from underwater sound related to operation of the WTGs at the South of Tuckernuck Island Alternative would be equivalent to the impacts from these activities at the Nantucket Sound Alternative. Acoustic modeling for the South of Tuckernuck Island Alternative was performed to predict the above-water, broadband continuous sound level L_{eq} (dBA) at the closest sensitive onshore receptors for this alternative. As with the other alternatives, the worst case was assumed with the WTGs operating at their design wind speed and wind directions corresponding to onshore conditions for the sensitive receptors. Sound data for a 3.6 MW GE WTG was used in the calculations.

The onshore receptor used for the South of Tuckernuck Island Alternative in the acoustic modeling is Madaket Beach on Nantucket. The maximum predicted sound level for the South of Tuckernuck Island Alternative is approximately 30 dBA. With respect to the Nantucket Sound Alternative as discussed previously, operational noise South of Tuckernuck Island is less likely to be noticeable than the pile driving noise during construction. Furthermore, wildlife and human receptors are expected to acclimate to the low noise levels and are not likely to be adversely affected. Noise impacts are minor for both the proposed site and the South of Tuckernuck Island Alternative with respect to construction, operation, and decommissioning. Compared to the proposed action, the South of Tuckernuck Island Alternative offers no significant environmental advantage with respect to noise over the proposed action during construction, operation, and decommissioning.

5.4.1.2.3 Physical Oceanography

Water depths for the South of Tuckernuck Island Alternative generally increase in a southwesterly direction. Tidal height and range information specific to the South of Tuckernuck Island Alternative are not available. However, the closest NOAA tide stations, located in similar conditions, are at Wasque Point on Chappaquiddick Island (about 8.0 miles [12.9 km] northwest of the South of Tuckernuck Island Alternative ESP) and Tom Nevers Head on Nantucket (about 18.0 miles [29 km] east of the South of

Tuckernuck Island Alternative ESP). Given the open sea location of the alternative site, it is expected that tidal ranges would be similar to those at the two NOAA tidal stations (see below). The NOAA also has tidal current stations located within and northwest of the South of Tuckernuck Island Alternative.

The fetch at the South of Tuckernuck Island Alternative is restricted to the northwest by Martha's Vineyard and to the north and east by Muskeget, Tuckernuck and Nantucket Islands, and shallow shoals. Since the fetch is open to the Atlantic Ocean to the south and west the largest waves are likely to come from those directions. Oceanographic data for the site is as follows:

- Water Depth:** The estimated depths within the alternative site is between 60 and 90 ft (18.3 and 27.5 m) at MLLW except at the northwest edge which has water depths of between 10 and 25 ft (3.1 and 7.6 m) at MLLW.
- Tide:** Average Tides:
– Mean Range = 1.15 ft (0.35 m)
– MHWS = 1.40 ft (0.43 m)
- Current:** Station ID: 1716
– Avg. Max Flood = 0.5 knots (0.26 m/s) 90°
– Avg. Max Ebb = 1.0 knots (0.51 m/s) 270°
- Wave Conditions:** WIS Station IDs: 87 and 86 Extreme storm waves of approximately 52.5 ft (16 m); larger value of the two WIS stations.

Compared to the proposed action, the oceanography of the South Tuckernuck Island Alternative offers no significant environmental advantage over the proposed action.

5.4.1.2.4 Climate and Meteorology

The weather conditions for the South of Tuckernuck Island Alternative are similar to the site of the proposed action. However, the alternative site is estimated to have a predicted mean wind speed between 19.0 and 20.1 mph (8.5 and 9.0 m/s) in the near shore and between 20.1 and 21.3 mph (9.0 and 9.5 m/s) in the far shore. This is fairly close to the wind speed at the Horseshoe Shoal site which has a mean wind speed of 17.9 to 20.1 mph (8 to 9 m/s). Compared to the proposed action, impacts on climate and meteorology within the South of Tuckernuck Island site, including its offshore and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.5 Air Quality

The existing air quality conditions for the South of Tuckernuck Island Alternative site are similar to the site of the proposed action. Vessels and equipment involved in the pre-construction G&G investigations, construction and decommissioning, and maintenance would emit, or have the potential to emit air pollutants. However, emission impacts would be minor and overall, impacts on air quality associated with the South of Tuckernuck Island Alternative, including its offshore and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.6 Water Quality

The Massachusetts Surface Water Quality Standards (314 CMR 4.06(3)) categorize surface waters adjacent to Nantucket Island as Class SA coastal and marine water bodies. According to the MassDEP standards, Class SA waters are designated as “an excellent source of habitat for fish, other aquatic life and

wildlife, and for primary and secondary contact recreation”. It is expected that water quality at the South of Tuckernuck Island Alternative and along the approximate 33.4 mile (53.8 km) long offshore cable route, would meet this water quality designation, since there are no known major sources of pollutant input or other degrading factors. In approved areas, Class SA waters are “suitable for shellfish harvesting without depuration (Open Shellfish Areas).” Compared to the proposed action, impacts on water quality would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.7 Electric and Magnetic Fields

Electric and magnetic field strength along the offshore cables and onshore cables would have negligible impacts on the marine environment and to humans, and be of the same strength as that for the proposed action. Compared to the proposed action, impacts from electrical and magnetic fields would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.8 Terrestrial Vegetation

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay, landfall site at New Hampshire Avenue, and onshore cable route (see Section 4.2.1 of this document for detailed information on terrestrial vegetation). Compared to the proposed action, impacts on terrestrial vegetation within the South of Tuckernuck Island Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.9 Coastal and Intertidal Vegetation

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay and landfall site at New Hampshire Avenue (see Section 4.2.2 of this document for detailed information on coastal and intertidal vegetation). Compared to the proposed action, impacts on coastal and intertidal vegetation within the South of Tuckernuck Island Alternative, including its offshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.10 Terrestrial and Coastal Faunas Other than Birds

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay, landfall site at New Hampshire Avenue, and onshore cable route. See Section 4.2.2 of this document for detailed information on coastal and intertidal resources. Compared to the proposed action, impacts on coastal and intertidal resources within the South of Tuckernuck Island Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.11 Avifauna

During the winter, seabirds likely to use the South of Tuckernuck Island Alternative area include eiders, scoters, and long-tailed ducks while the summer months attract pelagic species, such as shearwaters, storm-petrels, and jaegers. Other species of waterbirds such as loons and Northern Gannets use the general area for foraging (National Audubon Society, 2002). Tens of thousands of long-tailed ducks leave Nantucket Sound each day on foraging trips (Veit and Petersen, 1993) and many may spend the day foraging in areas south of Tuckernuck, depending on the food availability. Terns and gulls are

also likely to forage in the area while seabirds and other waterbirds use the area as a staging area before migrating to their nesting colonies in the spring and to wintering grounds further south. Other migratory birds such as landbird species likely pass over South of Tuckernuck Island typically at high altitudes during spring and fall migrations.

Compared to the proposed action, the South of Tuckernuck Island Alternative would have a greater potential for impacts to terrestrial, coastal, and marine birds, primarily because of the increased area in which the turbines would be located.

5.4.1.2.12 Subtidal Offshore Resources

Since Massachusetts Geographic Information System (MassGIS) data for eelgrass beds is limited to within the 3.5 miles (5.6 km), no eelgrass data is readily available for the proposed action (MassDEP, 2006). However, given the water depths, none would be expected at this location.

Benthic Habitat

As described above, water depths are variable throughout the South of Tuckernuck Island Alternative. The composition of the bottom sediments there has been documented in several studies (Theroux and Wigley, 1998; Poppe et al., 1989). Although no studies focused solely on the South of Tuckernuck Island Alternative, they did encompass the general area. The site is dominated by sand-sized particles (Theroux and Wigley, 1998; Poppe et al., 1989). In marine environments these substrates typically support the highest density and biomass of organisms per square meter, as compared to either larger or finer grained material (Theroux and Wigley, 1998).

The benthic habitat types for the South of Tuckernuck Island Alternative are similar to the site of the proposed action (see Section 4.2.5 of this document). The dominant bottom substrate of the area of the proposed action includes sand (fine- and coarse grained), mud, and other fine-grained sediments. The SAV (i.e., eelgrass), boulders, and cobbles are not common.

Benthic Community Composition and Abundance

The South of Tuckernuck Island Alternative is generally reported as a moderately productive area for benthic invertebrates. Densities of benthic organisms typically range between 65 and 510 individuals/ft² (700 and 5,500 individuals/m²) and benthic organism biomass typically ranges between 0.01 and 0.1 lbs/ft² (50 and 500 grams/m²) (Wigley and McIntyre, 1964 and Theroux and Wigley, 1998).

This South of Tuckernuck Island Alternative is reported to have slightly higher benthic organism diversity than Nantucket Sound and diversity similar to that found near the proposed action (Sanders, 1968; Theroux and Wigley, 1998). This may be a function of the generally deeper water depths and more stable substrate at this alternative site. The reduced magnitude and frequency of sand movement is believed to be correlated with more diverse benthic communities, since relatively few species have adapted to recover from burial (Pratt, 1973).

The most abundant taxa at the South of Tuckernuck Island Alternative are crustaceans and mollusks, followed by polychaete worms (Theroux and Wigley, 1998). Among the crustaceans, the amphipods are reported to be by far the most abundant, which is similar to the community found in Nantucket Sound. Several taxa are expected to occur at the South of Tuckernuck Island Alternative that would be much less common within Nantucket Sound. These include Amphipoda, Cumacea, and Isopoda, as well as the Nemeitea, Nematoda, and Sipuncula; all within the Crustacean taxa.

Twenty benthic macroinvertebrate taxa were recorded during benthic sampling programs conducted at the site of the proposed action (see Section 4.2.5 of this document). Of the sites sampled, the average faunal density was 1078 individuals/ft² (11,589 individuals/m²). Nematoda were more abundant than any other class (70 percent of the samples) and was followed by Oligochaeta (27 percent of the samples) and gastropod *Crepidula fornicata* (17 percent of the samples).

Compared to the proposed action, the benthic community composition within the South of Tuckernuck Island Alternative is smaller with regards to overall abundance of species and differs with regard to community structure. The site of the proposed action provides habitat preferred by deposit- and suspension- feeding species whereas the alternative site provides habitat preferred by scavenger and predator species.

The additional pilings, cross-braces, and scour protection required at the South of Tuckernuck Island Alternative substantially increase (by more than 10 times) the vertical habitat structure available for colonization by benthos for the life of the Project. However, anchoring impacts associated with construction would be greater at the South of Tuckernuck Island Alternative than the Horseshoe Shoal proposed site. The area of direct impact at the South of Tuckernuck Island Alternative would be nearly twice that of the Horseshoe Shoal site, likely resulting in greater overall impact to benthos at the South of Tuckernuck Island Alternative than at the proposed action. The South of Tuckernuck Island alternative also would have greater impacts on benthic resources as a result of the much longer offshore transmission cable requirement compared to that of the proposed Horseshoe Shoal site. Accordingly, benthic impacts are expected to be greater at the South of Tuckernuck Island alternative than the Horseshoe Shoal site with respect to construction, operation, and decommissioning.

5.4.1.2.13 Non-ESA Marine Mammals

Four federally protected cetaceans, North Atlantic Right, humpback, and fin whales may occur in the vicinity of the proposed South of Tuckernuck Island Alternative (see [Table 5.4.1-1](#)), but are typically found in areas of deeper water. The South of Tuckernuck Island Alternative contains some features that favor dense aggregations of whale prey species, but these are not as well developed as other areas farther north (Kenney and Winn, 1986). Although preferred prey species for whales occur in the South of Tuckernuck Island area higher-use areas occur further north. The South of Tuckernuck Island area does not appear to be an important area even though there have been more recorded sightings of Northern Atlantic right whales in the South of Tuckernuck Island area than in Nantucket Sound or Buzzards Bay.

As shown in [Table 5.4.1-1](#), several other species of protected marine mammals may be present within the vicinity of the South of Tuckernuck Island Alternative. These species include harbor, harp, and hooded seals, white-sided and striped dolphins, harbor porpoise, and long-finned pilot whale.

The species identified in [Table 5.4.1-1](#) could also be present at the site of the proposed action (see Section 4.2.6 of this document) as could the Atlantic spotted dolphin, Risso's dolphin, and Kogia species (sperm whale).

With respect to overall impacts on marine mammals, the South of Tuckernuck Island Alternative is in closer proximity to seal haul-out and breeding sites than the proposed action, and therefore, development at this site has a greater potential to impact seals both during construction and operation. In addition, there is somewhat greater potential to impact whales at the South of Tuckernuck Island alternative during construction since the site is proximate to historical sightings of these mammals. There is a potential for greater impact to prey species at the South of Tuckernuck Island Alternative compared to the proposed action given the greater potential benthic habitat disturbance at this Alternative and anticipated longer construction duration. In conclusion, there may be a somewhat greater potential for impacts on marine

mammals within the South of Tuckernuck Island Alternative than the site of the proposed action with respect to construction, decommissioning, and operational impacts.

5.4.1.2.14 Fish and Fisheries

Table 5.4.1-2 lists common finfish and shellfish resources which are known to occur within the general offshore vicinity of Cape Cod and the Islands. Section 4.2.7 of this document provides detailed information on fish and fisheries for the proposed action. The South of Tuckernuck Island Site contains a greater number of fish species than the proposed site, since it has habitat that is preferred by species that typically occur in deeper, cooler waters. The South of Tuckernuck Island Site has more species and life stages with designated EFH unique to this Site. There are eight species (common thresher shark, dusky shark, monkfish, ocean pout, ocean quahog, spiny dogfish, whiting, and witch flounder) that have EFH life stage designations at the South of Tuckernuck Island Alternative and not at the proposed action. There are also eight life stages of certain species that only have designated EFH at the South of Tuckernuck Island Alternative. The habitat requirements for these species/life stages typically are waters that have a deeper depth range and cooler temperatures.

Once in operation, the South of Tuckernuck Island Alternative offers a greater surface area for potential fish aggregations compared to the proposed action because of the larger foundations required as a result of the deeper water. However, the South of Tuckernuck Island Alternative would likely require a longer construction timeframe and greater benthic habitat disturbance, resulting in greater impacts to fisheries from sediment disturbance compared to the proposed action. Finally, the South of Tuckernuck Island Alternative has the potential for greater acoustical impacts to finfish compared to the proposed action, because that alternative would require a longer construction/decommissioning timeframe. In conclusion, the South of Tuckernuck Island Alternative would be expected to have a greater impact on finfish than the proposed action during construction, operation and decommissioning.

Shellfish Resources

Since the South of Tuckernuck Island Alternative is, on average, deeper than the proposed action, it is expected that the shellfish community in the area would not contain as many of the suspension (filter) feeding mollusk species. The highest abundance and diversity of suspension-feeding mollusks tend to be associated with water depths of less than 60 ft (18.3 m) in areas south of Cape Cod (Saila and Pratt, 1973). Suspension-feeding species such as northern quahog, bay scallop, sea scallop, surf clam, and soft-shelled clam are reported to be less common South of Tuckernuck Island than at the proposed site (Weiss, 1995; Saila and Pratt, 1973; Gosner, 1978). The channeled whelk (conch) and knobbed whelk are more common in shallow waters (Weiss, 1995) and would therefore be expected to be less common in the deeper waters of the alternative site.

Two species of mussel are common to the region, blue mussel (*Mytilus edulis*) and horse mussel (*Modiolus modiolus*). The blue mussel thrives in shallower waters near low tide attached to rocks and shells (Weiss, 1995). Rocky habitat is not present at the South of Tuckernuck Island Alternative; therefore, it is expected that fewer blue mussels would be found at the alternative site. The horse mussel is far less common in the region, particularly in areas south of Cape Cod. It typically lives in deeper waters to depths of 240 ft (73.2 m) (Weiss, 1995) and would be more common at the South of Tuckernuck Island Alternative than at the proposed action. Ocean quahogs are also more common in deeper waters, between 60 and 90 ft (18.3 and 27.5 m), with finer sand to mud substrates (Weiss, 1995; Saila and Pratt, 1973). They too would be more common at the South of Tuckernuck Island Alternative than at the proposed site.

The South of Tuckernuck Site is expected to have somewhat fewer shellfish resources than the proposed action because of its deeper waters. However, this is balanced by the fact that at South of

Tuckernuck, the area of construction impacts is more extensive as a result of the larger foundation, larger area of anchor sweep associated with deep water construction, and longer offshore transmission cable distance. In general, shellfish impacts are expected to be comparable between Tuckernuck Shoal and the proposed site with respect to construction, operation, and decommissioning.

Finfish

Commercial fishing landings data for the specific fisheries in the South of Tuckernuck Island Alternative area are not readily available. This Alternative site is located outside of the three-mile (4.8 km) territorial limit but within a small portion of the MassDMF statistical reporting Area 16 for lobsters. According to McBride and Hoopes (2001), Area 16 has one of the highest landings for lobster of all offshore statistical reporting areas in Massachusetts (1,000,001 to 2,000,000 lbs [453,593 to 907,185 kg] in 1999). Since the offshore area along the northern coast, north of Cape Cod Bay, produced the highest landings of lobsters and because statistical reporting Area 16 is so large, it is difficult to determine if and how much of the South of Tuckernuck Island Alternative contributes to the total lobster harvest.

Recreational fishing in the waters south and east of Cape Cod includes both private recreational vessels and charter services. Due to the weather conditions on Nantucket Sound, the prime season for recreational fishing occurs during late spring to late summer. Main target species for recreational fishing include striped bass, several tuna species, scup, bluefish, bonito, sea bass, sharks, and cod. Section 4.2.7 of this document provides information on commercial and recreation fish and shellfish for the proposed action.

Overall the South of Tuckernuck Island Alternative would be expected to have a greater impact on fish and commercial fisheries than the proposed action as a result of longer construction time frame and the size of the foundation. The larger foundation size is expected to result in increased fish aggregation compared to the proposed action.

5.4.1.2.15 Essential Fish Habitat

Habitat within the South of Tuckernuck Island Alternative has been designated as EFH for 28 federally-managed fish species and 4 federally-managed invertebrate species. Table 5.4.1-3 provides a listing and specific life stage designations of those species within the area of the South of Tuckernuck Island. The proposed action has been designated EFH for 17 federally managed fish and 3 federally managed invertebrates all of which overlap with those listed in Table 5.4.1-3. The EFH species included for the South of Tuckernuck Island Alternative but not the proposed action are the Atlantic sea herring (*Clupea harengus*), Common thresher shark (*Alopias vulpinus*), Dusky shark (*Carcharhinus obscurus*), Haddock (*Melanogrammus aeglefinus*), Monkfish (*Lophius americanus*), Ocean pout (*Macrozoarces americanus*), Ocean quahog (*Artica islandica*), Red hake (*Urophycis chus*), Sandbar shark (*Carcharhinus plumbeus*), Spiny dogfish (*Squalus cubensis*), Whiting (*Merluccius bilinearis*), and Witch flounder (*Glyptocephalus cynoglossus*).

The Magnuson-Stevens Act requires an assessment of potential impacts to federally managed fish and invertebrate species when EFH habitat may be affected, as is the case with the proposed action (NOAA, 2006). Section 4.2.8 of this document provides information on EFH for the proposed action. Temporary and localized sediment disturbance from construction vessel anchoring, anchor line sweep, and scour protection are anticipated. The anchoring and scour protection impact for the South of Tuckernuck Island Alternative would likely be more than that of the proposed action. As a result, this alternative would be expected to result in more temporary impact than that of the proposed action during construction and during decommissioning. Greater foundation size at Tuckernuck, and thus increased aggregation, would result in somewhat greater impact during operation.

5.4.1.2.16 Threatened and Endangered Species (T&E)

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the site of the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route. See Section 4.2.9 of this document for detailed information on endangered and threatened species along this cable route. Compared to the proposed action, impacts on endangered and threatened species along the near shore and onshore cable routes associated with the South of Tuckernuck Island Alternative would be comparable to and offer no significant environmental advantage over the proposed action.

The South of Tuckernuck Island Alternative area may provide suitable foraging habitat for the federally-endangered roseate tern (*Sterna dougallii*) and suitable nesting habitat for the federally-threatened piping plover (*Charadrius melodus*) on shorelines on Tuckernuck Island and Nantucket. The Massachusetts Natural Heritage Atlas (2003 edition) indicates that Tuckernuck Islands, approximately 3.8 miles (6.1 km) northeast of Tuckernuck Island, is located within Priority Habitat for State-Protected Rare Species and Estimated Habitat for Rare Wildlife for onshore, nesting areas for shorebirds and terns. Two state species of special concern (common loon and least tern) and one state-endangered species (roseate tern) may use the waters near the South of Tuckernuck Island Alternative as a winter resident (common loon) and/or foraging (Veit and Petersen, 1993).

Potential impacts to listed species at the South of Tuckernuck Island Alternative would be comparable to the proposed action. Piping plover is known to nest on Tuckernuck Island, but is unlikely to visit this offshore area except during migration. There would likely be fewer terns present at the South of Tuckernuck Island Alternative than the proposed action during the breeding season because of the distance from the primary breeding colonies in Buzzards Bay. However, there would be terns present at South of Tuckernuck Island Alternative during other seasons, and potential impacts would be comparable to the proposed action.

As shown in [Table 5.4.1-1](#), three federally and/or state protected sea turtle species may be present within the South of Tuckernuck Island Alternative: loggerhead, leatherback, and Kemp's Ridley sea turtles. Kurkul (2002) reported that these sea turtles are found within Massachusetts waters at varying times of the year. Therefore it is possible that they may utilize the South of Tuckernuck Island area during some portion of the year as well. The federally protected green sea turtle is less likely to be found within Nantucket Sound. Loggerhead, leatherback, and Kemp's Ridley sea turtles may also use Horseshoe Shoal (see Section 4.2.9 of this document). Compared to the proposed action, impacts on sea turtles within the South of Tuckernuck Island Alternative would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.17 Socioeconomic Analysis Area

The existing socioeconomic conditions for the South of Tuckernuck Island Alternative are similar to that of the proposed action (see Section 4.3 of this document) as the two locations are within the same general socioeconomic area of the Cape Cod and the Islands of Martha's Vineyard and Nantucket. Compared to the proposed action, socioeconomic impacts associated with the South of Tuckernuck Island Alternative would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning.

5.4.1.2.18 Urban and Suburban Infrastructure

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route and affect the same urban and suburban infrastructure (see Section 4.3 of this document). Compared to the

proposed action, impacts on urban and suburban infrastructure within the South of Tuckernuck Island Alternative, including its submarine and onshore cables, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.19 Population and Economics

The South of Tuckernuck Island Alternative is located in the same general socioeconomic area as the proposed action and is expected to result in negligible impacts on changes to population or the economy of the region. Hence, the South of Tuckernuck Island Alternative would be comparable to and offer no significant advantage in terms of population and economics over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.20 Environmental Justice

Concerns about environmental justice typically center on areas with higher than average minority populations and higher than average poverty levels. The area South of Tuckernuck is in the same general socioeconomic area as the proposed action and not located near any communities of higher than normal minority populations or higher than normal poverty rates nor is it located any closer to the WTGHA or the Wampanoag Tribe of Mashpee. As such, the South of Tuckernuck Island Alternative would be expected to be comparable to that of the proposed action with respect to environmental justice and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.21 Visual Resources

The seascape from Tuckernuck Island southwest towards the South of Tuckernuck Island Alternative consists of panoramic open ocean views of the Atlantic Ocean. The visual impacts toward the South of Tuckernuck Island Alternative would be somewhat more significant as there are no other lands or human structures visible when viewed from Nantucket or Martha's Vineyard. However, generally fewer viewers would see the WTG array at the Tuckernuck area, since it would be beyond or close to beyond visible range from Cape Cod which has the major population density in the area (see [Figure 3.3.5-4A and B](#)). As a result, a WTG array would have less visual impact at the South of Tuckernuck Island site than the proposed action for construction, operation, and decommissioning.

5.4.1.2.22 Cultural Resources

To access the Barnstable Substation, both the South of Tuckernuck Island Alternative and the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route and affect the same onshore cultural resources (see Section 4.3.5 of this document). Compared to the proposed action, impacts on onshore cultural resources within the South of Tuckernuck Island Alternative, including its submarine and onshore cables, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts. With respect to visual impacts on cultural resources (i.e., historic homes and historic sites), this site is located further from historic areas of Cape Cod, but closer to the historic area of Nantucket. Thus no difference in impact is expected compared to the proposed action with respect to impact on cultural resources.

No submerged historic properties or archaeological sites are recorded in the South of Tuckernuck Island Alternative area, and there are no shipwrecks charted in the vicinity of the alternative site. Four vessel casualties ranging in date from 1817 to 1969 are reported in the Northern Shipwreck Database. A review of the MHC's records indicates that no marine archaeological investigations have been conducted in the area. The archaeological sensitivity for submerged Euro-American and Native American cultural

resources near the South of Tuckernuck Island Alternative is expected to be low because of the area's homogenous bathymetry and exposed location to the open waters of the Atlantic Ocean. Since a detailed marine sensitivity assessment and marine archaeological reconnaissance survey have not been conducted for the South of Tuckernuck Island Alternative, it is difficult to determine whether any subtidal archeological resources (i.e., historic or pre-historic sites) would actually be affected by the proposed action if it were sited at this alternative location. However, if such sites were documented at the alternative site, the applicant would have to implement mitigative measures similar to those for the proposed action (see Section 4.3.5 of this document). Therefore, impacts on subtidal archeological resources within the South of Tuckernuck Island Alternative would be expected to be comparable to that of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.23 Recreation and Tourism

The South of Tuckernuck Island Alternative is located closer to land (Nantucket Island) and the popular boating and recreational area around Nantucket Island than the proposed action, but it is located further from the popular boating and recreational areas of Cape Cod than the proposed action. In general, impacts on recreational activities within the South of Tuckernuck Island Alternative would be expected to be comparable to that of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.24 Competing Uses of Waters and Sea Bed

The 115 kV offshore transmission cable system from the ESP at the South of Tuckernuck Island Alternative to the landfall site at New Hampshire Avenue, within Lewis Bay, would traverse approximately 12.8 miles (20.6 km) of State waters and sea bed. Competing uses that exist along the offshore cable route include aquaculture, submarine electric transmission cables (2 Nantucket cables would be crossed), recreational and commercial activities, and maintenance dredging activities. Compared to the proposed action, impacts on competing use activities within the South of Tuckernuck Island Alternative would be expected to be comparable to that of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.25 Overland Transportation Arteries

Like the proposed action, the South of Tuckernuck Island Alternative is located offshore and not near any overland transportation arteries and would be expected to have comparable traffic impacts associated with onshore equipment deliveries or commuting of workers as the proposed action. Thus the South of Tuckernuck Island Alternative offers no significant environmental advantage for overland transportation arteries over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.26 Airport Facilities

The South of Tuckernuck site is located closer to the Nantucket Airport but further away from the Barnstable Airport in Hyannis than the proposed action. Regardless, both locations received FAA approval (see [Appendix E](#)). The net impact on airport facilities from the South of Tuckernuck Island Alternative would therefore likely be comparable to that of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.27 Port Facilities

The impact on port facilities from the proposed action and its alternatives would primarily be with respect to vessels navigating in the area. Assuming that the spacing of the WTGs remains the same for

the alternative locations, the potential impacts to navigation at the South of Tuckernuck Island Alternative would be equivalent to the potential impacts for the proposed action. Installation of the wind turbines would result in structures being present where no structure has previously existed and mariners would need to navigate with consideration of these new structures. The South of Tuckernuck Island Alternative is located closer to land (Nantucket Island) than the proposed action and thus would experience vessel traffic associated with that area and nearby Nantucket Harbor, but it is further away from the popular boating area near Cape Cod and its associated ports, than the proposed action. On whole, the South of Tuckernuck Island Alternative would have an impact on ports and related marine traffic that is comparable to that of the proposed action and offer no significant advantage to Port Facilities over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.1.2.28 Communications: Electromagnetic Fields (EMF), Signals and Beacons

Recreational vessels, commercial fishing and marine cargo ships traverse Nantucket Sound via the nearby Muskeget Channel. All of these vessels use marine radios, which operate at a range of 156.05 to 157.425 megahertz (MHz). Shore radios operate at approximately 156.85 to 162.025 MHz. The NOAA weather service operates at frequencies between 162.4 and 162.55 MHz. In addition, the site is in sufficiently close proximity to allow telecommunications signals from cellular phone towers, local emergency response communication towers, radio towers, and television (TV) towers to be transmitted and received. The FAA has conducted an aeronautical study for each of the South of Tuckernuck Island Alternative turbine locations (See [Appendix E](#)). As part of these studies, the FAA has analyzed the potential for the WTGs to affect aviation radar. Based on the completion of the aeronautical studies, the FAA has issued a “Determination of No Hazard to Air Navigation”.

5.4.2 Monomoy Shoals (East of Monomoy, Massachusetts) Alternative

5.4.2.1 Description of the Monomoy Shoals Alternative

The Monomoy Shoals Alternative site is 3.5 miles (5.6 km) southeast of Monomoy Island, within the eastern approach to Nantucket Sound ([Figure 3.3.5-1](#)). Water depth within the Monomoy Shoals Alternative site ranges between 13 ft and 34 ft (3.9 and 10.4 m) below MLLW, with an estimated average depth of approximately 24 ft (7.3 m) (Navigational Chart No. 13237 – Nantucket Sound and Approaches. Ed. 38, March 3, 2001). The alternative would be the same generation size as the proposed action (130 WTG’s, 3.6 MW machines plus and ESP), but would require a slightly larger area (25.9 square miles [67.1 km²]). The proposed turbine spacing for the Monomoy Shoals Alternative site is a grid arrangement approximately 9.0 rotor diameters (0.63 miles[1,000 m]) by 5.7 rotor diameters (0.39 miles [629 m]).

The construction and decommissioning methods at the Monomoy Shoals Alternative site would be similar to those presented in Section 2.3 of this document for the proposed action. Although driven monopile foundations and jet plow cable embedment are anticipated to be the proposed method of construction, it is possible that bed rock outcroppings and shallow surface bedrock at the Monomoy Shoals Alternative site may necessitate surface laying of the cable or other alternative installation methods. In addition, it is anticipated that the construction and decommissioning timetables for this alternative would be significantly longer than the proposed action, due to more limited accessibility (primarily due to wave conditions).

The 115 kV offshore transmission cable system for the Monomoy Shoals Alternative site would consist of the same equipment as described in Section 2.1 of this document. As shown in [Table 3.3.5-2](#), the total length of the offshore cable route, from the alternative site ESP to the Barnstable Substation, would be 29.8 miles (48 km). Of this amount, approximately 2.9 miles (4.7 km) of offshore cable would be in Federal waters, 21.0 miles (33.8 km) would be in State waters, and 5.9 miles (9.5 km) of cable would be located in an onshore transmission ROW. The offshore cable would be routed from the ESP in

a north-northwesterly direction for about 20.6 miles (33.2 km) and then turn north-northeast for about 3.3 miles (5.3 km) before making landfall. The offshore cable would be located approximately 3.0 miles (4.8 km) south of Monomoy Island. The total inner array length of 33 kV cable would be approximately 74 miles (119.1 km). The location, WTG configuration, and interconnection routing for this alternative are provided in [Figure 3.3.5-5](#).

5.4.2.2 Environmental Resources of the Monomoy Shoals Alternative and Comparison with the Proposed Action

5.4.2.2.1 Regional Geologic Setting

The narrow shelf east of lower Cape Cod, south of Chatham, is made up of a wave-built terrace that contains surface sediments composed of coarse sand (Schlee and Pratt, 1970; Schlee 1973; Aubrey and Gaines, 1982). Fragments of rock recovered from the terrace's seaward scarp are coated with manganese oxide suggesting that little or no sediment is being deposited on the scarp present at the Monomoy Shoals Alternative site. High-resolution seismic reflection profiles taken with an EG&G Uniboom in the wave-built terrace area show a prominent reflector about 10 to 30 m below the sea floor and an unconformity shoaling to the north and south (Aubrey and Gaines, 1982).

Offshore from Monomoy Island, and Nauset Beach, the sea floor is dominated by northeast-trending swells that can be traced to a depth of approximately 65 ft (20 m). Beyond 65 ft (20 m), the sea floor roughness diminishes to the near 130 ft (40 m) depth and sea floor declivity increases as it descends to the Wilkinson Basin complex in the Gulf of Maine.

The geological setting of the Monomoy Shoals Alternative differs from the proposed action with regard to surface sediment type (see Section 4.1.1 of this document). Horseshoe Shoal is generally composed of medium sands dominating the shallow water sediments and poorly graded fine and silty sands located in the deeper shoal waters. Monomoy Shoals is generally composed of coarse sand. Compared to the proposed action, the geologic setting at the Monomoy Shoals Alternative site offers no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning.

With respect to coastal geomorphology, analyses of historical charts show changes at Nauset Beach in front-and east-of the Chatham Lighthouse and north of Monomoy Island. Nauset Beach and Monomoy Island are two barrier beaches with tidal flows between Chatham Harbor and Pleasant Bay Estuary through the South Inlet located south of Nauset Beach. A comparison of maps from 1887, 1940, 1947 through 1953, and 1961 through 1964 with stereoscopic aerial photographs taken in 1969, show that the northern end of Monomoy Island (Shooters Island) has been receding since 1948. During 1971, Oldale et al. estimated that this area could separate from the rest of the island in about 70 to 80 years. However, island separation occurred in 1978, much earlier than was estimated. The southern half of Monomoy Island has been prograding eastward at a rate of about 39 ft (12 m) per year since at least 1853. Growth of Monomoy Island would most likely slow down in the future as it continues to prograde southeast into Butler Hole.

The regional geology and coastal morphology of the proposed action and the Monomoy Shoals Alternative are similar; however specific conditions at the two sites differ (see Section 4.1.1.1 of this document for a discussion of the site-specific conditions at the sites of the proposed action). Compared to the proposed action, the geology and coastal morphology of the Monomoy Shoals Alternative site are more dynamic, since it is closer to the open ocean and the adjacent Monomoy Island is undergoing constant change in its overall structure. The Monomoy Shoals Alternative offers no significant geological advantage over the proposed action with respect to construction, operation or decommissioning impacts.

5.4.2.2.2 Noise

The potential impacts from above background noise related to construction and decommissioning activities at the Monomoy Shoals Alternative would be less than at the Horseshoe Shoal site due to the site's greater distance to sensitive receptors than the Horseshoe Shoal site. Because noise impacts of the proposed action are expected to be minor, those associated with the Monomoy Shoals Alternative should be considered negligible. Noise impacts to marine life are expected to be the same as for the proposed action. In general, the Monomoy Shoals Alternative would be comparable with respect to noise impacts to the proposed action during construction, operation, and decommissioning.

5.4.2.2.3 Physical Oceanography

Monomoy Shoals consists of numerous detached shoals extending about 5.5 miles (8.9 km) in an easterly direction and 9.5 miles (15.3 km) in a southeasterly direction from Monomoy Point. Narrow sloughs separate the many parts of the Shoal. Monomoy Shoals is shifting in character and is subject to change in location and depth.

Bearse Shoal and Pollock Rip extend about 5.0 miles (8.0 km) eastward of Monomoy Point with a series of sand shoal and ridges. The Pollock Rip Channel lies between Monomoy and Bearse Shoal. Stone Horse Shoal, Little Round Shoal, and Great Round Shoal are part of a continuous series of sand shoals and ridges in 4 to 18 ft (1.2 to 5.5 m) of water. These shoals are directly eastward of the entrance to Nantucket Sound and lie between the two main channels. Southward and eastward of these shoals are numerous other shoals, including Orion Shoal in 16 to 19 ft (4.9 to 5.8 m) of water.⁷

The following is background information on physical oceanography at the Monomoy Shoals Alternative:

Water Depth: The estimated average depth within the Monomoy Shoals Alternative site is approximately 24 ft (7.3 m); however the water depth ranges between 13 ft and 34 ft (3.9 to 10.4 m) below MLLW (Navigational Chart No. 13237 – Nantucket Sound and Approaches. Ed. 38, March 3, 2001).

Tide: Station ID: 1015 (41°33' N, 070°00' W) Average Tides:
 – Mean Range = 3.70 ft (1.1 m)
 – MHWS = 4.30 ft (1.3 m)
 – Mean Tide = 1.90 ft (0.58 m)

Current: Station ID: 1731 (41°33.00' N, 070°01.30' W)
 Average Currents:
 – Avg. Max Flood = 1.7 knots (0.87 m/s) 170°
 – Avg. Max Ebb = 2.0 knots (1.03 m/s) 346°

Wave Conditions: Extreme storm waves of approximately 66 ft (20.1 m); shallow waters of the shoal result in breaking waves.

With regard to physical oceanography, the Monomoy Shoals Alternative offers no significant environmental advantage over the proposed action (see Section 4.1.3 of this document).

⁷ Chartmaker.ncd.noaa.gov/NSD/CP2/CP2-36ed-Ch04_2.pdf

5.4.2.2.4 Climate and Meteorology

The weather conditions for the Monomoy Shoals Alternative site are similar to the site of the proposed action. However, the alternative site is estimated to have a predicted mean wind speed (at a height of 70 m) of 20.1 to 21.3 mph (9.0 to 9.5 m/s) (MTC /AWS TrueWind map). This is fairly close to the wind speed at the site of the proposed action, which has a mean wind speed of 17.9 to 20.1 mph (8 to 9 m/s). Compared to the proposed action, impacts due to climate and meteorology associated with the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.5 Air Quality

The existing air quality conditions for the Monomoy Shoals Alternative site are similar to the site of the proposed action. Vessels and equipment involved in the pre-construction G&G investigations, construction and decommissioning, and maintenance would emit, or have the potential to emit air pollutants. Such impacts would be somewhat greater for the Monomoy Shoals Alternative due to the longer distance between Monomoy and the construction staging area at Quonset, Rhode Island, and worker loading area in Falmouth, Massachusetts. However, in both cases, emission impacts would be minor. Overall, impacts on air quality associated with the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.6 Water Quality

The Massachusetts Surface Water Quality Standards adjacent to the Monomoy Shoals Alternative site are similar to the standards described above for the South of Tuckernuck Island Alternative. In addition, the existing water quality conditions for the Monomoy Shoals Alternative site are similar to the site of the proposed action and would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.7 Electric and Magnetic Fields (EMF)

Electric and magnetic field strength along the offshore cables and onshore cables would have negligible impacts on the marine environment and to humans, and would be of the same strength for the Monomoy Shoals Alternative as that for the proposed action. Compared to the proposed action, impacts would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.8 Terrestrial Vegetation

To access the Barnstable Substation, both the Monomoy Shoals Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay, landfall site, and onshore cable route (see Section 4.2.1 of this document for detailed information on terrestrial vegetation). Compared to the proposed action, impacts on terrestrial vegetation within the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.9 Coastal and Intertidal Vegetation

To access the Barnstable Substation, both the Monomoy Shoals Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay and landfall site at (see Section 4.2.2 of this document for detailed information on coastal and intertidal vegetation). Compared to the proposed action, impacts on coastal and intertidal vegetation within the Monomoy Shoals Alternative, including its

offshore transmission cable system cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.10 Terrestrial and Coastal Faunas Other than Birds

To access the Barnstable Substation, both the Monomoy Shoals Alternative and the proposed action would utilize the same near shore cable route within Lewis Bay, landfall site, and onshore cable route (see Section 4.2.2 of this document for detailed information on coastal and intertidal resources). Compared to the proposed action, impacts on terrestrial and coastal fauna within the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.11 Avifauna

Monomoy Island (including the Monomoy National Wildlife Refuge) provides important resting, nesting and feeding habitat for migratory birds. Specifically, Monomoy Island is an important staging area for roseate terns, provides habitat for roseate, common and least tern nesting colonies, harbors roseate and common tern restoration sites, and is a known piping plover nesting area (Perkins, et. al., 2003). A large post-breeding, pre-migration staging area for terns is located at South Beach/North Monomoy (Trull et al., 1999). Large numbers of terns (more than 10,000) gather in this area from August through September to roost and forage. Some birds stop over or cross Nantucket Sound and may rest by day at several points along the immediate shoreline. All of these birds are believed to return to South Beach each night. Generally, the foraging range is about 3 miles (4.8 km); however, some birds may travel up to 20 miles (30 km). In addition, the Monomoy National Wildlife Refuge has been designated a Western Hemispheric Shorebird Reserve Network Regional Site and an Important Bird Area (IBA).

Due to the proximity to Monomoy Island, the Monomoy Shoals Alternative would have greater potential impacts than the proposed action to terrestrial, coastal, and marine birds during construction, decommissioning, and operation.

5.4.2.2.12 Subtidal Offshore Resources

Since MassGIS data for eelgrass beds is limited to within the 3.5 miles (5.6 km), no eelgrass data is readily available for the Monomoy Shoals Alternative site (MassDEP, 2006).

Benthic Habitat

The shallows within Monomoy Shoals are nearly continuous, forming a broad shelf. The composition of the bottom sediments at the Monomoy Shoals Alternative site has been documented in several studies (Theroux and Wigley, 1998; Poppe et al., 2004). Although no studies focused solely on the Monomoy Shoals Alternative site, they did encompass the Shoals in general. The Monomoy Shoals Alternative site can be characterized as an area dominated by sand-sized particles (Theroux and Wigley, 1998; Poppe et al., 1989), which typically support the highest density and biomass of organisms per square meter, as compared to either larger or finer grained material (Theroux and Wigley, 1998). However, Poppe et al., (2004) note that patches of gravel and gravelly sediments (between 10 and 50 percent gravel) are found locally within the area and these substrates can support a moderate density and biomass of organisms per unit area, as compared to poorly sorted till or finer grained material such as sand-silt or silt-clay (Theroux and Wigley, 1998).

The benthic habitat types for the Monomoy Shoals Alternative differ from the site of the proposed action (see Section 4.2.5 of this document). The dominant bottom substrate of the proposed action

includes sand (fine- and coarse-grained), mud, and other fine-grained sediments. The SAV (i.e., eelgrass), boulders, and cobbles are not common. As a result the benthic community can be expected to differ.

Benthic Community Composition and Abundance

The Monomoy Shoals Alternative site is generally reported as a moderately productive area for benthic invertebrates, with densities of benthic organisms typically ranging between 93 and 465 individuals/ft² (1,000 and 4,999 individuals/m²) and benthic organism biomass typically ranging between 0.02 and 0.1 lbs/ft² (100 and 499 grams/m²) (Theroux and Wigley, 1998).

The Monomoy Shoals Alternative site is reported to have a benthic organism diversity similar to Nantucket Sound site as discussed above (Theroux and Wigley, 1998). While only some benthic species have adapted to recover from burial, the abundance of suspended food in sandy shoals suggests that motile filter-feeders would be well-adapted to the shifting sands of the Monomoy Shoals Alternative site (Pratt, 1973).

The most abundant taxa at Monomoy Shoals are crustaceans and annelids, followed by hydrozoans, mollusks and echinoderms (Theroux and Wigley, 1998). Among the crustaceans, amphipods are reported to be by far the most abundant; however, mollusks are the dominant taxon followed by echinoderms and annelids. Bivalves contribute most significantly to the mollusk biomass. This is similar to the community found in Nantucket Sound; however, several taxa are expected to occur at the Monomoy Shoals Alternative site that would be much less common within Nantucket Sound (Theroux and Wigley, 1998). [Table 5.4.2-1](#) lists the dominant benthic taxonomic groups and the corresponding densities (number of individuals/m²) occurring at Monomoy Shoals.

Twenty benthic macroinvertebrate taxa were recorded during benthic sampling programs conducted at the site of the proposed action (see Section 4.2.5 of this document). Of the sites sampled, the average faunal density was 1078 individuals/ft² (11,589 individuals/m²). Nematoda were more abundant than any other class (70 percent of the samples), followed by Oligochaeta (27 percent of the samples) and the gastropod, *Crepidula fornicata* (17 percent of the samples).

Compared to the proposed action area, the benthic community composition within the Monomoy Shoals Alternative site is comparable to with regard to over all abundance of species but differs with regard to community structure. The site of the proposed action provides habitat preferred by deposit- and suspension- feeding species whereas the alternative site provides habitat preferred by scavenger and predator species. Construction and Decommissioning impacts on benthic habitat are expected to be somewhat more for the Monomoy Shoals Alternative than for the proposed action because of the additional offshore transmission cable length, and the greater wave heights which would tend to prolong the construction time frame. Operational impacts are expected to be the same as the proposed action.

5.4.2.2.13 Non-ESA Marine Mammals

As with the proposed action, four federally protected cetaceans, North Atlantic Right, humpback, long-finned pilot, and fin, may occur in the vicinity of the proposed Monomoy Shoals Alternative, but are typically found in areas of deeper water. The Monomoy Shoals Alternative site is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat (NOAA Chart No. 13200, 2005). Due to the location of this critical habitat, it is possible that Northern Right Whales may pass through the proposed alternative site during their annual migration to and from their summer and wintering grounds.

Several other species of protected marine mammals may be present within the vicinity of the Monomoy Shoals Alternative site. These species are similar to those described for the proposed action and include gray, harbor, harp, and hooded seals, white-sided and striped dolphins, harbor porpoise, and long-finned pilot whale. The Monomoy Shoals Alternative is located due east and southeast of gray seal pupping grounds on Monomoy Island. This pupping ground is known to be used year round with the greatest used occurring during the winter and spring (Natural Heritage and Endangered Species Program (NHESP), 2002). The species identified in [Table 5.4.1-1](#) could also be present as could the Atlantic spotted dolphin, Risso's dolphin, and Kogia species (sperm whale). However, compared to the proposed action, the Monomoy Shoals Alternative site is located close to the designated Northern Right Whale Critical Habitat, and thus there may be a greater likelihood of construction, decommissioning, and operational impacts to Right Whales in this area.

5.4.2.2.14 Fish and Fisheries

[Table 5.4.1-2](#) lists common finfish and shellfish resources which are known to occur within the general offshore vicinity of Cape Cod and the Islands. Section 4.2.7 of this document provides detailed information on fish and fisheries for the proposed action. The Monomoy Shoals Alternative would likely require a longer construction timeframe and greater benthic habitat disturbance as a result of higher waves and longer offshore transmission cable distance, which would result in greater temporary impacts to fisheries from sediment disturbance compared to the proposed action. In addition, the Monomoy Shoals Alternative has the potential for greater acoustical impacts to finfish compared to the proposed action, since that alternative would likely require a longer construction/decommissioning timeframe. In conclusion, the Monomoy Shoals Alternative would have a somewhat greater impact on finfish than the proposed action during construction, and decommissioning, and would be expected to have similar impacts during operation.

Shellfish Resources

Since the greatest abundance and diversity of suspension-feeding mollusks tends to be associated with water depths of less than 60 ft (18.3 m) in areas south of Cape Cod (Saila and Pratt, 1973), suspension-feeding species are likely to be present in suitable habitat on the Monomoy Shoals Alternative site. These species include: northern quahog, bay scallop, sea scallop, surf clam, and soft-shelled clam (Weiss, 1995; Saila and Pratt, 1973; Gosner, 1978). The channeled whelk (conch) and knobbed whelk are also common in shallow waters (Weiss, 1995) and would be expected to be present in the shallower areas of the site.

Two species of mussel are common to the region, blue mussel (*Mytilus edulis*) and horse mussel, (*Modiolus modiolus*) and have been described above. As sand is abundant in the Monomoy Shoals Alternative site area, it is expected that fewer blue mussels would be found at the Monomoy Shoals Alternative site. The horse mussel is far less common in the region. Similarly, ocean quahogs are more common in deeper waters in substrates with finer sand and mud substrates (Weiss, 1995). Saila and Pratt (1973) report that the ocean quahog was found to occur at depths between 60 ft and 90 ft (18.3 and 27.5 m); therefore, it is likely to be less common at the Monomoy Shoals Alternative site.

The shellfish resources for the Monomoy Shoals Alternative site area are similar to the site of the proposed action (see Section 4.2.5 of this document). However, compared to the proposed action, construction impacts on shellfish resources associated with the Monomoy Shoals Alternative may be somewhat more, because of the longer offshore transmission cable distance to shore and longer construction timeframe associated with work in a location with much greater wave heights. Operational impacts would be similar with respect to shellfish.

Commercial and Recreational Fish and Shellfish

Commercial fishing landing data for the specific fisheries in the Monomoy Shoals Alternative area are not readily available. As with the proposed action described above, the Monomoy Shoals Alternative site would be located within a zone where approximately 250,000 to 500,000 lbs of American Lobster are collected annually (MassGIS Lobster Harvest Zones, 1997). Recreational fishing in the area includes both private recreational vessels and charter services. The prime season for recreational fishing occurs during late spring to late summer and the main target species include striped bass, bluefish, bonito, shark, and several tuna species. Section 4.2.7 of this document provides information on commercial and recreation fish and shellfish for the proposed action. Compared to the proposed action, construction impacts on commercial and recreational fish and shellfish may be somewhat more than the proposed action because of the longer offshore transmission cable distance to shore. Operational impacts would be similar to the proposed action.

5.4.2.2.15 Essential Fish Habitat

Habitat within Monomoy Shoals has been designated EFH for 11 federally managed fish and 3 federally managed invertebrates. Table 5.4.2-2 provides a listing and specific life stage designations of those species within Monomoy Shoals. The proposed action has been designated EFH for 17 federally managed fish and 3 federally managed invertebrates of which 12 species overlap with those listed in Table 5.4.2-2. The EFH species included for Horseshoe Shoal but not the alternative site include windowpane flounder (*Scophthalmus aquosus*), yellowtail flounder (*Limanda ferruginea*), shortfin mako shark (*Isurus oxyrinchus*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), cobia (*Rachycentron canadum*), little skate (*Leucoraja erinacea*), and winter skate (*Leucoraja ocellata*). Since EFH habitat would be affected by both the proposed action and the Monomoy Shoals Alternative, the Magnuson-Stevens Act requires that there be an assessment of potential impacts to the federally managed fish and invertebrate species (NOAA, 2006). No Habitats Areas of a Particular Concern (HAPC) have been identified within the Monomoy Shoals Alternative. Section 4.2.8 of this document provides information on EFH for the proposed action. Compared to the proposed action, construction impacts on EFH may be somewhat more than the proposed action because of the longer offshore transmission cable distance to shore. Operational impacts would be similar.

5.4.2.2.16 Threatened and Endangered Species (T&E)

To access the Barnstable Substation, both the Monomoy Shoals Alternative site and the site of the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route (see Section 4.2.9 of this document for detailed information on endangered and threatened species along this cable route). Compared to the proposed action, impacts on endangered and threatened species along the near shore and onshore cable routes associated with the Monomoy Shoals Alternative would be comparable to and offer no significant environmental advantage over the proposed action.

Monomoy Island and the Monomoy National Wildlife Refuge provide habitat for two federally threatened bird species: bald eagle (*Haliaeetus leucocephalus*) and piping plover (*Charadrius melodus*), and one federally endangered species, the roseate tern (*Sterna dougallii*) (USFWS, 2001a). Since the Monomoy Shoals Alternative site is located outside state waters it is not located in an area identified by NHESP as Estimated or Priority Habitat (USFWS, 2006). However, Estimated and Priority habitat occurs within state waters surrounding Monomoy Island and the Monomoy National Wildlife refuge which are located 4.5 miles (7.2 km) northwest of the alternative site. State listed species known to occur in this area include one state endangered species (roseate tern), one state threatened species (piping plover) and two species of special concern (the USACE, 2004). Six federally and/or state protected species have nested at the Monomoy National Wildlife Refuge (pied-billed grebe, northern harrier, piping plover, roseate tern, and arctic tern (USFWS, 2001a). As the Monomoy Island Alternative is located

close to the avian T&E habitat associated with the Monomoy National Wildlife Refuge, avian T&E impacts would be greater than for the proposed action location.

As shown in [Table 5.4.1-1](#), three federally and/or state protected sea turtle species may be present within the Monomoy Shoals Alternative: loggerhead, leatherback, and Kemp's Ridley sea turtles which can be found within Massachusetts waters at varying times of the year (Kurkul, 2002). Therefore it is possible that they may utilize Monomoy Shoals during some portion of the year as well. The federally protected green sea turtle is less likely to be found within Nantucket Sound. Loggerhead, leatherback, and Kemp's Ridley sea turtles may also use Horseshoe Shoal (see Section 4.2.9 of this document). Compared to the proposed action, impacts on sea turtles with the Monomoy Shoals Alternative would be comparable to and offer no significant environmental advantage over the proposed action.

Overall compared to the proposed action, more impacts on endangered and threatened species would occur as a result of the potential impact of T&E avian species in the vicinity of Monomoy Island and Monomoy National Wildlife Refuge (3.0 to 4.5 miles [4.8 to 7.2 km]).

5.4.2.2.17 Socioeconomic Analysis Area

The existing socioeconomic conditions for the Monomoy Shoals Alternative are similar to those of the proposed action (see Section 4.3 of this document). Compared to the proposed action, impacts on social and economic conditions associated with the Monomoy Shoals Alternative would be comparable to and offer no significant environmental advantage over the proposed action, with respect to construction, operation, and decommissioning impacts.

5.4.2.2.18 Urban and Suburban Infrastructure

To access the Barnstable Substation, both the Monomoy Shoals Alternative and the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route and affect the same urban and suburban infrastructure (see Section 4.3.2 of this document). Compared to the proposed action, impacts on urban and suburban infrastructure within the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.19 Population and Economic Background

The Monomoy Shoals Alternative is located in the same general economic area as the proposed action and is expected to result in negligible or changes in population or the economics of the region. Hence, the Monomoy Shoals Alternative would be comparable to for population and economic impacts and offer no significant advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.20 Environmental Justice

Concerns about environmental justice typically center on areas with higher than average minority populations and higher than average poverty levels. The area of the Monomoy Shoals Alternative is in the same general geographic area as the proposed action and not located near any communities of higher than average minority populations or higher than average poverty rates. It is not located near WTGHA or Mashpee. As such, the Monomoy Shoals Alternative would be expected to be comparable to that of the proposed action with respect to environmental justice and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.21 Visual Resources

The seascape from Monomoy Island east-southeast towards the Monomoy Shoals Alternative site consists of panoramic open views of the Atlantic Ocean. The site is located further from the more populated area of Cape Cod than the proposed action and is thus expected to have fewer visual impacts than the proposed action (see [Figure 3.3.5-6](#) for photo simulations).

5.4.2.2.22 Cultural Resources

To access the Barnstable Substation, both the Monomoy Shoals Alternative and the proposed action would utilize the same near shore cable route, landfall site, and onshore cable route and therefore potentially affect the same onshore cultural resources (see Section 4.3.5 of this document). Compared to the proposed action, impacts on onshore cultural resources within the Monomoy Shoals Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts. With respect to visual impacts on cultural resources (i.e., historic homes and historic sites), this site is located further from the populated and historic areas of Cape Cod and is thus expected to have fewer visual impacts on historic structures than the proposed action.

A review of the NOAA Automated Wreck and Obstruction Information System database indicates that numerous shipwrecks are located within state waters, southeast of South Monomoy; however, there are no mapped shipwrecks shown within the Monomoy Island Alternative area (US DOC, 2002). For the proposed action, three targets with moderate probability of representing submerged historic cultural resources were identified in the vicinity of Horseshoe Shoal. However, the applicant has committed to avoid ground disturbing activities around the detectable limits of each of these potentially sensitive targets. Since a detailed marine sensitivity assessment and marine archaeological reconnaissance survey have not been conducted for the Monomoy Shoals Alternative, it is difficult to determine whether any subtidal archeological resources (i.e., historic or pre-historic sites) would be affected if the proposed facilities were sited at this alternative location. However, if such sites were documented at the alternative site, the applicant would implement mitigative measures similar to those for the proposed action (see Section 4.3.5). Therefore, impacts on subtidal archeological resources within the Monomoy Shoals Alternative would be comparable to those of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.23 Recreational and Tourism Activities

Fishing and boating (power and/or sail), seal-tours, bird watching, and beach-going are common activities among visitors to and off the waters off of Monomoy Island. Public access to state waters is provided at various boat ramps located in harbors and sheltered inlets inside Chatham harbor. The Monomoy Shoals Alternative site is located closer to land (Monomoy Island) and the popular recreational area of Chatham Harbor, but is located further from the popular boating areas around Hyannis and other south Cape Cod harbors than the proposed action. In general, impacts on recreational and tourism activities with the Monomoy Shoals Alternative would be expected to be comparable to those of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.24 Competing Uses of Waters and Sea Bed

The 115 kV offshore transmission cable system from the ESP at the Monomoy Shoals Alternative site to the landfall site at New Hampshire Avenue, within Lewis Bay, would traverse approximately 21.0 miles (33.8 km) of state waters and sea bed. Competing uses that exist along the offshore cable route include aquaculture, submarine electric transmission cables (2 Nantucket cables would be crossed),

recreational and commercial activities, and maintenance dredging activities. The Monomoy Shoals Alternative is located further from the Hyannis and nearby Cape Cod areas used for recreational/boating/fishing and are located closer to recreational/fishing/boating areas around Monomoy Island and Chatham Harbor. In general, the impacts on competing uses of the Monomoy Shoals Alternative are expected to be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.25 Overland Transportation Arteries

Like the proposed action, the Monomoy Shoals Alternative is located offshore and not near any overland transportation arteries and would have a negligible effect on such arteries as a result of onshore equipment deliveries or commuting of workers. Therefore impacts from the Monomoy Shoals Alternative on overland transportation arteries would be expected to be comparable to those of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.26 Airport Facilities

The applicant has received an FAA approval for both the proposed action and for the original Monomoy Shoals Alternative described in the USACE draft EIS (located to the west of Monomoy) indicating that airport facilities would not be affected by this alternative or the original Monomoy Shoals Alternative (see FAA Determinations in [Appendix E](#)). The current Monomoy Shoals Alternative is located to the east of these locations and offset from the navigational flyways between Nantucket and Cape Cod, and Martha's Vineyard and Cape Cod. Therefore it may not interfere with FAA navigational requirement and is likely comparable to the proposed action for impacts to airport facilities with respect construction, decommissioning and operation.

5.4.2.2.27 Port Facilities

The impact on port facilities from the proposed action and its alternatives would primarily be to vessels navigating in the area. Assuming that the spacing of the WTGs remains the same for the alternative locations, the potential impacts to navigation at the Monomoy Shoals Alternative site would be equivalent to the potential impacts for the Nantucket Sound Alternative. Installation of the wind turbines would result in structures being present where no structure has previously existed and mariners would need to navigate with consideration of these new structures. The Monomoy Shoals Alternative site is located further from Hyannis and nearby Cape Cod and associated ports and vessel traffic, but is located closer to the vessel traffic areas associated with Monomoy Island and Chatham Harbor. Like the proposed action location, the Monomoy Alternative is also located on a shoal and thus setback from navigation channels and in a location where vessel traffic is not likely to occur. The Monomoy Shoals Alternative would be comparable to that of the proposed action and offer no significant advantage to Ports and associated vessel traffic over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.2.2.28 Communication: EMF, Signals and Beacons

Recreational vessels, commercial fishing and marine cargo ships traverse the area of Monomoy Shoals Alternative via channels to the north and south of the Monomoy Shoals Alternative. All of these vessels use marine radios, which operate at a range of 156.05 to 157.425 MHz. Shore radios operate at approximately 156.85 to 162.025 MHz. The NOAA weather service operates at frequencies between 162.4 and 162.55 MHz. Impacts on marine radar and other telecommunication devices are expected to be generally the same as for the proposed action and the Monomoy Shoals Alternative and offer no significant advantage to communications over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3 Smaller Project Alternative

5.4.3.1 Description of the Smaller Project Alternative

The Smaller Project Alternative is located in the same general area as the proposed action but contains only half the number of monopiles, and thus has half the generation capacity of the proposed action. Each monopile included in the Smaller Project Alternative is located within a footprint of a monopile of the proposed action. For the proposed Smaller Project Alternative, the monopile locations along the north and south of the turbine array have been removed, making it further from Cape Cod and from Nantucket than the proposed action (See [Figure 3.3.5-1](#), which shows the Smaller Project Alternative superimposed over the proposed action). Further detail on the location of the Smaller Project Alternative is shown in [Figure 3.3.6-1](#).

5.4.3.2 Environmental Resources of the Smaller Project Alternative and Comparison with the Proposed Action

5.4.3.2.1 Regional Geologic Setting

The geological setting of the Smaller Project Alternative is the same as the proposed action though impacts are focused on a smaller geographic area. The area of Horseshoe Shoal is generally composed of medium sands dominating the shallow water sediments and poorly graded fine and silty sands located in the deeper shoal waters. The geologic setting of the Smaller Project is therefore comparable to and offers no significant environmental advantage over the geographic setting of the proposed action with respect to construction, decommissioning and operation. Geomorphology is also expected to be the same.

5.4.3.2.2 Noise

Noise impacts to humans would be reduced under the Smaller Project Alternative as the alternative would be located further from both Cape Cod and from Nantucket, and because there would be half as many wind turbines to construct and decommission, and hence a shorter construction time. Operational noise would also be reduced due to the smaller number of turbines and further distance to land. Underwater noise during construction would be reduced due to the reduced number of turbines. In summary, the noise impacts of the Smaller Project Alternative are less than the proposed action and therefore provide some reduction in noise impacts due to construction, decommissioning and operation.

5.4.3.2.3 Physical Oceanography

Water depths for the Smaller Project Alternative are the same as for the proposed action since they are at the same location. Tides, current speed and wave conditions are also the same. Overall, the physical oceanography impacts of the Smaller Project Alternative would be expected to be comparable to those of the proposed action with respect to construction, decommissioning and operation.

5.4.3.2.4 Climate and Meteorology

The weather conditions for the Smaller Project Alternative are the same as for the proposed action as they are at the same location. Compared to the proposed action, impacts due to climate and meteorology would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.5 Air Quality

Vessels and equipment involved in the pre-construction G&G investigations, construction and decommissioning phases of this alternative would emit, or have the potential to emit air pollutants. The vessels and equipment involved in constructing (and decommissioning) the Smaller Project Alternative

would emit fewer air contaminants as compared to the original 130 WTG configuration, however the emissions reductions are not anticipated to be proportional to the 50 percent reduction in WTGs for the following reasons:

- The frequency of mobilization and demobilization of major construction vessels for each distinct segment of construction (pile foundation installation; ESP installation; WTG installation; 115 kV cable installation and 33 kV installation) would not change.
- Emissions related to G&G activities are not expected to be significantly different.
- Emissions related to the installation of the ESP would remain the same.
- Emissions related to the installation of the temporary cofferdam at landfall would remain the same.
- The total number of vessel trips and /or the duration of deployment required to complete the small alternative WTGs (pile installation; tower, nacelle and rotor installation; and scour protection installation) would be approximately 50 percent less than those estimated for the proposed action.
- Emissions related to installation of the 115 kV cable system would be a small percentage greater for the Smaller Project Alternative as compared to the proposed action due to an additional one mile (1.6 km) of cable required to connect to the re-sited ESP.
- Emissions related to the installation of the 33 kV inner-array cables for the small alternative would be approximately 55 percent less due to the lower number of cable miles (29.7 miles versus 66.7 miles [47.8 km versus 107.3 km]).

As a result, it is anticipated that the overall emissions from the construction vessels and equipment related to the Smaller Project Alternative would be substantially reduced relative to those estimated for the proposed action. Similarly the emissions due to decommissioning activities for the small alternative would be expected to be reduced relative to those resulting from the proposed action. However, given the normal vessel traffic volumes regularly experienced in the proposed action area, and the limited timeframe of the construction period, the impacts of air emissions from the construction and decommissioning of either alternative would be considered minor on a local and regional scale.

Maintenance activities would consist of small vessels transiting to and from the proposed action area in order to service the WTGs and/or ESP. This vessel traffic represents an insignificant increase in traffic over current levels in Nantucket Sound, and is not expected to impact air quality in the proposed action area or the region.

5.4.3.2.6 Water Quality

A reduction in WTGs from 130 to 65 would not have a strictly proportional reduction in impacts to water quality related to sediment disturbance. By reducing the number of WTGs to 65 under the smaller alternative, the temporary impacts to sediments related to the WTGs are reduced roughly proportional to the number of WTGs. Impacts related to the installation of the 115 kV offshore transmission cable system would increase by one mile (1.6 km) as the Smaller Project Alternative is further from shore. The total temporary impacts related to the construction of the smaller alternative would be less, using rock armor, than the comparable impacts estimated for the proposed action.

Other impacts to water quality associated with the construction/decommissioning of the Smaller Project Alternative would be the potential for oil spills related to work vessels transiting to and from the Project Area. The marine vessels used to transport maintenance workers and equipment would be required to operate under USCG regulations. Also, an OSRP would be in place during construction/decommissioning to prevent/control potential impacts to water quality that could result from spills of fuel, lubricating oils, or other substances associated with the use of marine vessels and machinery. Because the number of vessels required to transit to and from the Project area during construction would decrease with the Smaller Project Alternative, the probability of marine vessels spilling fuel, lubricating oils or other substances would also decrease.

Operation of the revised 65 WTG layout is not anticipated to impact hydrodynamics or water quality. The only changes in the potential impacts to water quality associated with the operation of the Smaller Project Alternative would be the decrease in the size of the ESP. This would result in a decrease in the total number of gallons of electrical insulating oil utilized on the ESP. The proposed action of 130 WTGs would require the ESP to contain approximately 40,000 gallons (151,400 liters) of naphthenic mineral oil for cooling the ESP transformers. The revised layout would likely decrease to approximately 20,000 gallons (75,700 liters) of oil. Based on analyses conducted for the proposed alternative for oil spill probabilities and impacts which showed that probabilities of a large spill are extremely small, it is anticipated that the smaller alternative would also have small probabilities of a large spill of fluids from the ESP.

Maintenance activities would consist of small vessels transiting to and from the Project area in order to service the WTGs and/or ESP. This vessel traffic represents an insignificant increase in traffic above current levels in Nantucket Sound, and would not impact water quality in the Project area.

Overall, the water quality impacts of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint and smaller impact area.

5.4.3.2.7 Electric and Magnetic Fields

Electric and magnetic field strength of the Smaller Project Alternative would be less than the proposed action as the Smaller Project Alternative has half the generation capacity and thus a smaller amount of electrical current in its interconnection cable and smaller EMFs than the proposed action. However, EMF impacts are negligible under the proposed action and thus reductions in the levels result in no advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.8 Terrestrial Vegetation

Impacts of the Smaller Project Alternative on terrestrial vegetation as a result of cable construction work on land would be the same as those of the proposed action. Therefore the impacts on terrestrial vegetation from the Smaller Project Alternative would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.9 Coastal and Intertidal Vegetation

To access the Barnstable Substation, both the Smaller Project Alternative and the proposed action would utilize the same near shore cable route and landfall site (see Section 4.2.2 of this document for detailed information on coastal and intertidal vegetation). Compared to the proposed action, impacts on coastal and intertidal vegetation within the Smaller Project Alternative, including its offshore

transmission cable system would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.10 Terrestrial and Coastal Faunas Other than Birds

Impacts of the Smaller Project Alternative on Terrestrial and Coastal Faunas other than birds would be the same as those of the proposed action as work within the terrestrial area and along the coast would be the same. Therefore the impacts on terrestrial and coastal faunas other than birds would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.11 Avifauna

According to research completed for the proposed action, it is expected that some temporary displacement of birds would result from the disturbance associated with construction/decommissioning activities (increased vessel traffic, presence of equipment, human presence, and noise). Sediment plumes could cause fish to avoid the construction site, which could also temporarily displace some avian species. Because the number and size of the proposed action components would decrease as a result of the revised layout, the number of construction/decommissioning events that could potentially displace the birds would similarly decrease over that of the proposed action.

Maintenance activities would consist of small vessels transiting to and from the Project area in order to service the WTGs and/or ESP. This vessel traffic represents an insignificant increase in traffic over current levels in Nantucket Sound, and would not impact avifauna in the Project area.

Overall, the impacts to avifauna of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller size footprint and fewer turbines.

5.4.3.2.12 Subtidal Offshore Resources

The oceanographic conditions and predominantly sandy sediments on Horseshoe Shoal combine to produce a dynamic, shifting substrate that favors benthic communities of relatively low diversity. However, the shallow depths of Horseshoe Shoal also allow for a relatively high density and biomass of benthic organisms. Total invertebrate abundance is highly variable from site to site due to the high degree of environmental variability found on Horseshoe Shoal.

Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact due to the WTG and ESP piles is 0.33 acres (1,335 m²) for the Smaller Project Alternative (as compared to 0.67 acres [2,711 m²] for the proposed 130 WTG layout).

Temporary impacts to benthic resources would be caused by anchoring activities associated with cable-laying and decommissioning activities (anchors, anchor sweep, pontoons) and the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of scour control structures (scour mats and/or rock armor). A reduction in WTGs from 130 to 65 would not have a strictly proportional reduction in impacts to benthic communities for the following reasons.

- The smaller alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 29.7 miles (107.3 km to 47.8 km).

- This would result in a reduction of temporary impacts to benthic habitats from 580 acres to 258 acres (2.3 to 1.04 km²).
- The smaller alternative would increase the length of the 115 kV cable connecting the ESP to the landfall site in Lewis Bay from 12.5 miles to 13.5 miles (20.1 to 21.7 km). This is due to the ESP being sited further to the west in order to provide a more centralized location for connection of the smaller alternative 33 kV cables. This would increase the temporary impacts to benthic habitat from 86 acres to 104 acres (0.3 to 0.4 km²).
 - With the smaller alternative, temporary impacts to benthic habitat from the jack-up barges used to install the WTGs and ESP would decrease from 9.4 acres to 4.81 acres (38,041 to 19,465 m²). Under the revised layout, temporary impacts to benthic habitat from the construction and placement of scour control structures would be reduced from 3.0 acres to 1.6 acres (12,141 to 6,475 m²) with scour mats and from 57 acres to 29 acres (0.2 to 0.1 km²) if rock armor is used.
 - For the complete summary of maximum anticipated temporary and permanent impacts to benthic habitat for the Smaller Project Alternative (see [Tables 5.4.3-1](#) and [5.4.3-2](#)).

By reducing the number of WTGs to 65 under the Smaller Project Alternative, the temporary impacts to benthic habitat and resources related to the WTGs are reduced roughly proportional to the number of WTGs. Impacts related to the installation of the 115 kV cable outside of the 3 mile (4.8 km) limit would increase in proportion to the additional one mile (1.6 km) of cable. The impacts inside of state waters would remain unchanged. The total temporary impacts related to the construction of the smaller alternative would be approximately 39 percent less, using rock armor, than the comparable impacts estimated for the proposed 130 WTG alternative.

During operation the number of WTG monopiles, would reduce the number of structures that would provide new localized hard-bottom habitats for benthic resources to inhabit. These benthic macro invertebrates and fouling organisms are anticipated to attract prey and larger finfish to the monopiles.

Overall, the benthic impacts of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint and impact area.

5.4.3.2.13 Non-ESA Marine Mammals

The marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the Smaller Project Alternative area include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale. The two types of potential harassment that may occur during construction are vessel strikes and noise. Both types of harassment are classified as Level A and Level B harassments under the 1994 Amendments to the MMPA. There would be some potential for reduction of impacts to marine mammals with the Smaller Project Alternative as there would be half as many WTGs and thus half as many vessel trips and chances for vessel strikes.

Underwater noise impacts associated with the operation of the WTGs are not expected to cause Level A harassment to non-ESA mammals. The operations and maintenance plan would not be significantly altered with a reduction in the number of WTGs. Similar maintenance intervals would be expected for the smaller alternative, with a reduction in the number of WTGs still requiring approximately 325 maintenance days (5 days/WTG x 65 WTGs). It is assumed that 2 crews would be retained to perform the

required maintenance; however the number of vessel trips for maintaining the smaller alternative would be expected to be the same as for the proposed alternative. The crew boat would transport and drop off two crews rather than three crews during each deployment.

Overall, the non-ESA mammal impacts of the Smaller Project Alternative would be expected to be less for construction and decommissioning and about the same for maintenance activities.

5.4.3.2.14 Fish and Fisheries

In general, the disturbance to benthic habitats would be short-term and localized because many benthic invertebrates are adapted to high energy environments such as the Smaller Project Alternative area, and are capable of opportunistically re-colonizing benthic sediments after disturbance. Thus, fish species that prey on benthic species would be impacted temporarily during construction. Shellfish species spawn, at a minimum, once per year, and would likely resettle the disturbed areas within one or two years. The changes in temporary impacts to fisheries mirror those outlined in the Benthic discussion of the Smaller Project Alternative, and are as follows:

- Length of 33 kV cable needed to connect the WTGs to the ESP would decrease from 66.7 miles to 29.7 miles (107.3 to 47.8 km) = reduction of temporary impacts to benthic habitats from 580 acres to 258 acres (2.3 to 1.04 km²).
- Length of the 115 kV cable connecting the ESP to the 3 mile boundary would increase from 4.9 miles to 5.9 miles (7.9 to 9.5 km) = increase in temporary impacts to benthic habitat from 86 acres to 104 acres (0.3 to 0.4 km²).
- Temporary impacts to benthic habitat from the jack-up barges used to install the WTGs and ESP would decrease from 9.4 acres to 4.81 acres (38,040 to 19,465 m²).
- Temporary impacts from the construction and placement of scour control structures would be reduced from 3.0 acres to 1.6 acres (12,141 to 6,475 m²) with scour mats; 57 acres to 29 acres (230,671 to 117,359 m²) if rock armor is used.

The changes in impacts to fish and shellfish with the revised layout are roughly proportional to the reduction in habitat disturbed from construction of the 33 kV cable, scour control structures, and the use of the jack-up barges. The permanent impacts to fish and shellfish from the placement of the WTG and ESP piles would be decreased from 0.67 acres to 0.33 acres (2,711 to 1,335 m²). Mortality and injury due to cabling activities would be limited to demersal fish and shellfish located in the direct path of the jet plow and or anchoring equipment. The revised 65 WTG layout would potentially increase this impact along the 115 kV route and decrease the impact for the 33 kV route.

Operation of the Smaller Project Alternative would result in half as much new hard bottom substrate associated with the monopiles, which would reduce the area for new reef-like effects that would alter fish or shellfish communities.

The potential impacts to fish from EMF and thermal emissions from the normal operation of the offshore cables are expected to be negligible (These findings are discussed in further detail in the final EIR Appendix Sec. 3.7-C). The burial depth (6 ft) of the offshore cable systems would minimize the EMF and thermal impacts to shellfish resources. By reducing the number of WTGs from 130 to 65, there would be no significant reduction to these negligible impacts that have already been mitigated in the proposed layout.

Overall, impacts on fisheries of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint and impact area.

5.4.3.2.15 Essential Fish Habitat (EFH)

The revised 65 WTG layout under the Smaller Project Alternative would decrease the area of permanent EFH impacts from 0.67 acres to 0.33 acres. Potential temporary impacts to EFH due to construction include physical displacement of sediments due to cable installation and pile driving, suspended sediments in the water column, and acoustical impacts.

The temporary impacts to benthic EFH would result from jet plow embedment of the 33 kV and 115 kV cables, the installation of the scour control mats and/or rock armor, and the vessel positioning and anchoring activities that would be associated with all structures. Temporary disturbances of the proposed action would total up to 812 acres with scour control mats or 866 acres with rock armoring. Under the small alternative layout, these disturbances would decrease to 502 acres with scour control mats or 529 acres with rock armoring. The areas of benthic habitat that would be temporarily affected by construction activities are expected to recover relatively rapidly, allowing for the EFH functions of affected areas to be restored.

The Smaller Project Alternative layout would not alter the route of the 115 kV cable inside Lewis Bay. Therefore, no changes in the potential impacts to these EFH resources would occur (i.e., no changes to winter flounder impacts) with the revised layout).

The operation of the proposed action has the potential to alter EFH due to acoustical interference caused by the WTGs, the “reef effect” associated with placing hardened structures in a soft bottom substrate, EMF, and changes to water flow and sediment transport. The Smaller Project Alternative would reduce the potential for these impacts. For instance, as the Smaller Project Alternative has half the number of piles it would result in reduced duration of pile driving noise, reduced amount of hard area that could create a reef effect, and reduced EMF levels. Overall, impacts on EFH from the Smaller Project Alternative would be expected to be less than the proposed action with respect to construction, decommissioning and operation.

5.4.3.2.16 Threatened and Endangered Species (T&E)

The Smaller Project Alternative would have a smaller affected area and would therefore reduce impacts to T&E species by limiting disturbance during construction compared to the proposed action. Disturbance associated with construction/decommissioning activities such as increased vessel traffic, presence of equipment, human presence, and noise would be reduced as a result of the Smaller Project Alternative scope and shorter duration of pile driving activities. The Smaller Project Alternative would also result in less interconnection disturbance between the individual WTGs and hence reduce the sediment plumes which could cause fish to avoid the construction site and displace some avian T&E species. The Smaller Project Alternative would reduce the number of wind turbines by half and thus could be expected to reduce the amount of avian T&E collisions predicted for the proposed action by half.

Because the number and size of the Smaller Project Alternative components would decrease as a result of the revised layout, the number of construction/decommissioning events that could potentially displace birds would similarly decrease over that of the proposed action.

Maintenance activities would consist of small vessels transiting to and from the WTG array area in order to service the WTGs and/or ESP. This vessel traffic represents an insignificant increase in traffic above current levels in Nantucket Sound, and would not impact avifauna in the area.

Overall, the impacts to avifauna of the Smaller Project Alternative would be expected to be less than those of the proposed action with respect to construction, decommissioning and operation because of its smaller footprint size and fewer WTGs.

5.4.3.2.17 Socioeconomic Analysis Area

The existing social and economic conditions for the Smaller Project Alternative are similar to those of the proposed action as it is in the same geographic location. Compared to the proposed action, socioeconomic impacts associated with the Smaller Project Alternative would be less in terms of number of construction jobs, electricity generated and revenues from taxes, than from the larger proposed action.

5.4.3.2.18 Urban and Suburban Infrastructure

To access the Barnstable Substation, both the Smaller Project Alternative and the proposed action would utilize the same near shore cable route, landfall site a, and onshore cable route and affect the same urban and suburban infrastructure (see Section 4.3.2 of this document). Compared to the proposed action, impacts on urban and suburban infrastructure associated with the Smaller Project Alternative, including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.19 Population and Economic Background

The Smaller Project Alternative is located in the same general geographic area as the proposed action and is expected to result in negligible changes in population or the economy of the region. Hence, the Smaller Project Alternative would be comparable to and offer no significant advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.20 Environmental Justice

Concerns about environmental justice typically center on areas with higher than average minority populations and higher than average poverty levels. The area of the Smaller Project Alternative is in the same location, and same socioeconomic area as the proposed action. It is not located near any communities of higher than average minority populations or close to the tribal lands of the WTGHA or the Wampanoag Tribe of Mashpee. As such, the Smaller Project Alternative would be expected to be comparable to that of the proposed action with respect to environmental justice and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.21 Visual Resources

Visual impacts of the Smaller Project Alternative would be less than those associated with the proposed action. The views of the facility show a somewhat reduced breadth of visual impacts when looking out at the horizon and it is somewhat further away from Nantucket and Cape Cod (see [Figure 3.3.6-2](#) which shows visual simulations of the Smaller Project Alternative). Construction impacts would also be reduced due to the shorter period of construction, and less time when large construction vessels would be visible. Compared to the proposed action, visual impacts would be less than the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.22 Cultural Resources

The Smaller Project Alternative has the same monopile locations (though fewer) as the proposed action, though some inner-array cables between the monopiles are located in different areas. This area

has been assessed for underwater cultural resources and it was found that this configuration would not impact such resources. The onshore portion of the cable work is in the same location as the proposed action, and therefore there would be no change in archaeological impacts. Visual impacts to historic structures may be reduced due to the more limited area occupied by the turbine array and because it is further away from the Cape Cod and Nantucket shorelines than the proposed action (see [Figure 3.3.6-2](#)).

5.4.3.2.23 Recreation and Tourism

The Smaller Project Alternative is located in the same general location as the proposed action but covering a smaller area. Impacts to recreation boating would be reduced as there would be a smaller area of turbines to navigate through by recreational vessels. The breadth of visual impact from Cape Cod would appear somewhat smaller as well, though this change would not likely result in any measurable impact on tourism over that of the proposed action. (Refer to visual resource discussion above). Overall, impacts to recreation and tourism from the Smaller Project Alternative would be comparable to and offer no advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.24 Competing Uses

Competing uses in the vicinity of the Smaller Project Alternative are the same as for the proposed action and are limited to Commercial and Recreational Fishing and Boating, and the potential for maintenance dredging of nearby channels. The impact of the proposed action on these competing uses was determined to be minor. As the Smaller Project Alternative is smaller than the proposed action, it would have even less of a potential to impact competing uses in the area.

5.4.3.2.25 Overland Transportation Arteries

The Smaller Project Alternative is located in the same area as the proposed action and not near any overland transportation arteries. It would have a negligible effect on such arteries as a result of onshore equipment deliveries or commuting of workers. Therefore impacts from the Smaller Project Alternative on overland transportation arteries would be expected to be comparable to those of the proposed action and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.26 Airport Facilities

The Smaller Project Alternative is located in the same area as the proposed action but spread out over a smaller area. The proposed action received FAA approval indicating that it would not affect navigation or associated communication systems (Refer to [Appendix E](#)) and therefore the Smaller Project Alternative would also not affect airport facilities. In summary, the Smaller Project Alternative would be expected to be comparable to that of the proposed action with respect to impacts on Airport Facilities and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.3.2.27 Port Facilities

The Smaller Project Alternative is smaller than the proposed action and hence is less likely to impact port facilities and marine traffic related to port facilities. Overall, the impacts on port facilities from the Smaller Project Alternative would be expected to be comparable to those of the proposed action with respect to construction, operation, and decommissioning.

5.4.3.2.28 Communications: Electromagnetic Fields, Signals and Beacons

The Smaller Project Alternative is located in the same area as the proposed action but covers a smaller area. The assessment for the proposed action found that impacts on entertainment satellite, entertainment broadcasting services, (AM, FM and TV stations), non-emergency ship-to-shore communications (cellular communications and VHF frequencies in the marine band), navigation and positioning services, LORAN, safety and emergency communications, sub-sea communication cables, and Micro Wave Communications would be minor (see Section 5.3.4.4). As the Smaller Project Alternative would have less surface area, it would have less effect on communication devices for those navigating in the area. As a result, the Smaller Project Alternative is expected to have comparable or less impacts than the proposed action.

5.4.4 Phased Development Alternative

5.4.4.1 Description of the Phased Development Alternative

In order to facilitate the study of a phased approach to constructing the proposed action of 130 WTGs, it was determined that for illustrative purposes, a 50/50 split would be most effective. A split in the proposed action of 130 WTGs into two phases was accomplished by dividing the proposed action into an eastern half and a western half, each containing 65 WTGs (see [Figure 3.3.5-1](#)). The initial 65 WTG phase would be designed to allow expansion to 130 WTGs with as little re-construction as possible. The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system) used in this Phased Development Alternative are the same as presented in the proposed action.

Phase I:

The western half of the proposed action would be constructed during the first phase primarily because the 65 westernmost turbine sites would be located in the shallower waters of Horseshoe Shoal and would be more regularly spaced in closer proximity to each other allowing for the least amount of inner-array 33 kV cable for interconnection to the ESP. This would be the least costly construction of the two phases, thereby reducing interest costs of financing during construction on the overall two phase project. Assuming that assurances were in place for the completion of both phases, the ESP and the complete 115 kV transmission system (both circuits for the offshore and upland components) would be completed during Phase I allowing for power from the first 65 WTGs to be transformed and transmitted into the regional power grid. Both the ESP structure and the complete 115 kV offshore transmission cable system would be the same as those for the proposed action; however some portion of the electrical equipment on the ESP would be delayed until the second phase. The construction of the ESP and the installation of the 115 kV transmission cable along the eastern edge of the first phase eliminates (to the greatest degree possible) the need to conduct Phase II installation activities (eastern half) within the area of the operating first phase of the alternative. Phase I will include 65 turbines connected in 7 full strings (each made up of 8 to 10 WTGs) and one partial string (3 WTGs), requiring approximately 32.7 miles (52.6 km) of 33 kV inner-array cable (see [Figure 3.3.6-3](#)).

Phase II:

The eastern half of the WTG array would be constructed during the second phase. In general, a developer would seek to minimize the time between the construction of the first and second phases in order to minimize the lag time and costs associated with:

- Procurement of equipment;
- Staging area acquisition and build out;

- Mobilization of construction and installation equipment and labor; and
- At sea construction.

For analysis purposes, Phase II would be scheduled within a reasonable time frame of five to ten years to coincide with the state's continued desire for renewable energy sources should renewable energy still be mandated. Construction of phase two within five years would not be considered a phased approach due to the short length of time between construction cycles. Construction of phase two beyond ten years is not considered reasonable due to anticipated change to the underlying purpose and need for this project.

The balance of the ESP electrical equipment required for the additional 65 WTGs would be installed during Phase II. For the purposes of this analysis it is assumed that the complete 115 kV offshore transmission cable system would be installed during the first phase. Phase II will include 65 turbines connected in 6 full strings (each made up of 9 or 10 WTGs) and the addition of 7 WTGs to one partial string of 3 WTGs that would have been installed in Phase I. Phase II will require approximately 34.0 miles (54.7 km) of 33 kV inner-array cable (see [Figure 3.3.6-3](#)).

Decommissioning

Because it is assumed that all of the WTGs will have the same effective useful life (approximately 20 years), the decommissioning of the Phased Development Alternative will also be conducted in phases to correspond to the phased construction and duration of lag time. Phase I of the decommissioning would remove the WTGs, scour protection, and inner-array cables that were installed 20 years prior during Phase I (western half of the WTG array). Following a period of time equal to the lag between construction phases, Phase II of the decommissioning would take place 20 years after the completion of the Phase II construction and would remove the eastern half WTGs, scour protection and inner-array cables, along with the ESP and the interconnecting 115 kV transmission system. Similar to the construction phases, the decommissioning of the Phased Development Alternative will require multiple mobilizations/demobilizations and staging and is expected to have similar impacts as the phased construction.

5.4.4.2 Environmental Resources of the Phased Development Alternative and Comparison with the Proposed Action

5.4.4.2.1 Regional Geologic Setting

The geological setting of the Phased Development Alternative is the same as the proposed action. The area of Horseshoe Shoal is generally composed of medium sands dominating the shallow water sediments and poorly graded fine and silty sands located in the deeper shoal waters. The geologic setting of the Phased Development Alternative is therefore comparable to and offers no significant environmental advantage over the geologic setting of the proposed action with respect to construction, decommissioning and operation. Geomorphology is also expected to be the same.

5.4.4.2.2 Noise

Noise impacts to humans would be increased under the Phased Development Alternative due to the longer construction and decommissioning time frames resulting from multiple mobilizations, demobilization and staging operations. Operational noise during Phase I would be less, however once the second Phase is completed there will be no difference between the Phased Development Alternative and the proposed action. The duration of underwater noise during construction would be less during each individual phase followed by some period of time with little or no construction activities. In general

noise impacts would be comparable and offer no significant environmental advantage with respect to noise impacts compared to the proposed action during construction, operations and decommissioning.

5.4.4.2.3 Physical Oceanography

Water depths for the Phased Development Alternative are the same as for those for the proposed action since they are at the same location. Tides, current speed and wave conditions are also the same. Overall, the physical oceanography impacts of the Phased Development Alternative would be expected to be similar to those of the proposed action with respect to construction, decommissioning and operation.

5.4.4.2.4 Climate and Meteorology

The weather conditions for the Phased Development Alternative are the same as for the proposed action as they are at the same location. The Phased Alternative would result in slightly more CO₂ emissions (a green house gas) than the proposed action due to the added work associated with two construction mobilizations. However, in general impacts to climate and meteorology would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.5 Air Quality

Vessels and equipment involved in the pre-construction G&G investigations, construction and decommissioning phases of the proposed action would emit, or have the potential to emit air pollutants. Although the air emissions for much of the Phased Development Alternative would be similar to the proposed action (emissions related to G&G, ESP installation, cable installation, and operations), the vessels and equipment involved in constructing and decommissioning the Phased Development Alternative would emit greater amounts of air contaminants as compared to the proposed action. The increased air emissions would be the result of multiple mobilizations and demobilizations of major construction vessels for pile foundation installation/decommissioning and WTG installation/decommissioning related to each distinct development phase. The total number of vessel trips and/or the duration of deployment required to complete the Phased Development Alternative would also be greater than if the proposed action was constructed and decommissioned from start to finish. As a result, it is anticipated that the overall emissions from the construction/decommissioning vessels and equipment related to the Phased Development Alternative would be greater than those estimated for the proposed action.

5.4.4.2.6 Water Quality

Water quality impacts related to construction (and decommissioning) of the Phased Development Alternative would be greater as the result of multiple mobilizations and demobilizations of major construction vessels for pile foundation installation and WTG installation related to each distinct development phase. The total number of vessel trips and/or the duration of deployment required to complete the Phased Development Alternative would also be greater than if the proposed action was constructed from start to finish. Water quality impacts from the cable installations (both 33 kV and 115 kV) will be the same for the both alternatives.

Other impacts to water quality associated with the construction/decommissioning of the Phased Development Alternative would be the potential for oil spills related to work vessels transiting to and from the area of the proposed action. Because the overall construction (and decommissioning) duration and number of vessel trips required to transit to and from the area of the proposed action would increase with the Phased Development Alternative, the probability of marine vessels spilling fuel, lubricating oils or other substances would increase.

Additionally, the Phased Development Alternative would delay the installation of some portion of the electrical equipment on the ESP until the second phase. This would likely involve the installation of one or more transformers at sea to accommodate the Phase II WTGs, along with an additional at-sea transfer of a significant amount of transformer oil (approximately 10,000 gallons [37,850 liters] per transformer). In comparison the ESP for the proposed action would be outfitted in Port and towed to the site for installation. This additional phased build-out of the ESP presents a greater chance for a potential spill during installation and transfer, thereby further increasing the potential for impacts to water quality during the construction of the Phased Development Alternative.

During operation the temporary water quality impacts of the Phased Development Alternative would be less than those associated with the proposed action following the completion of Phase I and prior to the installation of Phase II. Once the Phased Development Alternative is completed, there would be no difference in water quality impacts related to operations, between the Phased Development Alternative and the proposed action. Overall, the water quality impacts of the Phased Development Alternative would be expected to be greater than those of the proposed action with respect to construction and decommissioning. The impacts would be similar with respect to operation.

5.4.4.2.7 Electric and Magnetic Fields (EMFs)

Electric and magnetic field strength of Phase I would be less than the proposed action because it would have half the generating capacity and thus a smaller amount of electrical current in its offshore transmission cable system and smaller EMF's than the proposed action. However once the second phase of the development becomes operational, there would be no difference in EMF levels between the Phased Development Alternative and the proposed action. As a result, EMF impacts would be comparable and offer no significant environmental advantage with respect to EMF impacts compared to the proposed action during construction, operations and decommissioning.

5.4.4.2.8 Terrestrial Vegetation

Impacts of the Phased Development Alternative on terrestrial vegetation as a result of cable construction work on land would be the same as those of the proposed action. Therefore the impacts on terrestrial vegetation from the Phased Development Alternative would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation and decommissioning impacts.

5.4.4.2.9 Coastal and Intertidal Vegetation

To access the Barnstable Substation, both the Phased Development Alternative and the proposed action would utilize the same near shore cable route and landfall site (see Section 4.2.2 of this document for detailed information on coastal and intertidal vegetation). Compared to the proposed action, impacts on coastal and intertidal vegetation within the Phased Development Alternative, including its offshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation and decommissioning impacts.

5.4.4.2.10 Terrestrial and Coastal Faunas Other than Birds

Impacts of the Phased Development Alternative on Terrestrial and Coastal Faunas other than birds would be the same as those of the proposed action as work within the terrestrial area and along the coast would be the same. Therefore the impacts on terrestrial and coastal faunas other than birds would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.11 Avifauna

According to research completed for the proposed action, it is expected that some temporary displacement of birds would result from the disturbance associated with construction/decommissioning activities (increased vessel traffic, presence of equipment, human presence, and noise). Sediment plumes could cause fish to avoid the construction site, which could also temporarily displace some avian species. Impacts to birds during construction (and decommissioning) of the Phased Development Alternative is expected to be greater than the proposed action as the result of the longer construction/decommissioning time frames and multiple mobilizations and demobilizations of major construction vessels for pile foundation installation/decommissioning and WTG installation/decommissioning related to each distinct development phase. The total number of vessel trips and/or the duration of deployment required to complete/decommission the Phased Development Alternative would also be greater than if the proposed action was constructed from start to finish. Overall, the impacts to avifauna of the Phased Development Alternative would be expected to be greater than those of the proposed action with respect to construction and decommissioning. The impacts would be similar with respect to operation.

5.4.4.2.12 Subtidal Offshore Resources

The oceanographic conditions and predominantly sandy sediments on Horseshoe Shoal combine to produce a dynamic, shifting substrate that favors benthic communities of relatively low diversity. However, the shallow depths of Horseshoe Shoal also allow for a relatively high density and biomass of benthic organisms. Total invertebrate abundance is highly variable from site to site due to the high degree of environmental variability found on Horseshoe Shoal.

Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact due to the WTG and ESP piles would be the same for both the Phased Development Alternative and the proposed action (0.67 acres [0.003 km²]).

Temporary impacts to benthic resources would be caused by anchoring activities associated with cable-laying and decommissioning activities (anchors, anchor line sweep, jet plow pontoons) and the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of scour control structures (scour mats and/or rock armor). There would be some increase in anchoring impacts related to the increased overall number of vessel trips and multiple construction mobilization/demobilizations. During operation the WTGs will provide new localized hard-bottom habitats for benthic resources to inhabit. These benthic macro invertebrates and fouling organisms are anticipated to attract prey and larger finfish to the monopiles. Because of the localized, temporary nature of impacts related to the WTGs, there is no anticipated benefit or impact related to the phased approach with respect to operation.

Overall, the impacts to benthic resources of the Phased Development Alternative would be expected to be somewhat greater than those of the proposed action with respect to construction and decommissioning. The impacts would be similar with respect to operation.

5.4.4.2.13 Non-ESA Marine Mammals

The marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the proposed action include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale.

The two types of potential harassment that may occur during the construction of the proposed action are vessel strikes and noise. Both types of harassment are classified as Level A and Level B harassments under the 1994 Amendments to the MMPA. Because of an increased chance for vessel strike due to the increased number of vessel trips and the multiple mobilizations/demobilizations involved with the Phased Development Alternative, there is some potential for an increase of construction and decommissioning impacts to marine mammals from the Phased Development Alternative as compared to the proposed action.

The operations and maintenance plan would not be significantly altered with the phased development approach. Similar maintenance intervals would be expected for Phase I, with the 65 WTGs still requiring approximately 325 maintenance days (5 days per turbine). During the first phase it is assumed that 2 crews would be retained to perform the required maintenance; however the number of vessel trips for maintaining the smaller first phase would be expected to be the same as for the proposed action. The crew boat would transport and drop off two crews rather than three crews during each deployment. Once Phase II is completed and all 130 WTGs become operational the impacts from the Phased Development Alternative will be similar to the proposed action.

Overall, the non-ESA mammal impacts of the Phased Development Alternative would be expected to be somewhat greater for construction and decommissioning, and comparable for operations as compared to the proposed action.

5.4.4.2.14 Fish and Fisheries

In general, the disturbance to benthic habitats would be short-term and localized because many benthic invertebrates are adapted to high energy environments such as the area of the proposed action, and are capable of opportunistically re-colonizing benthic sediments after disturbance. Thus, fish species that prey on benthic species would be impacted temporarily during construction. Shellfish species spawn, at a minimum, once per year, and would likely resettle the disturbed areas within one or two years.

The changes in temporary impacts to fisheries mirror those outlined in the benthic discussion of the Phased Development Alternative. Temporary impacts to benthic resources would be caused by anchoring activities associated with cable-laying and decommissioning activities (anchors, anchor line sweep, jet plow pontoons) and the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of scour control structures (scour mats and/or rock armor). There would be somewhat greater anchoring impacts related to the increased overall number of vessel trips and multiple construction and decommissioning mobilizations/demobilizations. Operation of the first phase of the Phased Development Alternative would result in half as much new hard bottom substrate associated with the monopiles, for some period of time. This would reduce the area for new reef-like effects that would alter fish or shellfish communities. Following the completion of Phase II, these impacts will be similar to the proposed action. With respect to EMF impacts on fish and fisheries, operation of the Phased Development Alternative, once fully constructed, would result in the same EMF levels.

Overall, impacts on fisheries of the Phased Development Alternative would be slightly greater for construction and decommissioning, and similar for operations as compared to the proposed action.

5.4.4.2.15 Essential Fish Habitat

The Phased Development Alternative would have the same area of permanent EFH impacts as the proposed action (0.33 acres [0.001 km²]). Potential temporary impacts to EFH due to construction and decommissioning include physical displacement of sediments due to cable installation/removal and pile driving / removal, suspended sediments in the water column and acoustical impacts.

The temporary impacts to benthic EFH would result from jet plow embedment and removal of the 33 kV and 115 kV cables, the installation and removal of the scour control mats and/or rock armor, and the vessel positioning and anchoring activities that would be associated with all structures. There will be some increase in anchoring impacts related to the increased overall number of vessel trips and multiple construction/decommissioning mobilizations/demobilizations, the temporary impacts related to the Phased Development Alternative are expected to be similar to the proposed action. The areas of benthic habitat that would be temporarily affected by construction and decommissioning activities are expected to recover relatively rapidly, allowing for the EFH functions of affected areas to be restored.

The Phased Development Alternative layout would not alter the route of the 115 kV offshore transmission cable system inside Lewis Bay. Therefore, no changes in the potential impacts to these EFH resources would occur (i.e., no changes to winter flounder impacts) with the Phased Development Alternative. Because of the same overall number of WTGs and cable lengths, the operation of the Phased Development Alternative would have similar impacts to the proposed action.

Overall, impacts on EFH of the Phased Development Alternative would be greater for construction and decommissioning, and similar for operations as compared to the proposed action.

5.4.4.2.16 Threatened and Endangered Species (T&E)

Impacts to T&E species would be increased under the Phased Development Alternative due to the longer construction and decommissioning time frames resulting from multiple mobilizations, demobilization and staging operations. Impacts to birds during construction and decommissioning of the Phased Development Alternative is expected to be greater than the proposed action as the result of the longer time frames and multiple mobilization and demobilization of major construction vessels for pile foundation installation/ removal and WTG installation/removal related to each distinct development phase. The total number of vessel trips and/or the duration of deployment required to complete and decommission the Phased Development Alternative would also be greater than if the proposed action was constructed from start to finish.

Because of the same overall number of WTGs and cable lengths, the operation of the Phased Development Alternative would have similar impacts for T&E species as compared to the proposed action.

Overall, the impacts to T&E of the Phased Development Alternative would be expected to be more than the proposed action during construction and decommissioning due to the extended construction time frame and multiple mobilizations/demobilizations, and impacts would be the similar for operation.

5.4.4.2.17 Socioeconomic Analysis Area

The existing social and economic conditions for the Phased Development Alternative are similar to those of the proposed action as it is in the same geographic location. Compared to the proposed action, socioeconomic impacts associated with the Phased Development Alternative would be similar except that it would involve multiple mobilizations/demobilizations and procurement of staging areas and equipment. This would not significantly increase the number of construction jobs or revenues going into the local area, and thus socioeconomic impacts of the Phased Development Alternative are expected to be similar to that of the proposed action.

5.4.4.2.18 Urban and Suburban Infrastructure

To access the Barnstable Substation, both the Phased Development Alternative and the proposed action would utilize the same near shore cable route, landfall site and onshore cable route and affect the

same urban and suburban infrastructure (see 4.3.2 of this document). Compared to the proposed action, impacts on urban and suburban infrastructure associated with the Phased Development Alternative including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.19 Population and Economic Background

The Phased Development Alternative is located in the same general geographic area as the proposed action and is expected to result in negligible changes in population or the economy of the region. Hence, the Phased Development Alternative would be comparable to and offer no significant population and economic advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.20 Environmental Justice

Concerns about environmental justice typically center on areas with higher than average minority populations and higher than average poverty levels. The area of the Phased Development Alternative is in the same location, and same socioeconomic area as the proposed action. It is not located near any communities of higher than average minority populations or close to the tribal lands of the Wampanoag Tribe of Gay Head Aquinnah (WTGHA) or the Wampanoag Tribe of Mashpee. As such, the Phased Development Alternative would be comparable to that of the proposed action with respect to environmental justice and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.21 Visual Resources

Visual impacts of the Phased Development Alternative would be less than those associated with the proposed action following the completion of Phase I and prior to the installation of Phase II. Once the Phased Development Alternative is completed, there would be no difference in visual impacts related to operations, between the Phased Development Alternative and the proposed action.

Construction and decommissioning impacts from the Phased Development Alternative would be greater as the result of multiple mobilization and demobilization of major construction vessels for pile foundation installation/removal and WTG installation/ removal related to each distinct development phase. The total number of vessel trips and/or the duration of deployment required to complete and/or remove the Phased Development Alternative would also be greater than if the proposed action was constructed from start to finish, resulting in more time when large construction vessels would be visible.

Overall, the visual impacts of the Phased Development Alternative would be expected to be more than the proposed action during construction and decommissioning due to the extended work time frame and multiple mobilizations/demobilizations, and impacts would be the same for operation.

5.4.4.2.22 Cultural Resources

The Phased Development Alternative has the same monopile locations as the proposed action and the same inner array cabling layout. This area has been assessed for underwater cultural resources and it was found that this configuration would not impact such resources. The onshore portion of the cable work is in the same location as the proposed action. Therefore, impacts to cultural resources would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.23 Recreation and Tourism

The Phased Development Alternative is located in the same location as the proposed action. Because of the extended duration of activity, multiple mobilizations/demobilizations and increased number of vessel trips related to construction and decommissioning activities of the Phased Development, it is likely that the impacts to recreational boating, and any related visual impacts, during construction and decommissioning will be greater than the proposed action.

Once the Phased Development Alternative is completed, there would be no difference in recreation and tourism related to operations, between the Phased Development Alternative and the proposed action. Overall, the impacts to recreation and tourism of the Phased Development Alternative would be expected to be more than the proposed action during construction and decommissioning due to the extended work time frames and multiple mobilizations/demobilizations, and the impacts would be the same for operation.

5.4.4.2.24 Competing Uses

Competing uses in the vicinity of the Phased Development Alternative are the same as for the proposed action and are limited to commercial and recreational fishing and boating, and the potential for maintenance dredging of nearby channels. The impact of the proposed action on these competing uses was determined to be minor.

5.4.4.2.25 Overland Transportation Arteries

The Phased Development Alternative is located in the same area as the proposed action and not near any overland transportation arteries. It would have a negligible effect on such arteries as a result of onshore equipment deliveries or commuting of workers. Therefore, impacts from the Phased Development Alternative on overland transportation arteries would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.26 Airport Facilities

The Phased Development Alternative is located in the same location as the proposed action. The proposed action received FAA approval indicating the proposed action would not affect navigation or associated communication systems (Refer to [Appendix E](#)) and therefore the Phased Development Alternative would also not affect airport facilities. In summary, the Phased Development Alternative would be expected to be comparable to the proposed action with respect to impacts on Airport Facilities and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.4.2.27 Port Facilities

The Phased Development Alternative is likely to have greater impacts to port facilities and marine traffic related to port facilities due to the extended duration of activity, multiple mobilizations/demobilizations and increased number of vessel trips related to construction and decommissioning activities of the Phased Development.

During operation, impacts to port facilities and marine traffic would be reduced slightly, as compared to the proposed action, following the completion of Phase I and prior to the installation of Phase II. Once the Phased Development Alternative is completed, there would be no difference in impacts to port facilities and marine traffic related to operations, between the Phased Development Alternative and the proposed action.

Overall, the impacts to port facilities of the Phased Development Alternative would be expected to be more than the proposed action during construction and decommissioning due to the extended work time frames and multiple mobilizations/demobilizations, and the impacts would be the same for operations.

5.4.4.2.28 Communications: Electromagnetic Fields, Signals and Beacons

The Phased Development Alternative is located in the same area as the proposed action. The assessment for the proposed action found that impacts on entertainment satellite, entertainment broadcasting services, (AM, FM and TV stations), non-emergency ship to shore communications (cellular communications and VHF frequencies in the marine band), navigation and positioning services, LORAN, safety and emergency communications, sub-sea communication cables, and Micro Wave Communications would be minor. As a result, the Phased Development Alternative is expected to have comparable impacts to the proposed action during construction, operation and decommissioning.

5.4.5 Condensed Array Alternative

5.4.5.1 Description of Condensed Array Alternative

In designing an offshore wind energy project, turbine spacing is considered which effectively balances the capture of the wind resource (and ultimately the power production), with a number of site specific physical and economic constraints such as water depth and watersheet use. Pre-project modeling of wind wake⁸ effects can be performed by several proprietary computer models. In the case of proposed action, there is a predominately southwest wind direction that dictates the spacing necessary not only to reduce adjacent row wind wake effects (in order to optimize efficiency of operations), but to follow industry practice to reduce structural fatigue from turbulence created by the wake and associated higher maintenance costs. As a general rule, manufacturers of the WTGs recommend a minimum spacing of greater than 5 rotor diameters in order to avoid catastrophic structural fatigue and guarantee efficiencies.

In order to facilitate the study of a condensed configuration alternative with 130 WTGs, a 6 x 6 rotor diameter spacing was chosen (the proposed action has a 9 x 6 rotor diameter spacing). The 6 x 6 rotor spacing was chosen as a reasonable example that falls within the range of some existing offshore wind energy projects (see [Table 3.3.6-1](#)). The Condensed Array Alternative would maintain the same ESP location as the proposed action (see [Figure 3.3.5-1](#)), and therefore the interconnecting 115 kV transmission system would remain the same in all aspects of design, length, installation and routing as the proposed action. Both the ESP structure and the complete 115 kV offshore transmission cable system would be the same as those under the proposed action. The WTG locations in the proposed action currently are spaced approximately 6 rotor diameters apart in the north-south “columns” of the array. The 130 WTGs of the Condensed Alternative have been arranged with the same central column of WTGs as the proposed action’s “F” column (WTGs F1 through F14), maintaining the same location with 6 rotor diameters separation (see [Figure 2.1.2-1](#)). The WTGs of the proposed action are separated by 9 WTGs within the east-west “rows.” To reduce the spacing within these rows to 6 rotor diameters for the Condensed Alternative, the WTGs to the west of the ESP and the “F” column have been shifted to the east, and WTGs to the east of the ESP and the “F” column have been shifted to the west, providing for a 130 WTG array with 6 x 6 rotor diameter spacing condensed around a similar ESP location as the proposed alternative.

⁸ As wind passes through the rotor of a wind turbine generator, it becomes turbulent behind the rotor. This area on the downwind side of the rotor is termed “wind wake”. The wind wake dissipates and returns to smooth, laminar flow at some distance beyond the turbine.

The cabling layouts (both the inner array 33 kV and interconnecting 115 kV transmission system) used in this Condensed Alternative are the same as presented in the proposed action (see [Figure 3.3.6-4](#)). The WTGs in the Condensed Alternative have been arranged in similar interconnecting strings (14 strings of 8-10 WTGs each) as the proposed action. The overall inner-array 33 kV cable lengths would be reduced to 58 miles (93.3 km) (from 66 miles [106.2 km] for the proposed action). The reduction would not be proportionate to the 25-30 percent east – west reduction of the WTG array because the inner-array cables of the proposed action have been arranged to minimize overall length by maximizing the use of the shorter north – south transects and minimizing the cabling east to west.

The footprint area of the Condensed Array Alternative is approximately 16 square miles (41.4 km²) (as compared to 25 square miles [64.7 km²] for the proposed action). The distances to shore are presented in [Table 3.3.6-2](#).

5.4.5.2 Environmental Resources of the Condensed Array Alternative and Comparison with the Proposed Action

5.4.5.2.1 Regional Geologic Setting

The geological setting of the Condensed Array Alternative is the same as the proposed action. The area of Horseshoe Shoal is generally composed of medium sands dominating the shallow water sediments and poorly graded fine and silty sands located in the deeper shoal waters. The geologic setting of the Condensed Alternative is therefore comparable to and offers no significant environmental advantage over the geologic setting of the proposed action with respect to construction, decommissioning and operation. Geomorphology is also expected to be the same.

5.4.5.2.2 Noise

Noise impacts to humans related to construction activities would be slightly less under the Condensed Array Alternative because of the increased distance to shore from the perimeter WTG pile driving. In particular those receptors on Cape Poge would be located further from the WTGs on the western edge of the array. However, this decrease is expected to be of little significance since the temporary construction noise from the proposed action is expected to be inaudible with the possible exception during installation of those WTGs closest to Martha's Vineyard. Underwater noise during construction of the Condensed Array Alternative would be the same as the proposed action.

Impacts from operational noise, both above and below water, from the Condensed Array Alternative are expected to be the same as those of the proposed action. Decommissioning noise, which would not involve pile driving, would be the same as that of the proposed action.

In summary, the noise impacts from the construction of the Condensed Array Alternative are slightly less than the proposed action, but would be the same for operations and decommissioning.

5.4.5.2.3 Physical Oceanography

Water depths for the Condensed Array Alternative are generally the same as for the proposed action since they are at the same area. Tides, current speed and wave conditions are also the same. Overall, the physical oceanography impacts of the Condensed Alternative would be expected to be comparable to those of the proposed action with respect to construction, decommissioning and operation.

5.4.5.2.4 Climate and Meteorology

The Condensed Alternative would emit CO₂, a green house gas. The amount of CO₂ discharged and the impact on climate would be negligible. Accordingly, the Condensed Array Alternative would be

comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.5 Air Quality

Vessels and equipment involved in the pre-construction G&G investigations, construction and decommissioning phases of the proposed action would emit air pollutants. It is expected that the air emissions for construction of the Condensed Array Alternative would be slightly less than those of the proposed action primarily due to the 8 mile (12.9 km) reduction in the amount of inner-array 33 kV cabling required. Although the distances the construction and maintenance vessels must travel from the proposed staging area in Quonset RI to reach the furthest WTGs on the eastern edge of the Condensed Array Alternative is slightly less than the proposed action, this minor reduction is offset by the increased travel distances to reach the nearest WTGs on the western edge of the Condensed Array Alternative. As a result, there would be no significant change in air emissions between the two alternatives during construction. Emissions related to G&G, ESP installation, 115 kV offshore transmission cable system cable installation, and WTG installation would be expected to remain comparable to the proposed action.

5.4.5.2.6 Water Quality

Water quality impacts related to construction of the Condensed Array Alternative would be less than the proposed action due to the 8 mile (12.9 km) reduction in the amount of 33 kV cabling required. The total number of vessel trips and/or the duration of deployment required to complete the Condensed Array Alternative would also be the same as for the proposed action. Water quality impacts from the cable installation of the 115 kV transmission system will be the same for both alternatives.

Other impacts to water quality associated with the construction/decommissioning of the Condensed Array Alternative would be the potential for oil spills related to work vessels transiting to and from the area of the proposed action. The marine vessels used to transport maintenance workers and equipment would be required to operate under USCG regulations. Also, an OSRP would be in place during construction/decommissioning to prevent/control potential impacts to water quality that could result from spills of fuel, lubricating oils, or other substances associated with the use of marine vessels and machinery. Although the distances the construction and maintenance vessels must travel from the proposed staging area in Quonset RI to reach the furthest WTGs on the eastern edge of the Condensed Array Alternative is slightly less than the proposed action, this minor reduction is offset by the increased travel distances to reach the nearest WTGs on the western edge of the Condensed Alternative. As a result, there would be no net change between the two alternatives in the probability of marine vessels spilling fuel, lubricating oils or other substances.

During operation there would be no difference in temporary water quality impacts related to operations, between the Condensed Array Alternative and the proposed action. Operation of the 130 WTGs of the Condensed Array Alternative is not anticipated to impact hydrodynamics or water quality.

Overall, the water quality impacts of the Condensed Array Alternative would be expected to be less than those of the proposed action with respect to construction. The impacts would be similar with respect to operation and decommissioning.

5.4.5.2.7 Electric and Magnetic Fields

As a result of the less efficient spacing of the Condensed Array Alternative, there will be less power generated than the proposed action and therefore less electric and magnetic field strength (EMF) levels produced. However, since the EMF impacts are already negligible under the proposed action there is no

advantage from the Condensed Array Alternative with respect to construction, operation and decommissioning impacts.

5.4.5.2.8 Terrestrial Vegetation

Impacts of the Condensed Array Alternative on terrestrial vegetation as a result of cable construction work on land would be the same as those of the proposed action. Therefore the impacts on terrestrial vegetation from the Condensed Alternative would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation and decommissioning impacts.

5.4.5.2.9 Coastal and Intertidal Vegetation

To access the Barnstable Substation, both the Condensed Array Alternative and the proposed action would utilize the same near shore cable route and landfall site (see Section 4.2.2 of this document for detailed information on coastal and intertidal vegetation). Compared to the proposed action, impacts on coastal and intertidal vegetation within the Condensed Array Alternative, including its 115 kV offshore transmission cable system, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation and decommissioning impacts.

5.4.5.2.10 Terrestrial and Coastal Faunas Other than Birds

Impacts of the Condensed Array Alternative on Terrestrial and Coastal Faunas other than birds would be the same as those of the proposed action as work within the terrestrial area and along the coast would be the same. Therefore the impacts on terrestrial and coastal faunas other than birds would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.11 Avifauna

According to research completed for the proposed action, it is expected that some temporary displacement of birds would result from the disturbance associated with construction/decommissioning activities (increased vessel traffic, presence of equipment, human presence, and noise). Sediment plumes could cause fish to avoid the construction site, which could also temporarily displace some avian species. Although impacts to birds from the construction of the WTGs, ESP and 115 kV offshore transmission cable system are expected to be the same, the 8 mile (12.9 km) reduction in inner-array cable installation will slightly reduce impacts. However, construction activities are not expected to take place over the entire area of the proposed action simultaneously; thus the smaller footprint of the Condensed Array Alternative is not expected to result in any greater displacement impacts than would be expected for the proposed action. Overall impacts to birds during construction (and decommissioning) of the Condensed Array Alternative are expected to be slightly less than the proposed action as the result of the reduction in the length of 33 kV inner array cabling.

When compared to the proposed action, an alternative with condensed spacing is expected to have a greater “barrier” effect due to the higher concentration of structures, thereby increasing the potential for avoidance, collision or other impacts during operation. Maintenance activities would consist of small vessels transiting to and from the area of the proposed action in order to service the WTGs and/or ESP. This vessel traffic represents an insignificant increase in traffic over current levels in Nantucket Sound, and would not impact avifauna in the area of the proposed action for either the Condensed Array Alternative or the proposed action. Overall, the Condensed Array Alternative is expected to have increased impacts during operations.

5.4.5.2.12 Subtidal Offshore Resources

The oceanographic conditions and predominantly sandy sediments on Horseshoe Shoal combine to produce a dynamic, shifting substrate that favors benthic communities of relatively low diversity. However, the shallow depths of Horseshoe Shoal also allow for a relatively high density and biomass of benthic organisms. Total invertebrate abundance is highly variable from site to site due to the high degree of environmental variability found on Horseshoe Shoal.

Most of the impacts to soft-bottom benthic communities are expected to occur during the cabling activities of the construction and decommissioning periods. Permanent impacts include the direct mortality to benthic organisms due to jet plowing and the placement and removal of pilings for the WTGs and ESP. The total area of permanent benthic impact due to the WTG and ESP piles would be the same for both the Condensed Array Alternative and the proposed action (0.67 acres [0.003 km²]).

Temporary impacts to benthic resources would be caused by anchoring activities associated with cable-laying and decommissioning activities (anchors, anchor line sweep, jet plow pontoons) and the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of scour control structures (scour mats and/or rock armor). The Condensed Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km²). The temporary impacts related to the Condensed Array Alternative are expected to be less as compared to the proposed action. Impacts related to decommissioning of the Condensed Array Alternative would also be less due to the shorter inner-array cable.

During operation the WTGs will provide new localized hard-bottom habitats for benthic resources to inhabit. These benthic macro invertebrates and fouling organisms are anticipated to attract prey and larger finfish to the monopiles. There is no anticipated difference in operational impacts between the two alternatives.

Overall, the impacts to benthic resources of the Condensed Array Alternative would be expected to be less than those of the proposed action with respect to construction and decommissioning and would be similar with respect to operation.

5.4.5.2.13 Non-ESA Marine Mammals

The marine mammals that are not listed under the ESA, but are protected under the MMPA, that may be found in the area of the proposed action include the gray seal, harbor seal, harp seal, hooded seal, Atlantic white-sided dolphin, striped dolphin, common dolphin, harbor porpoise, long-finned pilot whale, and minke whale.

The two types of potential harassment that may occur during the construction of the proposed action are vessel strikes and noise. Both types of harassment are classified as Level A and Level B harassments under the 1994 Amendments to the MMPA. Because of a slightly reduced chance for vessel strike due to the shorter inner-array cabling activities involved with the Condensed Array Alternative, there is some potential for a reduction of impacts to marine mammals from the Condensed Array Alternative as compared to the proposed action.

Underwater noise impacts associated with the operation of the WTGs are not expected to cause Level A harassment to non-ESA mammals. The operations and maintenance plan would be the same for the Condensed Array Alternative as for the proposed action.

Overall, the non-ESA mammal impacts of the Condensed Array Alternative would be expected to be somewhat less for construction and decommissioning, and similar for operations and maintenance, as compared to the proposed action.

5.4.5.2.14 Fish and Fisheries

In general, the disturbance to benthic habitats would be short-term and localized because many benthic invertebrates are adapted to high energy environments such as the area of the proposed action, and are capable of opportunistically re-colonizing benthic sediments after disturbance. Thus, fish species that prey on benthic species would be impacted temporarily during construction. Shellfish species spawn, at a minimum, once per year, and would likely resettle the disturbed areas within one or two years.

The changes in temporary impacts to fisheries mirror those outlined in the benthic discussion of the Condensed Array Alternative. Temporary impacts to benthic resources would be caused by anchoring activities associated with cable-laying and decommissioning activities (anchors, anchor line sweep, jet plow pontoons) and the WTG/ESP construction and decommissioning, as well as the installation and decommissioning of scour control structures (scour mats and/or rock armor). The Condensed Array Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km²). The temporary impacts related to the Condensed Alternative are expected to be less as compared to the proposed action. Impacts related to decommissioning of the Condensed Alternative would also be less due to the shorter inner-array cable.

Operation of the Condensed Array Alternative would result in the same amount of new hard bottom substrate associated with the monopiles as the proposed action. Both alternatives would have the same amount of surface area with the potential for new reef-like effects that would alter fish or shellfish communities, and therefore similar impacts.

Overall, impacts on fisheries of the Condensed Array Alternative would be slightly less for construction and decommissioning, and similar for operations as compared to the proposed action.

5.4.5.2.15 Essential Fish Habitat

The Condensed Alternative would have the same area of permanent EFH impacts as the proposed action (0.33 acres [0.001 km²]). Potential temporary impacts to EFH due to construction include physical displacement of sediments due to cable installation and pile driving, suspended sediments in the water column and acoustical impacts. Because of the reduced amount of 33 kV inner-array cable required with the Condensed Array Alternative the temporary impacts to benthic habitat during construction (and decommissioning) are expected to be less than for the proposed action and thus reduce the extent of temporary impacts to EFH functions of affected areas.

Because of the same overall number of WTGs, the operation of the Condensed Array Alternative would have similar impacts to the proposed action.

Overall, impacts on EFH of the Condensed Array Alternative would be less for construction and decommissioning, and similar for operations as compared to the proposed action.

5.4.5.2.16 Threatened and Endangered Species

The disturbances associated with construction/decommissioning activities, including cable embedment, involve increased vessel traffic, presence of equipment, human presence, and noise. Sediment plumes from jet plowing could cause fish to avoid the construction site, which could also

temporarily displace some avian species. Although impacts to birds from the construction of the WTGs, ESP and 115 kV offshore transmission cable system are expected to be the same, the 8 mile (12.9 km) reduction in inner-array cable installation will reduce impacts. Although jet plowing on Horseshoe Shoal is not expected to have any impact on Piping Plovers who forage along the rack line of beaches, there may be some impact on roseate terns that do forage in the area to some degree. Overall impacts to birds during construction (and decommissioning) of the Condensed Array Alternative are expected to be slightly less than the proposed action as the result of the reduction in the length of 33 kV inner array cabling.

Impacts during operation of the Condensed Array Alternative would be increased when compared to the proposed action. This is due to the condensed spacing of WTGs, which would be expected to have a greater “barrier” effect due to the higher concentration of structures, thereby increasing the potential for avoidance, collision or other impacts.

Overall, the impacts to T&E species of the Condensed Array Alternative would be expected to be less than the proposed action during construction and decommissioning, and greater than the proposed action during operations.

5.4.5.2.17 Socioeconomic Analysis Area

The existing social and economic conditions for the Condensed Array Alternative are similar to those of the proposed action as it is in the same geographic location. Compared to the proposed action, socioeconomic impacts associated with the Condensed Array Alternative would be the same in terms of number of construction jobs and revenues from taxes. However, the Condensed Array Alternative would generate somewhat less electricity, producing less downward pressure on electricity costs. Overall, the Condensed Array Alternative does not offer any significant advantage over the proposed action with respect to socioeconomics.

5.4.5.2.18 Urban and Suburban Infrastructure

To access the Barnstable Substation, both the Condensed Array Alternative and the proposed action would utilize the same near shore cable route, landfall site and onshore cable route and affect the same urban and suburban infrastructure (see 4.3.2 of this document). Compared to the proposed action, impacts on urban and suburban infrastructure associated with the Condensed Array Alternative including its submarine and onshore cable, would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.19 Population and Economic Background

The Condensed Array Alternative is located in the same general geographic area as the proposed action and is expected to result in negligible changes in population or the economy of the region. Hence, the Condensed Array Alternative would be comparable to and offer no significant population and economic advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.20 Environmental Justice

Concerns about environmental justice typically center on areas with higher than average minority populations and higher than average poverty levels. The area of the Condensed Array Alternative is in the same location, and same socioeconomic area as the proposed action. It is not located near any communities of higher than average minority populations or close to the tribal lands of the Wampanoag Tribe of Gay Head Aquinnah (WTGHA) or the Wampanoag Tribe of Mashpee. As such, the Condensed

Array Alternative would be comparable to that of the proposed action with respect to environmental justice and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.21 Visual Resources

Potential visual impacts during construction and decommissioning activities of the Condensed Array Alternative would be based on the number, size, and spacing of construction vessels employed during the construction period and would not be expected to be significantly different than construction related visual impacts under the proposed action. With respect to operations, the breadth of the array would likely be reduced as viewed from the north, and remain the same when viewed from the south. Distances to shore will be slightly increased for the Condensed Array Alternative, making the turbines look smaller and reducing the visual impact. Thus in terms of overall breadth of impact, the Condensed Array Alternative would have less of a visual impact than the proposed action. However, the concentration of structures would be increased for the Condensed Array Alternative, and thus the visual intrusion of the portion of the Condensed Array Alternative that is visible, would create more of an impact than the proposed action.

5.4.5.2.22 Cultural Resources

The Condensed Array Alternative has been laid out along the same previously surveyed area transects as the proposed action. This general area of the proposed action of Horseshoe Shoal has been assessed for underwater cultural resources and it was found that the proposed action configuration would not impact such resources. Although the specific cable routes and WTG locations of the Condensed Array Alternative have not been fully surveyed, it is expected that due to the extent and overlap of previously surveyed area incorporated into the Condensed Array Alternative that the impacts would be similar. The onshore portion of the cable work is in the same location as the proposed action. Therefore, impacts to cultural resources would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.23 Recreation and Tourism

The Condensed Array Alternative is located in the same general location as the proposed action. The smaller overall footprint of construction activities and the shorter inner-array cabling will reduce some impacts to recreational boating. However, this will be offset by the concentration of construction activities within the Condensed Array Alternative footprint as compared to the proposed action resulting in greater impacts to boating. During operation, impacts to recreational boating will be reduced somewhat by the smaller overall size of the turbine array area, but this would be offset by the tighter spacing between WTGs which would make navigation more difficult. Overall, the impacts to recreation and tourism of the Condensed Array Alternative would be expected to be similar to the proposed action during construction, operation and decommissioning.

5.4.5.2.24 Competing Uses

Competing uses in the vicinity of the Condensed Array Alternative are the same as for the proposed action and are largely limited to commercial fishing and boating, and the potential for maintenance dredging of nearby channels. Any vessels involved in commercial fishing (i.e., trawling activities) within the area of the proposed action would experience increased impacts due to the tighter spacing between WTGs. The impact of the Condensed Array Alternative on these competing uses would therefore be greater than the proposed action during construction, operations and decommissioning.

5.4.5.2.25 Overland Transportation Arteries

The Condensed Array Alternative is located in the same area as the proposed action and not near any overland transportation arteries. It would have a negligible effect on such arteries as a result of onshore equipment deliveries or commuting of workers. Therefore, impacts from the Condensed Array Alternative on overland transportation arteries would be comparable to and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.26 Airport Facilities

The Condensed Array Alternative is located in the same general location as the proposed action. The proposed action received FAA approval indicating the proposed action would not affect navigation or associated communication systems (Refer to [Appendix E](#)) and although the new specific locations for the WTGs in the Condensed Array Alternative would need to be evaluated by the FAA, it is assumed that there would be no change in their determination of no hazard. Therefore, it is expected that the Condensed Array Alternative would also not affect airport facilities. In summary, the Condensed Array Alternative would be expected to be comparable to the proposed action with respect to impacts on Airport Facilities and offer no significant environmental advantage over the proposed action with respect to construction, operation, and decommissioning impacts.

5.4.5.2.27 Port Facilities

The Condensed Array Alternative is likely to have similar construction and decommissioning impacts to port facilities and marine traffic related to port facilities as the proposed action. During operations, marine traffic would have to contend with navigating through WTG configuration that is closer together. However, this is offset by the fact that the Condensed Array Alternative is located further away from shipping channels and takes up less water sheet area. Overall, the impacts to port facilities of the Condensed Array Alternative would be expected to be similar to the proposed action during construction, operation and decommissioning.

5.4.5.2.28 Communications: Electromagnetic Fields, Signals and Beacons

The Condensed Array Alternative is located in the same general area as the proposed action. The assessment for the proposed action found that impacts on entertainment satellite, entertainment broadcasting services, (AM, FM and TV stations), non-emergency ship to shore communications (cellular communications and VHF frequencies in the marine band), navigation and positioning services, LORAN, safety and emergency communications, sub-sea communication cables, and Micro Wave Communications would be minor (see Section 5.3.4.4). The Condensed Array Alternative is expected to have comparable impacts to the proposed action during construction, operation and decommissioning.

5.4.6 Assessment of No-Action Alternative and Comparison with Proposed Action

5.4.6.1 Description of the No-Action Alternative

In order to understand the environmental consequences to the region if the proposed action were not constructed, a qualitative cost benefit analysis has been provided that describes impacts of those energy producing technologies that likely would occur to address energy needs in the near future. Given the projected continued need for power in New England (ISO, 2007) it is expected that if the proposed action is not developed, one or more of the generation alternatives discussed above would be developed. As noted in the discussion of these alternatives, each fails to meet one or more of the objectives set forth in the purpose and need for the proposed action. [Table 5.4.6-1](#) shows for each of the 11 No-Action Alternatives, which of the objectives of the proposed action the alternative does not satisfy.

As [Table 5.4.6-1](#) shows, of the 11 No-Action Alternatives only four are feasible, of a comparable scale and able to be developed within the timeframe of the proposed action (i.e., meet both criteria Nos. 3 and 5). These technologies are: (1) New Natural Gas Fired Power Plants; (2) New Oil Fired Power Plants; (3) New Clean Coal Fired Power Plants; and (4) Repowering of Existing Facilities. This section provides a brief comparison of the environmental costs and benefits that would be associated with the development of these No-Action Alternatives, which could provide power otherwise provided by the proposed action. Other No-Action Alternatives that are not feasible in the near future are not assessed.

5.4.6.2 Impacts Associated with No-Action Alternative

5.4.6.2.1 Environmental Cost/Benefit Criteria

Important to an evaluation of environmental costs and benefits is a way of making meaningful comparisons. In a study *Assessing the Costs and Benefits of Electricity Generation Using Alternative Energy Resources on the Outer Continental Shelf*, Weiss et al. found that for many different types of environmental impacts that were important to describing and distinguishing among offshore alternatives, it was either difficult to quantify the criteria of interest or almost impossible to determine a monetary value. ISO-NE in their recently released report of *New England Electricity Scenario Analyses* (ISO, 2007) did monetize environmental costs and benefits, but did so for a relatively limited set of environmental variables (i.e., limited to several types of air pollutant emissions). Because of these difficulties in terms of quantifying and comparing environmental impacts, this analysis will use a limited set of criteria that capture the distinguishing features of the No-Action Alternatives and provide a qualitative discussion of the criteria as they relate to each alternative.

[Table 5.4.6-2](#) provides a simplified picture of the energy generation process. Starting with inputs which include fuel supply, fuel transport and water withdrawal, the actual generation facility has associated with it, a certain amount of surface disturbance, the need for on-site chemical management, and various support facilities or processes such as waste water treatment and fuel storage. The environmental outputs from the generation process can be captured by focusing on air emissions, water discharges and waste disposal.

The importance of selecting appropriate criteria is seen by looking at what ISO-NE used to compare alternatives versus the factors that Weiss et. al. used. The ISO report focuses largely on effects associated with the outputs of the alternatives whereas Weiss et al. tried to capture aspects of a project fuel cycle by including consideration of various inputs. This simplified presentation of the generation process highlights that in comparing wind to the no-action alternatives, wind generally has no input related environmental-effects (other than minor impacts associated with manufacturing and transport of wind turbine components). Differences, therefore, in environmental costs and benefits directly associated with these No-Action Alternatives can be addressed by focusing on 5 variables. These are defined as follows:

1. **Land disturbance.** This variable seeks to capture 3 aspects of land disturbance: (1) the area and natural resources (i.e., flora and fauna and wildlife habitat) that would be permanently disturbed by a building footprint; (2) the total area where there would be some land use restriction of activity such as a larger property boundary; and (3) what is often defined for thermal facilities as the “affected area” or the point at which changes in facility-related air concentrations are negligible.
2. **Air emissions.** A principal difference among the No-Action Alternatives is the emissions to the atmosphere resulting from fossil fuel burning. Compounds of interest are the regulated pollutants (NO_x, SO_x and PM) as well as mercury (HG) and CO₂.

3. **Water use.** Water is an important resource in power generation with consumptive use varying depending generally on the type of cooling that the facility uses, type of fossil fuel, and type of generation and pollution control technology. In the case of cooling via surface water sources, entrainment of fish and fish larvae are also an important impact related to water use.
4. **Solid waste generation and waste management.** Depending on the fuel used to generate power, there can be relative little solid waste generated or alternatively there can be large amounts that require use of an onsite or offsite disposal facility.
5. **Water discharge (both amount and quality).** Depending on the fuel used to generate power and the type of facility cooling, the quantity of water discharged from a facility will vary along with the quality. Important variables include absolute temperature, difference in temperature from the receiving water body; and several chemical constituents regulated by federal and state water quality programs.

Specifically excluded from consideration are such aspects of these facilities such as noise and aesthetic impacts. This does not suggest that these do not exist; rather that they are site-specific and do not distinguish one No-Action Alternative from the other.

Summary of Environmental Costs and Benefits of the No Action Alternatives

Gas Fired Electric Generation Facilities

A natural gas facility burns natural gas to run a combustion turbine to generate electricity. Natural gas would likely be delivered by underground pipeline via a new interconnection line attached to the existing intrastate natural gas pipeline system. The facility could be sited in an already designated industrial area or in an appropriately zoned greenfield site and would have to comply with zoning regarding setbacks, height limits, noise, and landscaping. If the turbines and associated facilities were enclosed, the facility would resemble a commercial 5 story structure with an associated 150 to 250 ft stack for each gas turbine. Ten to 15 employees would operate the facilities which would run 24 hours a day, every day of the year except for scheduled maintenance periods of 1 to 2 weeks. Depending on location, water for facility cooling could be provided by the local municipality, a nearby river or it could use gray water from a publicly owned treatment works (POTW). Likewise, wastewater, with appropriate pretreatment, could be discharged to a POTW or nearby stream. In order to operate, the facility would have to comply with all federal, state and local regulations relative to air pollution, water discharge and waste management. Emissions of regulated pollutants therefore would be at or below levels designed to be protective of human health and the environment.

For a gas fired facility, the principal pollutant of concern is NO_x. Emissions of NO_x result from the combustion of nitrogen contained in fuel and the air supplied for combustion. NO_x contribute to the formation of ground level ozone and acid rain. Natural gas facilities also emit VOC and carbon monoxide (CO) as a result of incomplete fuel combustion, which occurs to some degree even in state-of-the-art CCCT systems being installed today. Although efficient combustion techniques employed in today's combustion turbines combined with the use of relatively clean burning natural gas reduce VOC and CO emissions below any other fossil fuel fired combustion technology, large quantities of these pollutants would still be emitted. SO₂ emissions from natural gas fired facilities are the lowest of all fossil fuel fired combustion facilities due to the low sulfur content of natural gas. PM also forms through incomplete combustion of fuels or using fuels with high noncombustible content (ash).

In addition to the emissions of criteria pollutants, a gas-fired facility would also emit non-criteria pollutants and CO₂. Non-criteria pollutants include Hazardous Air Pollutants (HAPs), which the EPA considers of special concern and for which the EPA has developed national emission standards for specific source categories such as combustion turbines. Some of the hazardous air pollutants emitted by a natural gas fired combustion turbine include formaldehyde, xylene, toluene, and benzene.

CO₂ has been attributed to an increase in average global temperatures. The emission of greenhouse gases and climate change is a concern to many in the scientific community. Natural gas fired energy facilities represent the best method to reduce the total emissions of CO₂ from fuel burning power plants as compared to other combustion technologies because of the combustion efficiency of the CCCT system and the low carbon content of natural gas per MW of energy produced.

Coal Fired Electric Generation Facilities

Coal fired facilities typically use pulverized coal to fire a boiler to produce steam to operate an electric generator. Because of current air regulations a coal facility would likely be a low sulfur, “clean coal” facility. While the turbine building could be similar in size to the gas turbine facility, the overall property area would be larger due to the need for coal delivery (i.e., railroad unloading area or coal wharf), coal storage and ash storage. Again, the project would be developed in an area set aside for industrial use and so would have to comply with local regulations for noise, setbacks, height limits and landscaping. The coal for the facility would be delivered by rail or ship and limestone if used for emissions control could be delivered by truck or rail. Each would be processed prior to firing in the turbine. Waste generated would be a combination of fly ash from the air pollution control device and bottom ash or unburned coal from the combustion turbine. These would be collected and disposed of on or off site or recycled and reused as road bed material or for making concrete.

A coal-fired facility would be either a circulating fluidized bed boiler with a complex emission control system or integrated gasification CCCT in order to meet air emission requirements. Either of these types of facilities would emit significantly more criteria pollutants, non-criteria pollutants and HAPs than a natural gas or oil-fired facility. Emissions of HG, a persistent bioaccumulative toxin, have also been associated with coal combustion and are the focus of new regulations for existing coal-fired power plants. The storage of coal and the likely use of evaporative cooling technology increase the potential for particulate emissions.

A coal facility would emit SO₂, which contributes to acid rain, sulfate deposition and can react with other compounds in the atmosphere to form particulates. PM also forms through incomplete combustion of fuels or using fuels with high noncombustible content (ash). Elevated particulate levels have been attributed to a variety of health effects such as respiratory ailments, especially in the young and the elderly. A coal facility would also emit CO₂, a greenhouse gas.

Coal-fired facilities require significantly more water than natural gas or oil-fired facilities. A coal-fired boiler has a greater heat load than a natural gas fired turbine resulting in increased water consumption. Dry cooling technology can often become too large for this type of unit requiring the use of wet cooling towers that further increase evaporative losses and water consumption. Coal burning facilities consume water within scrubber systems used for the control of SO₂ and acid gas emissions. The source of water would vary depending on the site but could include a surface water body, municipal supply or gray water from a POTW.

Stormwater runoff from coal storage areas can have impacts on wetlands, groundwater quality, and the local environment. The stormwater runoff can contain toxic chemicals found in coal, which can be washed to surrounding surface water bodies through the stormwater collection systems.

Oil Fired Electric Generation Facilities

New oil fired facilities, like new coal facilities, are a cleaner design, specifically designed to use fuels with lower sulfur content than is typical in older oil fired facilities. As with a gas and coal fired power plant, a new oil fired facility would have to meet local zoning requirements and applicable federal, state and local air emission, water discharge and waste management requirements. Oil for the facility would likely be delivered via ship while limestone used for air pollution control would be delivered by truck or rail. Several large tanks would be required to store the oil, and oil fired facilities involve risks of oil spills during delivery, storage and operation, which can affect natural resources and water quality in the area. Like the other fossil fuel based generation facilities, discharges of air emissions to the atmosphere and/or local water bodies would extend beyond the facility property boundary. Types of air pollutants emitted would be similar to that of a coal facility described above. In addition to pollutant concerns, the U.S. currently depends heavily on foreign oil supplies, and this reliance coupled with regional instability in primary oil producing regions presents potential concerns with the long-term reliability and economic stability of an oil-fired energy facility.

Re-Powered Electric Generation Facility

As the name suggests, a repowered facility is one where new equipment is installed, typically for the purpose of improving the facility to make it more efficient or to bring it into compliance with new regulations. The most common repowering is where an oil fired facility is changed to one that uses gas as the main fuel. One of the advantages of repowering is that the original facility property is “reused” along with much of the supporting infrastructure. Repowered facilities can typically be brought on line more quickly than can new facilities. They do not represent a new land use so there are no issues of compatibility with surrounding land uses. By changing to a cleaner burning fuel the facilities typically can demonstrate a reduction in air emissions. Redesign can also result in more efficient operation and decreased use of water.

Conclusions on Cost Benefit Analysis

Projects likely to be constructed in the near future under the no-action alternative to address the bulk of regional energy needs would be fossil fueled electric generation facilities. These facilities would result in substantial emissions of various air pollutants during their operational life span, affecting the air quality in the region and continuing to increase global CO₂ levels.

5.4.7 Transmission Line Siting

5.4.7.1 Results of Environmental Facilities Siting Board Decision on Siting

On September 17, 2002, the applicant and NSTAR jointly filed a petition with the EFSB and a petition with the DTE to construct, operate and maintain two new 115 kV electric transmission lines to interconnect the proposed action with the regional electric grid in New England.

As part of its review process, the EFSB was required to evaluate whether there is a need for additional transmission resources and evaluate the proposed action in terms of its consistency with providing a reliable energy supply to the Commonwealth with a minimum impact on the environment at the lowest possible cost. A project proponent must present to the EFSB alternatives to its planned action which may include: (a) other methods of generating, manufacturing, or storing electricity or natural gas; (b) other sources of electrical power or natural gas; and (c) no additional electric power or natural gas.

The applicant identified and presented four alternatives to the EFSB that would potentially meet its Project need, each of which could provide reliable service for the applicant’s proposed action. These approaches included connecting the proposed action: (1) to NSTAR’s 115 kV Barnstable Switching

Station; (2) to NSTAR's 115 kV Harwich Substation; (3) to NSTAR's 115 kV Pine Street Substation in New Bedford; and (4) to a new 115 kV substation on Martha's Vineyard, then proceeding on to the mainland.

Upon its review, the EFSB concluded that the Martha's Vineyard Alternative did not warrant further consideration because of the magnitude of increased cost over the Barnstable Interconnect without any offsetting benefits. Although the Harwich and New Bedford Alternatives would be somewhat less costly than the Martha's Vineyard Alternative, each would cost approximately \$50 million more than the Barnstable Interconnect. Because the Barnstable Switching Station is the major bulk substation on Cape Cod, with six 115 kV transmission lines available to carry energy to various parts of Cape Cod, interconnection at this location would provide high reliability in that energy from the proposed action could be reliably delivered to the grid even if one of the lines emanating from the Barnstable Switching Station is out of service. Therefore, the EFSB determined that, all other considerations being equal, a direct connection at the Barnstable Switching Station provides greater reliability than an indirect connection through another, smaller substation at a greater distance from the Barnstable Switching Station.

The EFSB found that the Barnstable Interconnect was preferable to both the Harwich and New Bedford Alternatives with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost. In addition, the EFSB found that, with the implementation of the proposed mitigation and conditions, the environmental impacts of the proposed facilities along the primary route would be minimized with respect to marine construction impacts, land construction impacts and permanent impacts. Therefore, the EFSB approved the applicant and NSTAR's proposal to construct two approximately 18 mile (29 km), 115 kV underground electric transmission lines along the primary route identified by the applicant.

The applicant has conducted a comprehensive analysis to identify the best route to provide the needed transmission interconnection from the facility to the mainland electrical grid system. A detailed assessment of alternative routes was conducted that concluded that the route proposed would be preferable to alternative routes with respect to providing a reliable energy supply for the Commonwealth, with a minimum impact on the environment at the lowest possible cost (EFSB, 2004).

5.4.8 Conclusion

Impacts are summarized for the five economically and technically feasible alternatives relative to the site of the proposed action in [Table 3.3.5-1](#). The South of Tuckernuck Island Alternative would have the same environmental impacts as the proposed action in most categories of impact (22 of 28 impact categories evaluated, would be expected to have somewhat more impact than the proposed action with respect to five categories (avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, and EFH), and would be expected to have less impact than the proposed action in one category (visual impacts). The Monomoy Shoals Alternative would be expected to have the same level of impact as the proposed action in 20 of 28 impact categories, would be expected to have more impact than the proposed action in six impact categories. (Avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species.)⁹ The Monomoy Shoals Alternative would be expected to have less impact than the proposed action in two impact categories (visual resources and cultural resources as they relate to visual impacts to historic structures).

⁹ Under the Monomoy Shoals Alternative, the impact categories: subtidal offshore resources, fish and fisheries, and essential fish habitat, have impacts that would be greater than the proposed action but only with respect to construction and decommissioning. Operational impacts would be expected to be the same for these impact categories as for the proposed action.

The Smaller Project Alternative has less impact than the proposed action in 13 impact categories: noise, air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, cultural resources (as they related to visual impacts) competing uses of waters and sea bed, and port facilities.

The conclusions with respect to Smaller Project Alternative should be considered in light of the actual level of impacts expected for the proposed action. [Table E-1](#), which summarizes the impacts for the proposed action, shows that the impacts in almost all the categories are minor or negligible, indicating that potential environmental savings with respect to impacts of the Smaller Project alternative relative to the proposed action would not be significant. The Smaller Project alternative would reduce visual impacts (ranked as moderate from the shoreline for the proposed action) though the amount of visible area reduced is not proportional to the 50 percent reduction in generation capacity of the Smaller Project (see [Figure 3.3.6-2](#)).

The Condensed Array Alternative would have greater impact than the proposed action for the competing uses impact category during construction, operation, and decommissioning. Additionally, the Condensed Array Alternative would have less impact during construction for 8 impact categories: noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. Of these impact categories noise and water quality would be expected to have similar impact as the proposed action during decommissioning while the other 6 would have a lesser impact. There would be greater expected impact compared to the proposed action during operation for the avifauna and threatened and endangered species impact categories. The remaining 19 impact categories would have the same level of impact as the proposed action during construction, operation, and decommissioning.

The Phased Deployment Alternative would have greater impact than the proposed action for 10 of 28 impact categories (air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, and recreation and tourism). The impacts on these categories would be similar to the impacts of the proposed action during operation. There would be no change in impacts for the other 18 impact categories for the Phased Deployment Alternative compared with the proposed action during construction, operation, or decommissioning.

6.0 CUMULATIVE IMPACT ANALYSIS

The “cumulative impact” of a proposed action under 40 CFR Section 1508.7 of the NEPA regulations is defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or persons undertake such other acts.” In order to measure cumulative impacts, a point from which measurements begin must be established, called a “baseline.” The impact-producing factors of this cumulative effects analysis are baselined to current conditions. That is, the analysis of cumulative effects focuses on the current aggregate effects of all past actions that have taken place within the geographic area without itemizing the historical details of individual past actions. The proposed action is within a non-pristine, but unindustrialized area where current competition for OCS space is not intense. Competition for OCS space in this area is not expected to become intense during the reasonably foreseeable future (20 years) encompassed by this cumulative scenario. No past or present wind energy or other renewable energy projects exist in the geographic area defined for this cumulative analysis.

Geographically, the cumulative impact study area would be described as a polygon generally extending northeastward from Nantucket Island to Monomoy Island including Monomoy Shoals and northwestward from Nantucket Island through Narragansett Bay to Quonset, Rhode Island including Martha’s Vineyard. The northernmost boundary would be defined as the northern shore of Nantucket Sound and the easternmost boundary would be a point described as Latitude 41.4571, Longitude -69.8676. This geographic study area includes a broad scope of onshore and offshore projects that have been constructed, or may have the potential to be constructed in the future that could affect the location of the Project (Figure 6.1-1).

Temporally, projects included in the cumulative impact analysis were limited to present activity that includes: (1) the proposed action; (2) any ongoing projects or known proposed projects (i.e., projects for which an application has at least been filed or for which planning documentation exists); and (3) projects not now taking place, but which may occur periodically over the next 20 years because they have occurred in the recent past. Maintenance dredging of channels and harbor areas would be an example of such an activity. In combination, these three classes of activities comprise a cumulative scenario that explains expectations for the kinds of activities that could take place within the study area.

The following agencies were contacted in order to determine what projects were under review or proposed for the near future within the cumulative impact study area: the USACE, New England Division; MassDCR; the CZM; and the MassDEP. The impact levels characterizing cumulative impacts are those used in Section 5.0. Direct impacts occur at the same time and place that the activity occurs. Indirect impacts are displaced in time and space from the factor producing the impact.

6.1 ACTIVITIES IN THE CUMULATIVE SCENARIO

Activities included in the cumulative scenario are as follows:

- Offshore Wind Energy Projects
- Offshore Sand and Gravel Mining
- Tidal Energy Projects
- Marina Development
- Onshore Wind Energy Projects
- Submarine Cable and Pipeline Projects

- Maintenance Dredging and Beach Nourishment
- Upland Pipeline Projects
- Commercial Fishing Activities
- Small Marine Projects
- Vessel Traffic
- Population Growth and Onshore Development
- Wave Energy Projects

6.1.1 Offshore Wind Projects

Currently there is only one other known offshore wind project proposed within the spatial scope of this analysis, for which there is potential for cumulative impacts on environmental resources. This is the South Coast Offshore Wind Project, which is proposed by Patriot Renewables, LLC. The South Coast Offshore Wind Project would be located in the Cape and Islands Ocean Sanctuary of Buzzards Bay ([Figure 6.1-1](#)). M.G.L Chapter 132A, Section 15, prohibits among other things, the construction of “electrical generation stations” in an ocean sanctuary. As such, the approval and schedule of the South Coast Offshore Wind Project will depend on if and when the ocean sanctuary legislation can be amended to allow for the construction of wind facilities in an ocean sanctuary.

Patriot Renewables proposes to construct between 90 and 120 WTGs within three general study areas of Buzzards Bay. Study area 1 is an area south of Sconticut Neck and Weset Island and north of Buzzards Bay navigational channel, running from the east edge of the channel to New Bedford Harbor to the east of West Island and terminating at Nasketucket Bay. Study area 2 is located between the Buzzards Bay navigational channel and the Elizabeth Islands, running from Sow and Pigs Reef to Wood’s Hole. Study area 3 is located between the mainland of Dartmouth and Westport and the north edge of the Buzzards Bay Navigational channel, running from Hen and Chickens Reef to the west edge of the channel to New Bedford Harbor. The project is expected to produce 300 MW of electricity. Electricity would be transmitted to the mainland electrical transmission system via a submarine cable interconnection to a location in Fairhaven (Patriot Renewables, LLC, 2006). Due to the distance of this project away from the proposed action (approximately 17 miles [27.4 km]) away at its closest point), cumulative impacts are expected to be minor, with the exception of impact to the roseate tern, as discussed in more detail in the [Appendix C](#), where the Patriot Renewables project has the potential to add direct effects to the breeding islands and breeding activities that would not occur with the proposed action.

6.1.2 Offshore Sand and Gravel Mining

In September 2003 Massachusetts entered into a multi-year cooperative agreement with the MMS to locate and assess the quality of sand and gravel resources situated on the continental shelf offshore of Massachusetts. Initial efforts are to document sand and gravel deposits in the inner continental shelf of the Merrimack embayment using geophysical techniques and grab sampling from small vessels. Numerous beaches along the embayment have experienced long-term erosion. Sand and gravel resources on the inner shelf could be found suitable and available for future public works projects to restore beaches or wetlands in this region. The Merrimack embayment is north of Cape Cod and not within the cumulative impact study area, but future characterization activities conceivably could be extended to include the southern inner shelf area of Cape Cod, Martha’s Vineyard, and Nantucket Island. For sand and gravel mining in Federal waters beyond 3.5 miles (5.6 km) from shore, a permit from the MMS is needed.

Presently there is one proposal for an offshore sand mining project in the vicinity of Nantucket Sound within state waters. The Sconset Beach Nourishment Project is proposing that approximately 2.6 million cubic yards of beach compatible sediment be hydraulically dredged from a 195 acre (0.78 km²) borrow site located approximately 2.9 miles (4.6 km) east of Nantucket Island in water that is 30-60 ft deep. The material would then be transported to Sconset Beach on Nantucket and pumped onto the project shoreline from a barge or dredge as a slurry of sand and water. This project would provide beach and dune nourishment for approximately 3.1 miles (4.9 km) of shoreline on eastern Nantucket extending south from Sesachacha Pond, past Sankaty Head Lighthouse to Codfish Park and the Village of Siasconset, and includes dune restoration at Codfish Park and dune construction at the Town Sewer Beds. This sand mining project is in development and environmental review and is contingent upon approval and permitting from several state agencies and the USACE. The sand mining project is anticipated to take place from June to November 2008.

The Town of Barnstable has expressed interest in conducting sand mining projects outside the Cape Cod Ocean Sanctuary boundaries for future beach nourishment. Although there are presently no approvals for sand mining projects, the potential for future activities and associated construction do exist. In the event that two projects occur concurrently in close proximity, there is a potential risk for cumulative impacts associated with the proposed action on environmental and socioeconomic resources, which are discussed in Section 6.3.

6.1.3 Tidal Energy Projects

At present there is only one known proposed TISEC technology development project within the cumulative impact study area¹ Massachusetts Tidal Energy Company (MATidal) proposes to construct one or more clusters of TISEC devices to generate electricity via tidal currents in Vineyard Sound and sell the electricity to the grid. The project is located in navigable waters of the United States in Vineyard Sound in approximately 40 to 75 ft (12.2 to 22.9 m) of water. The underwater area begins at the southeast end of Naushon Island in Vineyard Sound and extends northeast in two separate areas located on either side of Lucas Shoal and Middle Ground, to their terminus at an existing underwater cable crossing that runs between Nobska point in Falmouth and an area west of Lake Tashmoo on Martha's Vineyard. Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard (FERC Preliminary Permit Application, 2006).

The project would consist of 50 to 150 TISEC devices, each having the generating capacity of 500 kW to 2 MW (FERC Preliminary Permit Application, 2006). The proponent has stated that the TISEC devices would consist of: (1) rotating propeller blades, approximately 20 to 50 ft (6.1 to 15.2 m) each in diameter; (2) an integrated generator, producing 500 kW to 2 MW of electricity; (3) anchoring systems supporting the TISEC device at varying depths underwater; (4) a mooring umbilical line to an anchor on the sea bottom; and (5) an interconnection transmission line to shore. Monitoring systems for parameters including but not necessarily limited to pressure, temperature, vibration, revolutions per minute, and power output may be located on the TISEC devices and onshore. Transmission from the TISEC device cluster to shore would also be by submerged cable, which may be buried beneath the seabed in its inshore portion. Onshore underground transmission cables would carry the electricity to where it would be fed into the land-based electrical use infrastructure (FERC Preliminary Permit Application, 2006). Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard. Information

¹ The Electric Power Research Institute has conducted feasibility studies for tidal projects in the general area, though none of these projects has been proposed by a developer and no permit application filings have been made (TRC, 2006).

regarding the location of on-land interconnects is not provided in the FERC preliminary permit filing (FERC Preliminary Permit Application, 2006).

The schedule indicates that the project would take place in three phases. The first phase would involve testing the devices and would take approximately 20 months to permit, followed by approximately 17 months of testing. The schedule shows that this in turn would be followed by permitting and installation of a partial build-out, followed by permitting and installation of the full build-out. The entire timeline for the project from start to completion of permitting for full build-out is approximately 51 months (FERC Preliminary Permit Application, 2006). This tidal energy project is 10 miles (16.1 km) away from the proposed action at its closest point.

6.1.4 Marina Development

Local marina development was also considered when determining the spatial and temporal scope of the cumulative impact analysis. Whether this activity involves new marina development or maintenance of existing locations, the environmental impacts associated with this activity do exist, but are expected to be relatively small and generally far-field relative to the majority of the proposed action location.

6.1.5 Onshore Wind Energy Projects

The Massachusetts Technology Collaborative's (MTC) Community Wind Collaborative is likely to result in a number of small community initiated wind projects for additional onshore wind power installations. These community based projects are small scale (generally only one or two WTGs) and collectively would fall far short of the producing capacity of the large scale offshore projects such as the proposed action and the South Coast Offshore Wind Project. The environmental impacts associated with the construction, operation, and maintenance of these small land based projects are expected to be localized.

6.1.6 Submarine Cable and Pipeline Projects

Presently, there are three existing submarine cable systems located in Nantucket Sound that connect the mainland with the offshore islands to provide reliable island-wide power supply. There are no known active proposals for new submarine pipelines in the Nantucket Sound area. There are five 25 kV distribution cables that interconnect Martha's Vineyard with Cape Cod, the closest being 13 miles (21 km) to the west of the area of the proposed action. There are two submarine cable systems that connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 miles (13 km) east of the proposed action area. There are no publicly available plans at this time for any future submarine cable system installations in Nantucket Sound or Vineyard Sound except for those associated with the proposed action.

6.1.7 Maintenance Dredging and Beach Nourishment

Another marine construction activity analyzed for cumulative impacts to environmental resources is the maintenance dredging of navigational channels and the disposal of dredged materials for beach nourishment in and around the shores of Nantucket Sound. Maintenance dredging is defined by 301 C.M.R. 11.02 as "any maintenance work or activity carried out on a regular or periodic basis in a manner that has no potential for damage to the environment or for which performance standards have been developed that avoid, minimize, or mitigate potential environmental impacts to the maximum extent possible." Much of the materials used for beach nourishment are from the dredged materials of maintenance dredging activities. The County of Barnstable carries on maintenance dredging in dozens of harbors and inlets for the various waterfront communities around Cape Cod on a rotational basis using the cutterhead DRAGON dredge "*Cod Fish*". Because of the high boat traffic peaking in late June, dredging halts for the summer and does not start again until October. On Martha's Vineyard, the dredge

“Edgartown” carries out scheduled maintenance dredging of channels, tidal inlets, and pools. Dredged sand and materials are used for beneficial purposes such as for local beach nourishment.

The submarine cable system for the proposed action would be placed adjacent to the eastern edge of the Federal Navigation Project in Hyannis Harbor. Hyannis Harbor was dredged in 1985, 1991, 1998, and 1999. No future dredging activities are currently scheduled. Nonetheless, if dredging activities were to occur concurrently with the jet-plow installation of the submarine cable system into Lewis Bay, and due to the close proximity of the two activities; they could potentially result in cumulative impacts. Another example is Oak Bluffs Harbor dredging, which is a project consisting of dredging the entrance to Oak Bluffs Harbor with beneficial use of the dredged sand as nourishment on an adjacent town beach. Sediment suspension, deposition, and some mortality of benthos and shellfish in the area of temporary disturbance would need to be considered given concurrent construction activities. Therefore, geology and sediment conditions, benthic and shellfish conditions, and fish resources and commercial/recreational fisheries are discussed in detail in Section 6.3.

6.1.8 Upland Pipeline Projects

This cumulative impact analysis has also taken into consideration the proposed onshore KeySpan Sagamore Line Reinforcement Project with respect to the onshore components of the onshore cable system for the proposed action. KeySpan proposes the construction of approximately 13.1 miles (21.1 km) of a new high-pressure, distribution gas pipeline that is planned to be constructed from the present up until 2013. This reinforcement project is an upgrade to an existing pipeline and the proposed route would be constructed in three segments: Western, Middle, and Eastern. The Western Segment would begin near the intersection of Route 130 and Service Road in Sandwich and extend along Service Road to Route 149 in Barnstable, approximately 5 miles (8 km) from the nearest point along the onshore cable route of the proposed action. The Middle Segment installation runs from KeySpan’s South Yarmouth LNG facility on White’s Path to the Depot Street and Main Street intersection in Harwich, nearly 2 miles (3.2 km) from the nearest point along the onshore cable route of the proposed action. The Eastern Segment, the farthest segment from the proposed action (approximately 12 miles [19.3 km]), would involve the installation of 1.6 miles (2.6 km) of pipeline from the Depot Road and Route 139 intersection in Harwich to the intersection of Church Street and Route 39 in Harwich. The three segments of the KeySpan Sagamore Line Reinforcement Project do not intersect the proposed onshore cable route and therefore there would be no gas line construction in the vicinity of the proposed action’s onshore cable route.

6.1.9 Commercial Fishing Activities

Nantucket Sound experiences a wide range of disturbances on a regular basis in and around the study area. Anthropomorphic disturbances (commercial fishing, anchoring, etc.) repeatedly and regularly affect the environmental resources associated with the water column and the seabed. For example, Churchill (1989) has measured near-bottom TSS to be up to 1,500 mg/L as a result of trawling operations. With the seafloor conditions found in portions of Nantucket Sound, it is possible that upwards of 1.32 yd³ (1.01 m³) of suspended sediment could be injected into the water column for every foot of commercial trawling. Commercial fishing is a baseline disturbance factor in Nantucket Sound, resulting in minor temporary disturbances to benthos and brief episodic increases in suspended solids, along with the harvesting of fish, shellfish, mollusks, and shrimp. The WTGs represent a new set of navigation obstacles that would need to be avoided, but they should not measurably alter the ability to undertake commercial fishing within the boundary of the WTGs.

6.1.10 Small Marine Projects

Other marine projects that could be considered in the cumulative impact scenario include the construction of sea walls, docks, piers, shoreline stabilization/erosion control measures, harbor dredging, etc, which collectively are considered as part of the cumulative scenario.

6.1.11 Vessel Traffic

Vessel traffic associated with Nantucket Sound includes ferry services between Cape Cod and the Islands, limited cruise ship traffic, use of the area by commercial fishing vessels, and recreational boating use. The majority of this boating traffic travels along channels setback from the proposed Project (i.e., commercial ferry traffic, cruise ships, large recreational vessels) with boating traffic limited to some recreational boating and commercial fishing in the specific area of the proposed turbine array. Cumulative impacts on vessel traffic are generally expected to be minor due to the limited vessel traffic in the specific area of the proposed action.

6.1.12 Population Growth and Onshore Development

Land-based activities near the ocean may contribute to indirect or associated cumulative impacts on a particular sensitive coastal resource area and may include power plant cooling water intake and discharge facilities, non-point and point source runoff, agricultural activities, storm water run off, and accidental pollutant discharges. Such far-field impacts can have varying degrees of impact on the marine environment in the geographic area of the proposed action depending on the location, extent, and type of activity to the adjacent receiving waters in Nantucket Sound. They are included as a general group of impacts called Population Growth and Onshore Development.

The Massachusetts statewide population over the last century has been continually increasing. Cape Cod and the Islands are no exception. Specifically, Barnstable, Dukes and Nantucket County populations have increased by 19, 29, and 58 percent, respectively between 1990 and 2000. Barnstable County gained 6,453 residents from 2000 to 2004 to reach an estimated total population of 228,683 (a 2.9 percent increase over 4 years), according to the U.S Census. Nantucket County had a 6.3 percent increase and Dukes County increased its total population by 4.6 percent from 2000 to 2004. From 2000 to 2005 the number of housing units in Barnstable County increased by an estimated 6,715 from the U.S Census count of 147,083 in April 2000 to reach 153,798 in 2005. This 4.6 percent housing growth rate (in 5 years) led the state's 12 mainland counties topped only by Nantucket County's 9 percent growth rate up from 9,210 in 2000 to 10,042 in 2004 and Dukes County's 5.6 percent, where homes on Martha's Vineyard and the Elizabeth islands increased from 14,836 in 2000 to 15,670 in 2004 (see Section 4.3.3.1 for further discussion of Cape Cod population trends). This trend of fast-growing population suggests that onshore residential and commercial development would also continue to increase. This increase in onshore development would in turn result in point and non-point source discharges and increased air pollution, which in turn may contribute cumulatively to water and air pollution in the area. The possible contribution of the proposed action to pollution associated with population growth and onshore development is discussed in Section 6.3 as applicable. The alteration of native vegetation, increased human activity on area beaches, and greater recreational boating on the Sound, all have the potential to create cumulative impacts on birds, protected species, aesthetics, noise, wildlife, and air quality.

6.1.13 Wave Energy Projects

Offshore wave energy devices are typically tethered to the seafloor, and could use either suction or gravity anchors. Cables are then connected between the wave energy device and the anchors. As with an offshore wind project, larger wave energy projects would have the devices positioned in an array to take maximum advantage of the prevailing wave direction. Some impacts associated with wave energy devices may include impacts to the benthic environment as a result of anchoring device used, potential for

collision of marine mammals with the devices and or fishery impacts, impacts associated with navigation, and impacts associated with the public use of the waterway.

At present there is a Rhode Island state-funded pilot wave energy project proposed off of Block Island, which is just beyond the southwest edge of the cumulative impact study area. After this is constructed, there are plans for another larger wave energy facility at an unspecified location off of Rhode Island. The developer of the two Projects, Oceanlinx Limited, proposes to first generate 1.5 MW with the pilot project, and then subsequently generate between 15 and 20 MWs as part of the larger project. The wave energy project would use oscillating water technology, whereby waves compress air to drive a turbine. The device includes computers to measure the air pressure and alter the angle of blades in the turbine so that, although the wave action ebbs and flows at different speeds, the turbine spins at a constant rate in a single direction. The wave energy project is anticipated to result in negligible cumulative impacts with the proposed action because it is located far from the area of the proposed action. In addition, the small wave energy associated with the waters of Nantucket Sound relative to other locations makes it unlikely that a wave energy Project would be constructed near the area of the proposed action.

6.2 CUMULATIVE IMPACTS ANALYSIS

The following section discusses impacts of the cumulative scenario and then assesses the extent that the proposed action would incrementally contribute to that impact. The discussion addresses each of the main impact areas discussed in this EIS including: geology and sediment conditions; physical oceanographic conditions; benthic and shellfish resources; fish resources and commercial/recreational fisheries; protected marine species; terrestrial ecology; wildlife and protected species; avian resources; coastal and freshwater resources; water quality; cultural/recreational resources and visual studies; noise; transportation and navigation; electric and magnetic fields; telecommunications; air and climate; and socioeconomics.

6.2.1 Geology and Soft Sediments

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) undersea pipeline or cable installation; (3) channel maintenance; (4) commercial fishing activities (trawling); and (5) other small marine projects. Direct impacts for all activities have the potential to disturb sediment by contacting the surface, by temporarily suspending sediments, or by temporarily increasing biologic oxygen demand in the water column from suspended organic matter in the sediment.

Impacts to the geology and sediment conditions within Nantucket Sound are likely to occur during construction and decommissioning of the proposed action (i.e., installation and removal of undersea cables and monopiles). Given the dynamic sediment transport and depositional/erosional environments within and surrounding the area of the proposed action, natural processes are anticipated to rapidly restore seabed topography and benthic biology following completion of all construction phases. This would include all proposed phases of construction and operation including pile-driving, jet plow embedment of submarine cable systems, landfall transition interconnections and onshore cabling and conduit installations, including anchoring, winching and spudding activities associated with construction vessels. Mitigation measures, such as scour mats would also be implemented to reduce the impacts to geology and sediments (see Section 9.3). Given the implementation of mitigation techniques used in the construction activities of the proposed action, the impacts would be localized and short-term, and therefore the incremental cumulative impacts to geology and soft sediment conditions as a result of the proposed action are expected to be minor, even if such impacts occur at the same time as activities that are part of the cumulative scenario.

No existing bottom-founded infrastructure exists within the area of the proposed action for which setback could be established, with the exception of the meteorological data tower. If sand borrowing is an activity that takes place on Horseshoe Shoal over the next 20 years, borrow areas would require setbacks from monopiles. Direct impacts from sand dredging that could occur would be equipment that punctures or strikes bottom-founded or buried infrastructure, particularly if locations are poorly known or if pipelines have moved as a result of storm activity. Indirect impacts from sand dredging could be partial exhumation or spanning of pipelines when the slopes at the edges of burrow pits undergo erosion to re-equilibrate with the slope of the surrounding sea floor over time. Pipelines or cables buried in the sediment could have cover reduced or be exhumed if sand dredging takes place too close to infrastructure, making them vulnerable to commercial fishers who bottom trawl, or recreational boaters dropping anchors, for example.

Setback distances from existing infrastructure are needed in the event of dredging or sand mining on Horseshoe Shoal. MMS (USDOI, MMS, 2005) determined that bottom substrates that are sandy need shorter setback distances; on the order of 150 ft (50 m) for borrow pits that are 15 ft (5 m) deep. The time periods needed for burrow pits to either fill or re-equilibrate with the sea bottom are generally on the order of 3 to 6 years for sandy bottom substrates (USDOI, MMS, 2005, p. 161). The high sedimentation rates of mobile sand typically fill disturbed areas or borrow pits relatively quickly making large setback distances from infrastructure unnecessary should sand borrowing occur on Horseshoe Shoal. The area of the sea bottom disturbed by the 130 WTG monopoles and the piles for the ESP totals 0.67 acre (0.003 km²). Scour protection will cover an additional 2.5 acres (0.1 km²) if scour mats only are used, or up to 41.8 acres (0.17 km²) with rock armoring. The sea bottom disturbed by construction or decommissioning vessels, either by direct contact or increased turbidity, is estimated to be 0.25 acre per monopile or 32 acres (0.12 km²) for 130 monopiles.

The area of sea bottom disturbed by constructing or decommissioning the proposed action is very small in comparison to the available area of sandy bottom on Horseshoe Shoal that would remain undisturbed between the monopiles as well as the area outside the wind park envelope. Bedrock geology below soft sediments will be completely undisturbed by the proposed action and the activities that are part of the cumulative scenario.

Conclusion

Minor long-term impacts to geology and soft sediments as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The total area of permanent benthic impact for the proposed action due to the WTG and ESP piles is 0.67 acres (2,711 m²) and the total area of temporary impact for the cable that connects the WTGs to the ESP is 580 acres (2.3 km²). The temporary impact of the area disturbed from installation of the cable from the ESP to the shore is 86 acres (0.3 km²). The majority of the impacts are temporary and localized and small relative to the size of Nantucket Sound.

6.2.2 Physical Oceanographic Conditions

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline projects; (3) submarine cable projects; and (4) the South Coast Offshore Wind Project.

In the unlikely event that a nearby sand and gravel mining project was approved in proximity to the proposed action it would not be expected to have any impact on waves, currents, tides or other physical oceanographic conditions because of the design parameters for the proposed action. The proposed action is not expected to result in changes to existing erosion patterns on the sea bed or on adjacent coastlines or

beaches. Studies have determined that the zone of influence of each WTG pile on current conditions is estimated to be limited to an area of several pile diameters around each WTG ([Report No. 4.1.1-4](#)).

Conclusion

Negligible long-term impacts on physical oceanographic conditions are expected as a result of the proposed action or the activities that are part of the cumulative scenario, since none of these potential activities would have anything other than a very small and localized affect on features such as tides, waves, or currents.

6.2.3 Benthic Fauna and Shellfish

Activities that are part of the cumulative scenario that may impact benthic fauna and shellfish include: (1) sand and gravel mining; (2) maintenance dredging; (3) pipeline projects; (4) submarine cable projects; (5) commercial fishing activities; and (6) small marine projects. Direct impacts from all of these activities are limited to the area in which the activity takes place.

If the proposed action was permitted and constructed, sand and gravel extraction within the designated MMS lease area would be precluded, but sand mining could possibly take place near the perimeter of the leased area. In the unlikely event that sand and gravel extraction was approved by MMS over the next 20 years, and took place in proximity to the proposed action, there is the potential for cumulative impacts on the benthic fauna and shellfish resources within the cumulative study area.

Potential impacts to benthic and shellfish resources associated with the construction, operation and maintenance of the proposed action relate directly to that area of the seafloor either displaced by monopiles and scour control systems, or temporarily disturbed during construction and decommissioning. Direct impacts would include crushing or smothering of benthic infauna and epifauna by construction equipment and anchors, monopile foundations, and scour mats. Indirect impacts could be increased turbidity that interferes with filter-feeding organs of benthic invertebrates. These impacts on benthic and shellfish conditions would be localized and short-term.

The applicant has attempted to plan, site, and design the proposed action to avoid and/or minimize impacts to benthic and shellfish resources. In addition, jet-plow embedment for the submarine cable system is minimally intrusive on the seabed and natural conditions are quickly restored after completion of construction due to the predominantly sandy bottom of Nantucket Sound and Lewis Bay (see Section 9 for more mitigation discussion).

The sea bottom area is living space for invertebrates living in, and on, the sediment surface. The degrees of disturbance of benthic area by the proposed action are discussed in 6.3.3. Following disturbance of the sea bottom, the general pattern of succession of marine benthic species begins with initial recolonization by small opportunistic species that reach peak population densities within months of a new habitat becoming available after catastrophic mortality of the previous assemblage. The population density of the initial colonizers declines as adult species migrate into the disturbed area from adjacent undisturbed areas. This transitional period, characterized by a benthic faunal assemblage of higher species diversity and a wide range of functional types may last for years, depending on numerous environmental factors. Provided no new bottom disturbances take place, some members of the transitional assemblage are eliminated by competition, and the benthic species assemblage forms a recovered community comprised of larger, long-lived, and slow growing species that maintain complex biological interactions with one another.

Benthic recolonization and succession have been reviewed to varying extents for a wide variety of habitats throughout the world (e.g., Thistle, 1981; Thayer, 1983; Hall, 1994; Coastline Surveys Limited,

1998; Newell et al., 1998). Re-colonization is highly variable and ranges from within months (e.g., Saloman et al., 1982) to more than 12 years (e.g., Wright, 1977), depending on the habitat type and other physical and biological factors. Focusing on dredging, Coastline Surveys Limited (1998) and Newell et al. (1998) suggested that in general, recovery times of 6 to 8 months are characteristic for many estuarine muds, 2 to 3 years for sand and gravel, and 5 to 10 years as the deposits become coarser.

Once installed and operating, monopile foundations would offer hard substrates in an area that otherwise consists of soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in or on the sediment surface to hardground communities having increased abundance of individual species as well as species diversity. The 130 monopiles and rock armor of the proposed action are expected to become encrusted by attached epifauna such as mussels, but could also include barnacles, sponges, bryozoans, and macroalgae, within 5 to 6 years. Abundance and biomass of benthic communities increased 50-150 times at the Danish wind park sites at Horns Rev and Nysed compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44).

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts to the benthic community as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Recolonization of sediment disturbed after the proposed WTG monopile and scour system installation and other bottom-disturbing work that could occur over the next 20 years, such as sand borrowing on Horseshoe Shoal, would occur rapidly. Although the number of individuals, species, and biomass of benthic infauna may approach pre-disturbance levels within 2 to 3 years on sandy substrates, recovery of community composition and trophic structure may take somewhat longer. Undisturbed areas between monopiles and outside of the wind park envelope are sources for faunal in migration and larval recruitment for recolonizing the small areas that are disturbed. The increase in benthic biomass from installation of hard substrate will be degraded in a converse manner after monopiles are decommissioned and removed unless artificial reefing of monopiles takes place to some degree.

6.2.4 Fish Resources and Commercial/Recreational Fisheries

Activities that are part of the cumulative scenario that may impact fish and commercial or recreational fisheries within the cumulative impacts study area include: (1) sand and gravel mining; (2) commercial fishing activities; and (3) maintenance dredging. Direct and indirect impacts are the result of habitat conversion that may improve or degrade existing bottom substrates.

Sand mining would have the potential of disturbing bottom substrates used by shellfish that are commercially fished; however, these disturbances would be limited to the mined area. Construction of the proposed action is not expected to result in measurable direct mortality to adult and juvenile pelagic fish since these life stages are mobile in the water column and are capable of avoiding or moving away from any disturbances associated with construction. Once installed and operating, the presence of the WTGs and ESP may make it more difficult for commercial trawling in the immediate vicinity of each structure. Any adverse impacts to commercial/recreational fisheries would be localized and minor given that commercial fishing activities would still occur in the area of the proposed action. In addition, it is likely that recreational fishing may increase due to the potential for the wind turbine bases to become FADs. As a result, incremental cumulative impacts to fish resources and commercial/recreational fisheries from the Project are expected to be minor.

Once installed and operating monopiles would be hard substrates in an area that otherwise consists of soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in, or on, the sediment to hardground communities having increased abundance of individual species as well as species diversity. At the Danish offshore wind parks at Horns Rev in the North Sea and Nysted in the Baltic Sea, the submerged WTG foundations became colonized and encrusted by the common mussel *Mytilus* within 5-6 years after emplacement (Danish Energy Authority, 2006, p. 53). At this latitude and marine setting the mussel is a superior competitor for space compared to other sedentary invertebrate species or algae. Abundance and biomass of benthic communities increased 50-150 times at both Danish wind park sites compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44). Artificial hard substrates are generally considered beneficial to the reproduction and growth of some native mobile species, such as crab, by providing shelter and nursery habitat. At Horns Rev the edible crab *Cancer* colonized the foundation structures as juveniles and adults.

Environmental monitoring studies at Horns Rev and Nysted showed few effects on the fish fauna that could be attributed to the establishment and operation of the wind parks. The use of advanced survey techniques and intensive surveys did not document any clear effects on fish communities. Fish abundance and diversity were not higher inside the wind parks than in the areas outside. At Nysted the effect of the wind park was inferred to be weak because the hard substrate monocultures of mussels encrusted on the foundation elements are only moderately attractive to fish. At Horns Rev investigators performed the fish surveys during the early stages of colonization of the turbine foundations, where a correlation between fish and the wind park may not have been measurable (Danish Energy Authority, 2006, p. 64).

Over the operating lifetime of the wind park, monopiles are expected to cause net increases in biomass on Horseshoe Shoal. In effect these small islands will be enriched ecosystems for duration of the project and are attractants to the invertebrates that live within and among encrusting mussels as well as birds and fish that could favor these associated communities as opposed to mussels alone. The degree of correlation between fish and monopiles in cold water has yet to be firmly established. If monopiles do attract fish they may also be attractants for recreational or commercial fishers.

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, and possibly to fish and birds, will be removed from the setting of Horseshoe Shoal, and these resources will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts on fish and commercial and recreational fisheries as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Environmental monitoring at Danish offshore wind parks to date has been inconclusive as to whether or not wind parks are net attractants for fish. Whether or not monopile foundations would serve as attractants for recreational or commercial fishers is equally inconclusive at this time.

6.2.5 Protected Marine Species

Activities that are part of the cumulative scenario that may impact protected marine species within the cumulative impacts study area include: (1) vessel traffic and vessel strikes associated with marine construction and service vessels; and (2) underwater noise. Direct impact caused by a vessel accidentally striking a marine mammal or turtle could range from lacerations and broken bones to internal injuries and mortality. Direct impacts caused by underwater noise could cause short- to medium-term habitat displacement (i.e., harassment due to decibel level) if marine mammals or sea turtles avoid the wind park

area during construction, as a result of underwater noise. It is likely that only protected species in immediate proximity to pile driving could experience physically harmful sound levels.

Increased vessel traffic could be due to construction and operation of the proposed action or for other marine renewable energy projects (i.e., South Coast Offshore Wind Project or the Cape and Islands Tidal Energy Project), marina development or other marine related work. The proposed action has been sited and designed to avoid, minimize, or mitigate potential impacts to protected marine species. Some mitigation measures include having a NMFS-approved observer on-site during all pile driving activities and using state-of-the-art hydraulic jet plow technology for cable installation and monopile foundations for the WTGs (see Section 9.0 for more mitigation discussion). If marine mammals or sea turtles are present in the area of the proposed action, they are likely to temporarily avoid the area during construction activities. Given the rarity of protected marine species observances in Nantucket Sound and the significant distances between activities within the turbine array and seal haul-out and breeding sites, the potential impacts to these species is further reduced.

During construction of the Danish wind parks at Horns Rev and Nysted, no general change in behavior at sea or on land for marine mammals could be linked to construction activities, such as pile driving. The only effect detected on land was a reduction in the number of seals during pile driving operations at Nysted (Danish Energy Authority, 2006, p. 14). Porpoise abundance were found to slightly decrease during construction at Horns Rev, and at Nysted a clear decrease in abundance was detected in porpoise abundance during construction and operation (Danish Energy Authority, 2006, p. 14).

Conclusion

Minor long-term impacts on protected marine species are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Mitigation is expected to effectively minimize the chance for vessel strikes during support of the proposed action. Increased commercial fishing, recreational fishing, and pleasure boat activity as a consequence of gradually increasing population and economic activity in the area over the next 20 years could result in several unreported or unrealized collisions with protected marine species, primarily turtles or seals, because boaters are not on alert, and therefore unaware of their presence.

6.2.6 Terrestrial Ecology, Wildlife and Protected Species

Activities that are part of the cumulative scenario that may impact terrestrial ecology, wildlife and protected species within the cumulative impacts study area include: (1) onshore sand and gravel mining; (2) beach nourishment; (3) upland pipeline projects; (4) onshore wind energy projects; (5) other offshore wind projects with onshore interconnections; and (6) population growth and onshore development.

Sand and gravel mining and beach nourishment onshore, upland pipeline projects, other offshore wind projects with onshore connections, and onshore wind energy projects have the effect of land conversion to these uses making cumulatively less available land for terrestrial ecosystems, wildlife, and wildlife habitat. Residential and commercial development can cause loss of wildlife habitat due to vegetation clearing. General population growth and increased intensity of land use may pressure wildlife habitat.

The proposed action has been planned, sited, and designed to avoid or minimize impacts to terrestrial ecology, wildlife and protected species and their mapped habitats within the area of the proposed action. For example the proposed onshore route for the cable system is configured to utilize previously developed or disturbed transportation and utility corridors.

Conclusion

Negligible to minor long-term impacts on terrestrial ecology, wildlife and protected species are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The growth of population and economic activity over the next 20 years is expected to place conversion pressure on land now available for terrestrial ecosystems and wildlife.

6.2.7 Avian Resources and Protected Bird Species

Activities that are part of the cumulative scenario that may impact avian resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore wind projects; (3) onshore wind projects; and (4) onshore development. Direct effects would be restricted to lethal collision hazard to birds or bats posed by operating WTGs. Indirect effects would include the wind park serving as a barrier to movement as a result of the 25 square miles (64.7 km²) area of the proposed action and temporary disturbance of avian resources in the area during construction and decommissioning activities.

The increase in biomass expected by colonization of the monopile foundations by monocultures of mussels and the invertebrates that live among them could enrich local food sources around monopiles that could attract birds. Environmental monitoring at the Danish wind parks has shown that most of the more numerous bird species showed avoidance responses at both Horns Rev and Nysted (Danish Energy Authority, 2006, p. 15). Birds tended to avoid the vicinity of the turbines and radar tracking has shown that there was considerable movement around the periphery of the wind parks. Post-construction studies showed almost complete absence of divers and scoters within the Horns Rev wind park and significant reductions in long-tailed duck densities within Nysted. Other species showed no significant change or occurred in too few numbers to allow statistical analysis (Danish Energy Authority, 2006, p. 15).

Although the type and extent of impacts to migratory birds are not yet well defined for offshore wind Projects in the United States, some level of bird-strike impacts and mortality associated with the turbine structures from the proposed action and any future offshore projects should be anticipated.

Sand mining could temporarily degrade sea bottom conditions by disturbing the substrate. If birds relied upon elements of the soft bottom fauna for food, they could be displaced from the sand borrow area until re-establishment of the normal community in 2 to 3 years time.

Onshore wind projects in Massachusetts are limited in size and scope due, in part, to a lack of large tracts of available land with adequate wind resources. As a result, all of the proposed onshore projects range from single turbine installations to less than ten WTGs. These projects are proposed in near-shore communities and in towns further inland that have forested hills or ridge tops. The addition of small numbers of widely scattered onshore wind turbines, each of which would have to go through regulatory review to determine appropriate siting and levels of environmental impacts, is not expected to have a significant cumulative effect in combination with the proposed action.

The estuaries, shoals, salt marshes, tidal flats, dunes, and beaches that comprise the Nantucket Sound ecosystem provide important breeding, nesting, and foraging habitat for many species of resident and migratory birds. Nantucket Sound is located along the Atlantic flyway and is recognized as an important migratory stopover area for millions of birds each year. General impacts associated with human activities occur wherever land development happens and where there is a high level of outdoor recreation, such as on Cape Cod and the Islands. Therefore, human activity results in ongoing and continuous impacts at a multitude of locations at very minor individual levels. The total result is that land bird habitat is being altered by residential and commercial development, hundreds of thousands of people visiting coastal beaches, myriads of watercraft (more so in summer months than winter) traversing the ocean and resources being harvested from the ocean. In contrast, the single timeframe to construct and

decommission the project has short-duration effects that would only occur twice. Avian populations are expected to exhibit some avoidance behavior as has been seen at the Danish wind parks. Whether or not birds become habituated to marine WTGs over time is unknown at this time.

One of the avian populations of most concern is the roseate tern, and studies have shown that several areas adjacent to the proposed South Coast Offshore Wind Project in Buzzards Bay (specifically Bird Island and Ram Island) are important breeding areas for endangered roseate terns. Mortality to breeding terns at these locations in Buzzards Bay may have a significant impact on the species. Therefore, although the exact location of the South Coast Offshore Wind Project is unknown, it is reasonable to anticipate that, if constructed, it would have substantially greater impacts than the proposed action on roseate terns. Thus, while the proposed action has the potential for some cumulative impacts, future evaluation and approval of the South Coast Offshore Wind Project would need to undertake the necessary evaluations of potential impacts on the roseate tern. The incremental cumulative impact from the proposed action combined with the South Coast Offshore Wind Project on the roseate tern population could range from minor to at least moderate. Cumulative impacts to the existing predator-prey relationships in Nantucket Sound are expected to be negligible.

Future onshore development would lead to more clearing and, therefore, less avian habitat, but the incremental impacts from the proposed action would be negligible. The greatest threat to birds, in general, continues to be loss or degradation of habitat due to human development and disturbance. For migratory birds requiring multiple areas for wintering, breeding, and stopover points, the effects of habitat loss can be complex (USFWS, 2002). The greatest threats to birds would be collisions with buildings and obstructions such as communication towers and collision or electrocution by high-tension transmission lines (USFWS, 2002). In a coastal and marine setting, bird deaths resulting from domestic and feral cats would be much reduced, and collision hazard with marine vessels and structures accentuated.

Conclusion

Minor long-term impacts on birds as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The proposed action would result in minor to moderate cumulative impacts on roseate terns. The addition of the potential activities that are part of the cumulative scenario (i.e., the South Coast Offshore Wind Project, refer to Section 6.1.1 for details on this proposed project) has the potential to result in greater cumulative impacts to this species. Existing monitoring devices for bird mortality, such as infra-red detectors, may not uniquely identify an individual species, nor can radar monitoring uniquely identify individual species within a resources area. If individual deaths occur within these populations they may not be able to be conclusively attributed to construction or operation of the proposed action. Monitoring may provide circumstantial evidence, for example, bird carcasses on the water.

6.2.8 Coastal and Freshwater Wetland Resources

Activities that are part of the cumulative scenario that may impact coastal and freshwater wetland resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline projects; (3) other offshore wind projects; and (4) onshore development. Direct impacts from all of these activities are limited to the area in which the activity takes place.

It is highly unlikely that any sand mining projects would be permitted and approved by Massachusetts inside the state 3.5-mile (5.6 km) limit and Cape and Islands Ocean Sanctuary that would have the potential to affect coastal and freshwater wetland resources. Other offshore wind projects are expected to have similar coastal and freshwater resource impacts (as the proposed action) and implement similar mitigation measures in order to avoid or minimize any coastal or wetland resource impacts. Wetlands have been identified in the vicinity of the area of the proposed action seaward and within the state

territorial limit of Nantucket Sound and Lewis Bay, and along the onshore transmission cable route. The proposed action does not directly impact freshwater wetlands.

Conclusion

Negligible long-term impacts on coastal and freshwater wetlands as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.9 Water Quality

Activities that are part of the cumulative scenario that may impact water quality resources within the cumulative impacts study area include: (1) offshore wind energy projects; (2) sand and gravel mining; (3) tidal or wave energy demonstration projects; (4) small marine projects and marina development; (5) submarine cable and pipeline projects; (6) maintenance dredging and beach nourishment; (7) vessel traffic; and (8) population growth and onshore development. All of these activities have potential for direct impacts that degrade water quality as a result of increased nutrient inputs, biological oxygen demand, and turbidity. These direct impacts occur from multiple and mobile point sources, are spatially disbursed, and range from temporary to semi-permanent.

Oil and grease can enter the water from vessel discharges, deck wash, and bilge discharges. Accidental diesel fuel spills and spills of fluids in the nacelles of the WTGs and spills on the Electrical Service Platform. Increased turbidity and biological oxygen demand can result from dredging or sand mining operations that disturb the bottom and suspend sediment and organic matter. Increased marina activity as well as population growth and onshore development could result in more storm and septic system runoff that may have enriched nutrient contents. Vessel traffic from marine construction projects or pipelines and more fishing or pleasure boats on the water increase the likelihood that deficient, poorly maintained, or out of compliance waste treatment systems could leak untreated human waste or biodegradable materials. The cumulative impact can include: degraded water quality, odors, floating debris, poor underwater visibility, and beach closings from higher bacterial counts on popular beaches.

Potential marine water quality impacts from the proposed action would be limited to sediment disturbance along the cable corridors and at monopile locations from construction vessel anchoring, anchor line sweep, and installation of the scour protection, foundation and cables. Potential impacts to water quality associated with construction and operation of the proposed action and the submarine cable system across Lewis Bay and within Nantucket Sound would be short-term and localized. Further, water quality impacts related to sediment disturbance from installation would be comparable to disturbance already occurring within Nantucket Sound from natural events and fishing gear (see Section 5.3.1.6).

Conclusion

Minor long-term impacts on water quality are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Direct impacts, such as increased turbidity as a result of monopile emplacement or decommissioning and removal are temporary and distributed among 130 monopile sites. The operation of onboard waste treatment systems can help to minimize water quality impacts (for further information on mitigation, refer to Section 9.0).

6.2.10 Visual Impacts

Activities that are part of the cumulative scenario that may affect visual resources within the cumulative impacts study area include: (1) other offshore wind projects; (2) onshore wind projects; (3) increased vessel traffic; and (4) onshore development. Direct impacts result to the presence of offshore infrastructure that can be seen from shore. Direct impacts can be temporary as vessels come and go,

short-term as construction vessels temporarily anchor for monopile construction or removal, and permanent over the operating lifetimes of renewable energy projects located offshore or on land.

Visual alteration to the historic Nantucket Sound setting caused by the WTGs and related structures would affect both historic properties and recreational areas (see Section 5.3.3.4). However, at this time the only other large scale wind farm proposed, the South Coast Offshore Wind Project, would be located in Buzzards Bay more than 17 miles (27.4 km) away and separated from the proposed action area by the Elizabethan Islands. Thus, most areas that have a view of the proposed action would not likely have a view of the South Coast Offshore Wind Project. No information is available at this time about whether the Cape and Islands Tidal Energy Project would require the installation of above water moorings or structures that could cause visual impact. The above discussion also applies to the historic properties analysis discussed in Section 5 in that there are unlikely to be cumulative visual impacts to historic structures from those other projects known to be proposed at this time (i.e., South Coast Offshore Wind Project and Cape and Islands Tidal Energy Project).

Within the cumulative impact study area, no other activity in the cumulative scenario other than the proposed action or onshore wind projects includes activity that has more than a temporary presence on Horseshoe Shoal. Construction or decommissioning vessels will be seen as monopiles are installed or removed and WTGs will be visible from land and on the water over the operating lifetime of the project.

Conclusion

Moderate long-term impacts on scenic quality are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Scenic quality is a highly subjective aesthetic characteristic. Some people believe that WTGs on the water are relatively unobtrusive, while others believe that WTGs represent an unwelcome presence by intruding on a vista with comparatively little man-made infrastructure upon it.

6.2.11 Cultural Resources

Activities that are part of the cumulative scenario that may impact sources of disturbance of cultural resources within the cumulative impacts study area include: (1) sand mining; (2) other offshore wind projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; and (6) small marine projects.

Sand mining projects could have physical effects on submerged prehistoric and historic resources that include ground disturbance or destruction. Because sand mining is an extractive process, there exists a possibility that prehistoric and historic resources could be either disturbed or destroyed. It is highly likely, however, that any submerged land approved for sand and gravel mining, as well as for pipeline or submarine cable projects, would be assessed for these resources (i.e., shipwrecks) prior to the start of any mining activities.

Similar to the proposed action, sand and gravel activities would likely be sited and designed to avoid or minimize any adverse impacts to cultural resources. Based on results of the terrestrial archaeological intensive survey, no significant prehistoric or historic archaeological resources have been identified within the Project's APE for ground disturbance along the onshore transmission line route (see Section 5.3.3.5). The proposed action has been sited and designed to avoid disturbance or destruction of submerged prehistoric and historic resources. An archaeological survey has been carried out over the footprint of the proposed action and cable route and has been reviewed by MMS.

Conclusion

Negligible long-term impacts on cultural or archaeological resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario (with the exception of visual impacts on historic properties which will be evaluated pending Section 106 review).

6.2.12 Recreational Resources

Activities that are part of the cumulative scenario that may impact recreational resources, such as beach-centric activity, touring, birding, and recreational fishing, boating or diving, within the cumulative impacts study area include: (1) sand mining; (2) other offshore wind projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; and (6) small marine projects.

Increased vessel traffic from these various projects, to the extent they occur concurrently, could cause some marine traffic and temporarily affect recreational boating. Offshore construction of more than one project at once could require temporary access restrictions to recreational boaters of small areas in the immediate vicinity of the construction work. While the proposed action would have visual impacts, they are not expected to affect tourism or the general use and enjoyment of recreational areas including beaches, parks, and use of Nantucket Sound (see Section 4.3.4). The proposed action has been sited and designed to avoid recreational disturbance to the extent possible. Furthermore, sand mining, on and offshore wind, pipeline, and cable projects would also be sited and designed to avoid or minimize potential recreational impacts according to permit requirements of the various applicable regulatory agencies.

Conclusion

Minor long-term impacts on recreational resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario since the proposed action does not preclude any existing recreation and only creates a minor change in the navigation scenario for recreational boaters.

6.2.13 Noise

Activities that are part of the cumulative scenario that may impact above or below-water noise level within the cumulative impacts study area include: (1) vessel traffic; (2) vessel traffic and construction activity for the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project; (3) sand and gravel mining; (3) dredging; and (4) other marine construction activity such as beach nourishment, submarine pipeline or cable construction, or small marine projects. Direct impacts would involve hearing damage, annoyance, or change in behavior patterns as a result of noise above or below water.

Direct impacts caused by underwater noise could cause short to medium-term habitat displacement if marine mammals avoid the wind park area during construction, either as a result of underwater noise or otherwise. During construction of the Danish wind parks at Horns Rev and Nysted, no general change in behavior at sea or on land for marine mammals could be linked to construction activities, such as pile driving. The only effect detected on land was a reduction in the number of seals during pile driving operations at Nysted (Danish Energy Authority, 2006, p. 14). Porpoise abundance were found to slightly decrease during construction at Horns Rev, and at Nysted a clear decrease in abundance was detected in porpoise abundance during construction and operation (Danish Energy Authority, 2006, p. 14).

It is expected that similar construction vessel noise from mining and channel maintenance vessels would be comparable to normal vessel traffic existing within Nantucket Sound. Mining equipment noise associated with offshore sand mining projects is likely to have sound levels somewhat less than the pile driving sounds from the construction of the proposed action. The South Coast Offshore Wind Project is expected to have similar noise impacts during construction and decommissioning as the proposed action,

though it is located 17 miles (27.4 km) away and would not likely result in cumulative noise impacts. Operation of the South Coast Offshore Wind Project could also create noise.

The sound impacts of construction of the proposed action would be temporary and are associated with the installation of the monopiles, installation of six smaller diameter piles for the ESP, and vessel traffic for transporting equipment, piles, and workers to and from the site. The jet plow embedment process for laying submarine power cables with a cable barge produces no sound beyond typical vessel traffic in Nantucket Sound. Therefore, the principal sound from construction would be temporary pile driving of the WTG monopiles. There would be no significant underwater sound from the proposed action beyond the general area of the WTG array. Project construction and decommissioning is expected to have minor noise impacts. Operating wind turbines would not be heard from shore, but they would be audible to boaters in proximity to them.

Conclusion

Minor long-term impacts on above- or below-water noise are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.14 Transportation and Navigation

Activities that are part of the cumulative scenario that may impact transportation and navigation within the cumulative impacts study area include: (1) sand and gravel mining; (2) channel maintenance; (3) submarine pipeline or cable projects; (4) other offshore wind projects; (5) commercial fishing activities; and (6) vessel traffic.

For example, impacts associated with sand mining projects would only be short-term and temporary during the time of mining activities. It would be expected that any approved mining activities would not occur in any authorized shipping channels. If projects were constructed at the same time, they could result in minor cumulative impacts on navigation. For example, to the extent the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project, sand mining projects and other projects were to occur at the same time, construction vessels may have to share navigational channels. However, such contractors would follow required safe vessel navigational practices and channel widths and water depths in these areas allow for ample room for navigation. There would be minimal temporary impacts to navigation in the immediate vicinity of ongoing construction of the proposed action. Any restrictions that are necessary during construction to protect the safety of mariners would be implemented in coordination with the USCG. Details of the marine-based construction would be closely coordinated with the USCG and local Harbor Pilots.

Conclusion

Minor long-term impacts on airborne or marine transportation or navigation are expected as a result of the proposed action and the activities that are part of the cumulative scenario. WTG lighting and audible proximity warnings provide adequate surface identification of the location of the wind park structures. Adequate lighting of commercial and pleasure vessels are a Coast Guard requirement. The proposed action would not be located in aircraft ascent/descent corridors and its presence would not interfere with military radar.

6.2.15 Electrical and Magnetic Fields

Activities that are part of the cumulative scenario that may impact electrical and magnetic fields within the cumulative impacts study area include: (1) submarine electrical cable installation; and (2) other offshore wind parks requiring electrical cable connections. A direct impact would be demonstrable link between electromagnetic field strength and a detrimental effect on fish or benthic communities. Direct

impacts are limited to behavior changes when in proximity to, or when crossing over, an electromagnetic field from a buried submarine electrical cable that may or may not be correlative with harmful effects or distress.

There are no existing sources of power frequency fields present in the offshore area of the proposed action or underground cables that are proposed near the site other than the proposed action. Electric cables for the South Coast Offshore Project and the Cape and Islands Tidal Energy Project would be 17 and 10 miles (27.4 and 16.1 km) away from the area of the proposed action, respectively, and would not interact with electric or magnetic fields from the proposed action. The addition of the onshore transmission line would not change the existing electric field levels. The new underground transmission line electric fields within the ROW are anticipated to be approximately the same as the existing condition, which is due to the presence of the overhead 115 kV lines. The predominant fields within the existing NSTAR ROW are those generated by the existing overhead lines, whose loading under this interconnection option is not changed by the addition of the proposed action. The predicted impact of adding the underground transmission lines is a negligible change from existing conditions within the ROW and no change in field strength at the ROW edges. The proposed submarine cable system for the transmission line would create no perceptible electric field. Therefore, impacts on humans and marine life from electric and magnetic fields would be negligible. The proposed action would not produce or add to any electric-field exposures in offshore waters or onshore; and any localized affect of magnetic fields is weak and localized to the immediate area around the cables.

The investigation performed at Nysted to detect any effects from the electromagnetic fields on migration and behavior of fish were characterized by a high degree of complexity and many challenges and difficulties in collecting and interpreting the data. The investigations along the cable route show some effects from the cable on fish behavior, but the analysis of these data have only shown a very limited correlation between behaviors and the strength of the electromagnetic field (Danish Energy Authority, 2006, p. 76).

Conclusion

Negligible long-term impacts on electrical and magnetic fields as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. There may be a demonstrable effect between electromagnetic field strength and fish behavior for certain bottom oriented fish, but such behavior cannot be shown to be detrimental to the individual or living activities.

6.2.16 Telecommunication Systems

Activities that are part of the cumulative scenario that may impact telecommunication systems within the cumulative impacts study area include: (1) other offshore wind parks; and (2) vessel traffic such as effects to sea-borne radio communications on marine vessels, and aircraft communications. A direct impact would be a demonstrable link between the proposed action or other offshore wind parks and interference or degradation of communication signals for existing and necessary means of communications on land, air, or water.

Most telecommunication devices operate on a line-of-sight basis; therefore only large physical obstructions can impede the transmission line-of-sight signals. These large physical obstructions could include multi-story buildings, wind turbines, communication towers, etc. Existing and proposed land based FCC licensed communications towers have been evaluated and were determined not to negatively impact these communication systems. Future projects, such as the South Coast Offshore Energy Project would also be required to obtain FAA approval to ensure they would not interfere with radar communications and to also ensure that they do not interfere with other forms of communications.

Conclusion

Minor long-term impacts on telecommunications systems are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.17 Air and Climate

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) vessel traffic such as commercial and recreational marine vessels emissions, air traffic emissions, personal and commercial vehicle emissions, construction equipment emissions; (2) population growth and onshore development such as power generation, industrial processing; and (3) incremental emissions from the activities of sand and gravel mining, submarine pipeline and cable emplacement, other onshore renewable energy facilities, other offshore wind energy facilities, small marine projects, dredging, beach nourishment, and marina development. Direct impacts constitute the emission of NO_x, SO_x, VOCs, particulate matter, and CO₂. All of the activities in the cumulative scenario produce incremental emission because all activities rely on the combustion of fossil fuels in one form or another. Indirect impacts would include the results of the build-up of air emissions over time, or displacement in time or space for impacts based on these emissions.

The turning of the WTG rotors, which react to the wind rather than create or modify it, would not affect the wind speed and/or wind direction in the waters of Nantucket Sound. Overall, the proposed action by itself would have a minor positive, beneficial effect on air quality by generating electricity for use in New England without producing emissions from the burning of fuel (see Air Benefits Analysis in Section 5.3.1.5.2). The activities associated with the construction, maintenance, and decommissioning would result in some temporary level of emissions over Nantucket Sound due to the fossil fuel fired mobile sources (e.g., material supply vessels, crew boats, cranes and other powered construction equipment). However all of the vessels and equipment would comply with applicable air emission standards.

Conclusion

Minor long-term impacts on air quality and climatic conditions are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.18 Socioeconomics

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore wind projects; (3) onshore wind projects; (4) commercial fishing activities; (5) small marine projects; and (6) onshore development. Direct impacts would be the number of jobs and paychecks attributable to all of the people directly employed who perform these activities. Indirect impacts are the multiplier effects that would result from good and services purchased to support these activities, or the number of jobs attributable to employers that are needed to supply goods and services.

Overall, the proposed action would have a positive socioeconomic effect. During the 27-month construction and installation phase, an estimated 371 full-time positions would result from the proposed action in Massachusetts and Rhode Island. In addition to this employment benefit, IMPLAN input/output economic model predicts secondary induced employment benefit of 206 to 622 jobs in Massachusetts and 388 to 1,150 jobs in Rhode Island. While there may be some minor economic losses should commercial fisherman find they are unable to fish some areas of Horseshoe Shoal during construction, recreational fishing and related spending would likely increase and become an economic benefit. The proposed action's incremental cumulative impact on socioeconomics relative to the other projects mentioned would be minor.

If environmental monitoring shows that monopiles that have been colonized by mussels which then serve to act as fish attracting devices, there would be a small incremental effect on commercial or recreational fishers who direct some of their activity to the areas around monopiles. Monitoring at Horns Rev and Nysted has not convincingly established that fish are attracted to the hard substrate benthic invertebrate community that formed on WTG foundations (Danish Energy Authority, 2006, p. 77).

Conclusion

Minor long-term impacts on socioeconomic resources as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.3 CUMULATIVE IMPACT ASSESSMENT OF ALTERNATIVES

In addition to assessing the potential cumulative impacts of the proposed action relative to other potential activities and developments that might occur in the cumulative study area, a cumulative impact assessment has been undertaken of the alternatives to the proposed action. The following subsections provide cumulative impact discussion of the alternatives that have been studied in detail in this DEIS in a comparative manner with the proposed action.

6.3.1 Monomoy Shoals Alternative

Assessing cumulative impacts of the Monomoy Shoals Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction, encompasses the proposed action and the Monomoy Shoals Alternative. As a result, the location of the Monomoy Shoals Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the Monomoy Shoals Alternative. This assumption is based upon the similarity between the proposed action and the Monomoy Shoals Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Monomoy Shoals Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Chapter 6, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Monomoy Shoals Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. The alternatives analysis at Section 5.4.2.2 shows that the Monomoy Shoals Alternative would have greater environmental impacts than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, essential fish habitat, and T&E species, and have less impact than the proposed action with respect to impacts on visual resources and impacts to cultural resources as they relate to visual impacts on historic structures. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Monomoy Shoals Alternative and the proposed action. Another important issue with the Monomoy Shoals Alternative site is that it is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat, and thus within the context of other activities that have the potential to impact whales, such as commercial shipping, there is a greater potential for cumulative environmental impacts to whales than at the area of the proposed action. Another important difference between Monomoy Shoals Alternative and the proposed action is that the Monomoy Shoals Alternative is in close proximity to Monomoy Island, which provides important resting, nesting and feeding habitat for migratory birds, and thus there would be greater potential for cumulative environmental impacts than the proposed action with respect to terrestrial, coastal, and marine birds as well as T&E avian species. With respect to subtidal offshore resources,

cumulative impacts from construction and decommissioning would be greater at the Monomoy Shoals Alternative because of the additional interconnection line length resulting in more acreage of temporary bottom disturbance associated with installation, and the greater wave heights, which would prolong the construction time frame.

6.3.2 South of Tuckernuck Island Alternative

Assessing cumulative impacts of the South of Tuckernuck Island Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction encompasses the proposed action and the South of Tuckernuck Island Alternative. As a result, the location of the South of Tuckernuck Island Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the South of Tuckernuck Island Alternative. This assumption is based upon the similarity between the proposed action and the South of Tuckernuck Island Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the South of Tuckernuck Island Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the South of Tuckernuck Island Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.1.2 of the alternative analysis shows that the South of Tuckernuck Island Alternative would have greater impact than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, and essential fish habitat, and less than the proposed action with respect to impacts on visual resources. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the South of Tuckernuck Island Alternative and the proposed action.

One difference that exists with respect to cumulative impacts is on avifauna. The South of Tuckernuck Island Alternative would have a greater potential for cumulative impacts to terrestrial, coastal, and marine birds than the proposed action, because of the increased area in which the turbines would be located (the South of Tuckernuck Island Alternative would require an area of approximately 36 square miles (93.2 km²) versus the area of the proposed action, which is 25 square miles (64.7 km²). The larger area of disturbance increases the potential for avian impacts, and thus to the extent other construction projects affect avian impacts in the area, the South of Tuckernuck Island Alternative would contribute more toward cumulative impacts than the proposed action. Another cumulative impact that would be greater is with respect to subtidal resources as the South of Tuckernuck Island Alternative would be constructed in deeper water and contribute more toward cumulative impacts of benthic habitat (as a result of larger foundation sizes and related alteration of the seafloor) than the proposed action.

6.3.3 Condensed Array Alternative

Assessing cumulative impacts of the Condensed Array Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Condensed Array Alternative. As a result, the location of the Condensed Array Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Condensed Array Alternative. This assumption is based upon the similarity between the proposed action and the Condensed Array Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Condensed Array Alternative be selected, it is not anticipated that in the aggregate,

the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Condensed Array Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.5.2 of the alternative analysis shows that the Condensed Array Alternative would have greater impacts than the proposed action with respect to the competing uses resource category (i.e., commercial and recreational fishing and boating, mining, etc.) during construction, operation, and decommissioning, and less impact during construction for eight resource categories: noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. These differences in environmental impacts are likely to result in the similar corresponding differences in cumulative impacts between the Condensed Array Alternative and the proposed action. One difference that exists with respect to cumulative impacts is that the Condensed Array Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts during construction and decommissioning to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km²). The decrease in length of the 33 kV cable would also decrease temporary impacts to fish and fisheries, and EFH as a result of decreased area of turbidity and disturbed sea bottom. Therefore to the extent other projects occur at the same time or near the same location, the Condensed Array Alternative would contribute less toward cumulative impacts on these resources than the proposed action. Cumulative impacts to T&E species would also be slightly less than for the proposed action as the shorter construction timeframe for the 33 kV cable would result in less disturbance to T&E avian species that could be in the vicinity.

6.3.4 Phased Development Alternative

Assessing cumulative impacts of the Phased Development Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Phased Development Alternative. As a result, the location of the Phased Development Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Phased Development Alternative. This assumption is based upon the similarity between the proposed action and the Phased Development Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Phased Development Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Phased Development Alternative and the proposed action as described above, there is the potential that some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.4.2 of the alternative analysis shows that the Phase Development Alternative would have greater impact during construction and decommissioning than the proposed action for 10 of 28 resource categories (air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, and recreation and tourism). These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Phased Development Alternative and the proposed action. One difference is with respect to cumulative impacts on avifauna. Avifauna impacts would be greater for the Phased Development alternative than for the proposed action because of the longer timeframes of the additional mobilizations and demobilizations of major construction vessels for

pile driving and WTG installation/decommissioning related to each distinct phase. The total number of vessels required to complete the construction and decommissioning would also be greater than required for the proposed action, increasing potential impacts. The longer duration of the phased construction work would result in greater chance of cumulative impacts to avifauna with other ocean related construction projects. For this same reason the longer construction time frame would also increase the chances of additional cumulative impacts to subtidal resources, marine mammals, and fishery resources.

6.3.5 Smaller Project Alternative

Assessing cumulative impacts of the Smaller Project Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Smaller Project Alternative. As a result, the location of the Smaller Project Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Smaller Project Alternative. This assumption is based upon the similarity between the proposed action and the Smaller Project Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Smaller Project Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Smaller Project Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.3.2 shows that the Smaller Project Alternative has less impact than the proposed action in 13 resource categories including: noise, air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, cultural resources (as they relate to visual impacts on historic structures) competing uses of waters and sea bed, and port facilities. These smaller impacts are likely to result in corresponding smaller cumulative impacts. One notable difference in cumulative impacts would be with respect to benthic impacts, which would be reduced by half (an area roughly proportional to the reduction in the number of WTGs). Thus to the extent other projects are taking place that could result in cumulative impacts, the contribution of impacts from the smaller project toward cumulative impacts would be much less. For this same reason, the difference in benthic disturbance is much smaller and results in a similar reduction in cumulative water quality impacts and cumulative fishery impacts.

6.3.6 No Action Alternative

Assessing cumulative impacts of the No Action Alternative includes analysis of past, present, and reasonably foreseeable future actions that will continue or may occur in the cumulative impact study area of the proposed action. Cumulative impacts associated with adopting this alternative instead of the proposed action would be derived from the absence of an alternative energy source to contribute to the Massachusetts RPS. The extent and degree of impact would be measured by how the loss of energy anticipated by the proposed action would be replaced by other renewable and/or non-renewable sources, and the cumulative impact of those energy sources. The continuation of the development of new non-renewable energy producing facilities would be more likely due to the lack of technology to produce renewable energy other than wind at the scale proposed.

If this energy is replaced by non-renewable sources (fossil fuel), cumulative impacts would be the sum total of the difference between energy facility development in a future that includes the proposed action, and one that does not. That is, the total projected facility development that would occur along with and including the proposed action, compared to the incremental increase of facility development due

to the proposed action not being developed. The Massachusetts Energy Facilities Siting Board has indicated an increasing need for energy in the New England area over the project lifespan of the proposed action. The Independent System Operator, New England 2005 Regional System Plan found that New England needed to supply its own resources to minimize its dependence on neighboring systems throughout the planning period (2009-13). Therefore, it is concluded that this demand will have to be met by the development of some type of energy production facility in the New England area.

The cumulative effect of the No Action Alternative on physical, biological, socioeconomic and human resources would be apportioned to the number and kind of facilities that would be developed to replace the loss of the proposed action's 468 megawatts of electricity. Impacts from new facility operation attributed to no action taken on the proposed project would be an increase of air emissions to those from existing sources that affect air quality; an increased demand for cooling water with the potential to contribute to water quality impacts in surrounding water bodies with associated environmental degradation; plots of land or sea bed upon which facilities are built that are excluded from competing uses, and an expansion in the adverse socioeconomic impact zone from the placement of a variety of fossil fuel (natural gas, oil, coal,) or nuclear facilities at multiple locations that may or may not be in proximity to the cumulative impact study area. An extensive analysis of impacts associated with the No Action Alternative is included in Section 5.4.6.2.

7.0 CONSULTATION AND COORDINATION

7.1 PUBLIC SCOPING

The NEPA EIS process is designed to allow participation by all interested parties. One of the first steps in allowing interested parties to participate in the preparation of the EIS involves public scoping meetings. This section describes the scoping that MMS has undertaken at an early stage in order to collect input on what should be the content of the EIS.

7.1.1 Description of Scoping Process

In order to develop the scope of study for the MMS draft EIS, the MMS requested comments on the proposed action via a public notice in the FR on May 30, 2006 (71 FR 30693). The following is the NOI to Prepare an EIS, which was published in the FR.

The MMS extended the time limit for the comment period from July 14, 2006, to July 28, 2006 at the request of commenter's to allow extra time for development and submittal of scoping comments. In addition, the proposed action and some alternatives had previously undergone a partial NEPA review with the USACE as the lead agency. During the USACE review process, a draft EIS was issued, and the USACE received approximately 5,000 comment letters and email comments on the USACE draft EIS. Although NEPA review has since been transferred to the MMS (Section 388 of the EPAct gives MMS responsibility for reviewing alternative energy projects on the OCS), the MMS has decided to incorporate all of the previous comments originally made on the USACE draft EIS as scoping comments for the new MMS draft EIS. The MMS is also taking into account in the scoping process, over 500 comments that were made at USACE public hearings held in Yarmouth, Martha's Vineyard, Cambridge, and Nantucket, Massachusetts. As a result, this draft EIS incorporates an extensive number of comments, that have been used to develop the content or "scope" of the draft EIS.

The following is a general summary of all the comments combined from both the MMS and the USACE process. This draft EIS has addressed these comments to the extent they are applicable and necessary to reach conclusions as to the scope and extent of proposed action impacts. The comments are summarized below in the following categories:

- Regulatory Process
- Alternatives Analysis
- Construction, Operations, Decommissioning
- Geology and Sediments
- Oceanography
- Water Quality
- Air and Climate
- Noise
- Electric Magnetic Fields
- Avian and Bat Resources
- Freshwater and Coastal Wetlands

- Wildlife
- Fisheries – Socio-economic Impacts to Commercial and Recreational Fishing
- Fisheries – Environmental Impacts
- Benthos and Eelgrass
- T&E Species
- Socioeconomics
- Transportation
- Communications
- Cultural Resources
- Aesthetic/Landscape/Visual
- Transmission Interconnection

7.1.2 Overview of Comments Received

The following sections provide a compilation of the comment topics received during the scoping process, organized to follow the categories listed in Section 7.1.1.

7.1.2.1 Regulatory Process

Comments with respect to the regulatory process generally fell into the following subtopics: (1) public trust issues; (2) objectivity concerns/conflicts; (3) request for further review/information/data in the new draft EIS; (4) homeland security; (5) need for a national policy for use of ocean resources; (6) the Ocean Sanctuary Act; (7) state boundary issues; (8) MMPA; (9) compensatory mitigation; (10) the USACE jurisdiction; and (11) inclusion of agency comments.

Many commenters were concerned with the private use of public land. Some stated that the applicant, as a private developer, does not have the right to exploit public lands. Most of these comments also stated that there should be a fee and/or leasing agreement for developers to use public land. Others suggested that there should be competitive bidding for the public land so that the public can benefit from its use.

Several comments addressed the concern that the draft EIS was not written objectively enough. Some believed the language in the USACE draft EIS favors the proposed action which raises into question the objectivity of the conclusions. Independent studies and third party verification, in order to confirm objectivity, were requested by several commenters.

Many comments discussed the need for additional information and data to be included in the new draft EIS. Some of those data requests included: a more detailed economic benefits discussion, accurate predictions of wind energy power production, leasing conditions, effects of construction, operation and maintenance, mitigation measures, and more detail on negative impacts of the proposed action.

Some commenters were concerned with the security of the proposed action. Commenters questioned how the proposed action would be guarded and the potential threat of terrorism/crime.

Commenters addressed concerns of the proposed action being located within a marine sanctuary, since the Massachusetts OSA specifically prohibits construction or operation of offshore floating electrical generating stations.

Several comments questioned the proposed action in relation to its location within the state boundaries. Commenters noted that the Massachusetts boundary had been expanded and are concerned that the analysis does not consider the true state boundaries.

Commenters expressed concerns that the proposed action would be in violation of the MMPA and/or needs to obtain a permit under the Act.

Several commenters requested that a more detailed compensatory mitigation section be included in the draft EIS for both temporary and permanent impacts. More specifically, comments recommended that funds should be established for impacts on avian and marine life/resources, and that a more thoughtful depiction of the impacts and mitigation on cultural resources be included as well.

Some comments requested that the relevant agency comment letters be included and specifically addressed in the new draft EIS. Some commenters also stressed concerns that some agency recommendations, especially from peer review comments, have been ignored.

7.1.2.2 Alternatives Analysis

Comments with respect to the types of alternatives considered generally fell under the following six categories: (1) an on land location should be considered; (2) further offshore/deeper water and other offshore locations should be considered; (3) a smaller scale and/or phased project should be considered; (4) alternative technologies instead of power generation by wind; (5) alternate configurations of the facilities; and (6) energy conservation instead of new power generation. The comments received on the types of alternatives are discussed in more detail below.

Several comments were received requesting the WTGs be moved on land. On land locations included the MMR encompassing Otis Air Force Base and Camp Edwards, the former Fort Devens Reserve Forces Training Area near Ayer Massachusetts, military sites in general, the Route 6 median or ROW, the median along highways, Route 28, existing utility easements such as transmission line ROW, the Blue Hills Reservation, the Pilgrim Nuclear Power Plant in Plymouth, the Canal Electrical Plant in Sandwich, New Bedford, Fall River, Westover, the Elizabeth Islands, Muskeget, central Massachusetts, the outer islands of Boston Harbor, Nomans Land southwest of Martha's Vineyard, Monomoy Island, existing waste disposal sites/dumps/landfills including the Barnstable landfill, lighthouse properties, industrial areas, municipal sites, on the top of hills or mountains, on the top of high rise buildings, a remote open area, golf courses, private property and land out west at existing wind energy projects. Some commenters combined the categories and recommended locating individual wind turbines or a smaller number of wind turbines in different, dispersed or decentralized locations on land (multiple smaller scale land-based projects).

In addition to the above recommended locations, commenters included arguments for locating the wind turbines on land. These arguments included the fact that on land sites would be less costly to build and to maintain, provide better access, be easier to connect to the electrical grid, and be closer to public safety resources such as police and fire. Other concerns were that land is a less destructive environment than salt water, and has fewer potential impacts on navigation, sediment transport, fish and avian mortality, commercial and recreational fishing, recreation, tourism, noise, aesthetics, real estate, the economy, etc. Other concerns that prompted land based recommendations as opposed to locating the WTGs in the water, were scour control, stabilization, and fish mortality during construction.

Numerous comments were received with respect to locating the WTGs further offshore or in deeper water. Specific further offshore locations identified by commenters include: further off the coast of Chatham; east of Cape Cod; south and east of Nantucket Island; South of Tuckernuck Island; South of Martha's Vineyard; South of Nantucket and East of Monomoy; and the area near Rose and Crown Shoals. Other offshore and deeper water suggestions included locating the WTGs over 12 miles (22.2 plus km) offshore, 30 to 80 miles (55.6 to 148.2 km) offshore, further offshore until the wind turbines are no longer visible, the outer Atlantic shelf, and in water up to 100 ft (30.5 m) deep.

In addition to the suggested further offshore and deepwater locations, commenters requested additional information on further offshore and deeper water locations to support the alternatives analysis. Information requests included greater detail with respect to engineering, design and environmental resources, as well as descriptions of further offshore and deepwater alternatives considered. Reasons for these requests are to allow for a better comparison of shallow water and deeper water alternatives.

Other offshore locations were also provided by commenters, however, the following recommended offshore locations are not necessarily "further" offshore: Boston Harbor; off the coast of Maine; off industrial/commercial shorelines; Barnstable Harbor on Cape Cod Bay; Buzzards Bay; Nantucket Shoals; and the center of Nantucket Sound.

Arguments provided by commenters for locating the WTG offshore, further offshore and in deepwater locations centered around visual impacts, the ability to produce more energy further offshore (better wind class/velocity), avoidance of bird migratory pathways and feeding areas, avoidance of air and shipping lanes (hazards to navigation), avoidance of marine sanctuary waters, and the creation of artificial reefs.

A third category of comments received with respect to alternatives was the implementation of a smaller scale project. Comments received with regard to the analysis of a smaller scale project included: evaluating the minimum size project practicable at Horseshoe Shoal in Nantucket Sound; a 200 MW project; decreasing the proposed project by a factor of 10 to 20; installing 10 wind turbines; the general comment to reduce the number of WTGs; and a smaller ESP. The primary reason provided for implementing a smaller scale project was the ability to gradually understand the potential impacts of the proposed action.

Similarly, other commenters suggested a phased approach. Phased approach comments included a project with the first phase large enough to be economically feasible and small enough to have a limited impact, a pilot project or the installation of a test unit, installation of 4 or 5 wind turbines, installing the proposed project in three to four phases with enough time between each phase to study and evaluate impacts, and using the same phasing as the Arklow Bank Project off the coast of Ireland.

The fourth category of comments addressed alternative technologies. Alternative technologies to be considered included: hydro; solar; ocean current; existing electrical plant upgrades and improvements to existing technologies/plants; tidal; wave; new nuclear facilities; an equivalently sized fossil fuel plant; coal facilities; other types of wind turbines; biomass; Wind Amplifier Rotor Platform (WARP) windpower technology; Ocean Wave Energy Converter (OWEC); and the Underwater Electric Kite® (uekus.com/index.html). Besides the recommendations for individual alternative technologies, a few commenters recommended the installation of a portfolio of technologies.

In addition to the different types of alternative technologies suggested, several comments were received on the USACE draft EIS alternative technology section. Several requested that more accurate and extensive analyses be carried out on each of the different types of alternative technologies analyzed.

Other comments received requested that dangers of other technologies be considered and analyzed such as the danger of a gas explosion compared to oil spill impacts from the wind turbines and ESP.

The fifth category of comments received included alternative WTG configurations (array and different sizes of turbines). Specific comments received with respect to configuration are the proposal for shorter towers, shorter towers on the outside with taller towers on the inside of the wind turbine array, a mix of turbine sizes, a more compact array of towers, a denser configuration based on the density of the Horns Rev facility off the coast of Denmark, a split facility alternative with two or more arrays that total 454 MW within Nantucket Sound, a straight grid, and a double elliptical grid. Commenters proposed the different WTG configurations to specifically address visual impacts and to minimize potential environmental damages.

The sixth category of comments received is associated with energy conservation. Commenters recommended the implementation of energy conservation measures, such as a reduction in fossil fuel consumption, using smaller vehicles, improving car fuel efficiencies, using hybrid vehicles, and fuel cells. Other commenters stated that money should be spent teaching and encouraging people to use less energy including implementing a comprehensive plan of policies to conserve energy. Multiple requests were also received to evaluate energy efficiency programs and energy conservation measures as an alternative to the proposed action. Others suggested supplementing energy development with conservation.

Lastly, other comments focused on the adequacy or sufficiency of the USACE draft EIS alternatives analysis and the appropriateness of commercial/utility scale, as defined in the purpose and need section of the USACE draft EIS. Numerous other comments were received that stated that the ACOE draft EIS was inadequate because there was a lack of alternatives addressed (including the no action alternative), and that the findings in the alternatives section lacked detail and sufficient technical support.

7.1.2.3 Construction, Operations, Decommissioning

Comments pertaining to construction, operation, and maintenance generally fell into the following subtopics: (1) decommissioning; (2) OSRP; (3) design, performance, stability and maintenance; (4) public safety; (5) pollution prevention; (6) grid integration problems; (7) inaccurate wind production numbers/production capacity of the proposed action; (8) construction issues; (9) taxes and insurance certificates; (10) monitoring before, during, and after construction; and (11) onshore construction concerns/SWPPP.

Numerous commenters were concerned with the decommissioning process. Many questioned who would be financially responsible and if the applicant could guarantee that adequate funding would be available for decommissioning. Other comments addressed the methods of removal. There were requests for a more specific explanation of the decommissioning procedure. Some commenters also noted that the new draft EIS should include a discussion of the impacts, both environmental and financial, of removing the WTGs, ESP, and scour protection.

Commenters noted that the USACE draft EIS did not include a description of the fluids that would be contained in the wind turbines and ESP. Those commenters requested that the characteristics and quantities of these fluids be included in the new draft EIS. Commenters also requested an explanation of the likelihood of an oil spill, required oil spill handling and containment equipment, and the biological impacts of an oil spill. Some requested an oil spill trajectory map as well.

Commenters were concerned with design features, especially the foundation system of WTGs. Numerous comments questioned the weathering and corrosion of the WTGs and requested specific detail on what would be done to minimize the effects of weather and waves and to predict the

reliability/stability of the turbines when facing harsh conditions. Several comments also addressed issues with the deployment of scour mats.

Public safety comments addressed concerns with ice buildup on WTG blades, emergency response restrictions (both helicopter and vessel access) within the turbine array area, fire protection, worker safety, and security risks.

Commenters noted that the containment and impacts of trash and debris likely to be produced was not addressed in the USACE draft EIS. Others suggested that the likelihood of impacts of diesel spills from vessels during construction, operation and maintenance should be discussed. Some commenters requested that a more detailed description of pollution prevention for all components of the proposed action be provided.

Grid integration concerns were addressed in several comments. Most of these comments questioned how the grid could be affected by inconsistent wind speeds and/or WTG malfunction, and if the introduction of an unpredictable energy source would cause more problems than benefits.

Some commenters questioned the accuracy of the predicted electricity production. Other comments address concerns that the wind predictions have been overestimated and are not sufficient enough to provide effective use of the WTGs.

The commenters were concerned with the cost, access restrictions during construction, construction equipment, noise, and the length of time and schedule of the construction process.

Commenters questioned who would be insuring the project and liable for any losses. Others questioned whether the facility would be taxed and, if so, who would benefit.

Numerous comments addressed the need for additional monitoring before, during and after construction. Many requested that more rigorous avian and mammal monitoring and an acoustic monitoring of impacts be implemented, especially during construction to minimize risk of injury to marine species. Comments also suggested that a more thorough and lengthy post-construction (during operation) monitoring and adaptive management plan be provided.

Several commenters requested that a SWPPP be provided. Others addressed concerns with the transmission line and suggested it should only go through previously developed land and/or along existing transmission lines. A few commenters requested a discussion of the potential hazardous material in the land-based equipment as well as the management of those materials.

7.1.2.4 Geology and Sediments

The comments submitted for the geology section can be generally characterized in the following seven categories: (1) impact to sand waves around tower foundations; (2) sedimentation impacts; (3) scour; (4) sediment characterization with limited coring locations; (5) sediment transport modeling; (6) impact of fixed structures on a shoal; and (7) impacts from a seismic event, including tsunamis.

Comments on sand waves centered on the impact fixed structures would have on sand wave movement and the impact to sedimentation. Some commented on the impact on existing sedimentation and questioned if sedimentation dynamics would change and if shipping channels would be impacted. An in-depth, quantitative assessment on sedimentation transport pathways was requested.

Several comments centered around scour and scour mats. Many were concerned with the viability of the scour mat design. Several commenters were in favor of a riprap or similar design and many were concerned about the lack of proven scour mat design. One commenter questioned if stabilization agents would be used, such as bentonite or caustic soda and the potential negative environmental impacts from their use. Many commenters questioned the limited number of sediment coring samples relative to the large area to be affected.

One agency requested more analysis on the effect on sediment transport to better evaluate potential impacts and requested an oceanographic modeling study be undertaken to better understand sediment transport pathways for all of the options in the alternative analysis, as well as Nantucket Sound. An evaluation of Nantucket Sound and South of Tuckernuck sites was requested with respect to different magnitude storms, fair weather, and tidal and wind-driven conditions.

One commenter questioned the logic of placing fixed structures on a dynamic shoal.

Other comments were regarding the seismic setting and the impact a seismic event and/or tsunami would have on the structures. One commenter described a catastrophic failure during such an event, leading to related tower debris washing up on beaches.

Most of the comments with respect to sediments involved general sediment movements and how they would differ after the proposed action was constructed. Other commenters wanted to know where the sediment would settle and how long it would take for the benthic community to recover. Other commenters were concerned about the sediments clogging the estuaries and the effects this would have on areas that are already subject to frequent maintenance dredging. A concern voiced often was the sediment's affect on the shipping channels and the possibility through accretion/erosion of creating uncharted shoals. A request for more precise mapping and description of surficial sediment conditions was made.

7.1.2.5 Oceanography

The comments submitted for the oceanography section can be characterized in the following eleven categories: (1) water flow around WTGs; (2) current velocity and patterns; (3) sea ice movement; (4) scouring; (5) data for scour mats; (6) turbidity; (7) jet plowing data; (8) possibility of cable being uncovered; (9) wave measurements; (10) sedimentation; and (11) alternative sites.

The comments involving water flow around the WTGs were concerned with the distance between the towers not being sufficient and that changes in water flow would occur as a result. These changes could trigger other changes such as sediment transport and sea ice flow. The main concern with water flow was how, if changed, it would affect the shoals in the area. In addition, there were questions on how the changes in flow and therefore the shoals would affect boating, both commercial and recreational. A general request for more recent circulation models was also made.

Current velocity and patterns were concerns mainly because of the lack of data. Commenters stated that the USACE draft EIS only used models to discuss these issues. Commenters wanted to know what affects the turbine platforms would have on the currents and if the changes would flatten the seabed. Actual data was requested instead of models in order for other areas of concern to be remedied (i.e., turbidity, spills).

Commenters were concerned about sea ice movement and build up during the winter months. There was a request for a discussion on the impacts and possible accretion from ice drifting out of the harbor

area to the north of the proposed action area. Also, there were concerns about ice build up on the turbine blades and whether this would affect the WTG's stability.

There were some concerns about scouring and its affects. A discussion on the size, shape, depth, and persistence of the "small depression" was requested. Other comments were related to how different sediment types would correct the scouring in the trench and around the foundation of the WTGs. An "extreme" scour projection was requested for the inner-array of the cables as well.

Many comments dealt with the scour mats. Most felt that there was insufficient data in general to back the claims about how effective the mats would be. In general, more data was requested on the scour mats. Regarding resedimentation on the mats, commenters were concerned that a finer grain of sediment would settle there and that these sediment changes would alter the benthic community and associated demersal fish. Also, there were concerns on how the mats would impact the oceanographic process and what the pattern of deployment and contingency plan would be, if they failed. There were also questions on how the mats would be anchored given the natural 15 ft (4.6 m) variation in bottom depth. Other concerns about the scour mats involved their durability.

Comments involving turbidity began by claiming that the SSFATE model to predict the turbidity plume in Lewis Bay based on three core samples was speculative. Other comments pertained to general questions such as how much turbidity would occur, what would be the size of the turbidity plume, how long would it last, and would it be localized.

There was skepticism expressed about the use of the jet plow method. A general request for more data was made along with comments that mathematical models for sediment transport and relocation are insufficient. Proof was requested that the jet plow method is the best method of trenching. A commenter claimed that the conclusion reached in the USACE draft EIS that jet plowing is the better method is contradictory to the conclusion reached on the HubLine project. Justification and basis that there would be no impacts on an eelgrass bed within 69 ft (21 m) of the jet plow was asked for as well. Another comment requested that the new draft EIS articulate why jet plow re-deposits are not regulated discharges under Sections 401, 403, and 404 of the CWA.

Comments regarding the transmission cables varied. The main concern was if they would stay covered given the sand waves, undulations, and extreme sediment transport in the region. There was a request for a contingency plan in the event that the cables became uncovered, and also in the event that fishing gear interacted with the cables. A general impact report was requested for the anchor line sweep and MMS requested that the applicant reduce the disturbance estimate to one significant figure. Other comments involved the size of each anchor sweep area, the size of the anchor chain, and whether repeated plowing would be needed. A description of the differences in installation methodology in different strata was requested as well.

There was a general request for an adequate assessment on the effects of waves on the WTGs. Also, wave measurements were requested for each of the alternative sites.

The last issue in the comments dealt with alternate sites. The comments were regarding more updated circulation models and request for wave measurements. In general, a better evaluation of sites from an oceanography standpoint was requested.

7.1.2.6 Water Quality

The comments made on water quality can be characterized into the following three categories: (1) suspended sediments; (2) spills; and (3) waste handling. They are further discussed below.

The comments on suspended sediments mainly requested more data on how much sediment would be suspended, how long it would be suspended for, and to what extent the sediment would spread. Other comments concerned the effects the suspended sediments would have on the species in the area, specifically eelgrass. Comments included concerns about resuspension and redistribution of sediments, especially due to the affects from propeller-driven construction traffic. There was also a data request for a hydrodynamic model to determine the extent and direction of movement of the suspended sand and silt.

There was concern for the potential of spills from construction and operation of the WTGs. Requests were made for the characterization of all the lubricating fluids, oil, and diesel fuel on each of the vessels and WTGs, as well as the amounts stored and routine discharge amounts. A request was made to characterize the oil spill containment kits. Other requests were for an OSRP and a SWPPP. People commented on the need for a lifetime monitoring plan and some sort of bonding in case a spill does occur. Also, in the case of a spill, requests were made for an oil trajectory analysis as well as the risks of a spill and predictive modeling.

The last grouping of water quality comments pertained to waste handling. A discussion on the regulations regarding solid and hazardous was requested. Also, the quantities of waste handling systems and their capabilities were requested.

7.1.2.7 Air and Climate

Comments with respect to air and climate generally fell under the following five subtopics: (1) global warming; (2) public health effects and emission reductions; (3) local air quality impacts; (4) visibility improvement; and (5) local meteorological data summary.

The majority of the concerns expressed in the comments were with respect to the potential impact on global warming and climate change. Some of the comments requested a more quantitative assessment of the actual reductions in CO₂ emissions and a comparison to the CO₂ emissions on a regional, state, and global basis. Others asked that the potential impacts of global warming and climate change and the current federal and state global warming policies be discussed in further detail in the draft EIS. There were also some comments that questioned if there would be any reduction in CO₂ emissions; and therefore, provide any benefits towards the global warming and climate change issue.

Comments on public health dealt primarily with the estimated emission reductions of NO_x, SO₂, HG, and PM from fossil fuel plants due to the proposed action. Some commented that the potential health effects of each pollutant should be addressed. A few comments requested quantitative estimates of these emission reductions and a comparison of these emission reductions to the estimated total emissions from the region, state, and upwind states. Others suggested that the estimated emission reductions should be revisited to consider whether the pollutants are included in a cap and trade program or not, while some of the comments stated that the emission reductions were overestimated.

Local air quality benefits were a concern for some of the commenters, especially with regard to the potential emission reductions from the existing fossil-fuel-fired plants. Comments requested that potential local air quality benefits to the Cape area and the surrounding islands be discussed further in the draft EIS.

Some of the comments were regarding the potential improvements to visibility, both locally and in the Arcadia National Park. Visibility impairment is a function of air pollution, thus this issue is directly linked to the estimated emission reductions, which were commented upon by others.

Information regarding the local meteorological conditions, which were recorded in Nantucket Sound, was also requested by the commenters.

7.1.2.8 Noise

Comments with respect to noise generally fell into the following subtopics: (1) effects on marine life; (2) monitoring systems; (3) utilizing references from other underwater construction projects; (4) mitigation plan for high noise levels; (5) analysis of ultrasonic and infrasonic sounds; (6) focusing on impacts to marine life by species' sensitivities; and (7) utilizing better modeling techniques for underwater sound.

Several commenters noted that while the analysis revealed that effects at onshore locations to humans would not be significant, they expressed concern that the noise analysis focused too much on effects on humans and required a much more detailed analysis on marine life, in particular marine mammals and sea turtles. They requested that the analysis should not be dominated by approaches to human hearing and that it should avoid human perceptual terms. In particular, it was noted by some commenters that the analysis should evaluate the hearing characteristics of different species of marine life, and the potential that sounds of varying frequencies and intensities could impact different types of marine life. Comments were made that these species should be grouped by their sensitivity to sound frequency.

Commenters noted that while it appeared unlikely that physiological damage would occur to marine life, the potential for "acoustical harassment" was more likely. It was noted that marine life such as great whales are more sensitive to very low frequencies (infrasound), while dolphins are more sensitive to ultrasonic sound. Effects on game and protected species should also be evaluated. Comments were made that an underwater monitoring system should be employed throughout the lifetime of the proposed action, including construction, operation and decommissioning. The monitoring system should be capable of measuring sounds from infrasound to ultrasonic sounds. Comments were made that the monitoring system should incorporate a mitigation plan that would be used to stop construction or other activity if levels exceeded thresholds.

Several commenters requested that the currently proposed surveillance system for marine life within the safety radius be enhanced to include additional spotters for marine mammals and sea turtles during construction, and that construction should be avoided during periods of peak abundance of any endangered species.

Some comments requested that the new draft EIS utilize studies done at other underwater construction projects. According to commenters, some of these other studies indicated higher underwater sound levels from pile driving than those presented in the USACE draft EIS. Commenters also noted that pile driving noise levels underwater should be provided for distances closer than 1,640 ft (500 m).

Several commenters noted that the USACE draft EIS analyses conducted for the alternative sites were very general and did not include noise measurements or modeling.

Comments were made that there are much better modeling techniques available for studying the propagation of sound underwater, and that these techniques should be utilized in the new draft EIS. The effects of refraction through the water should also be evaluated. One commenter noted that additional

discussion of the reported 180 dB underwater safety threshold for marine life should be provided, including its source, and how it is applied to the range of marine life.

Several comments were made requesting that more detail regarding the potential effects of noise on bats should be provided. In particular, the comments noted that bats are sensitive to ultrasonic sound, and that the new draft EIS should evaluate whether the WTGs generate any ultrasonic sound that could interfere with bats' sonar systems.

In addition to total noise levels, commenters requested that a discussion of the response of game species to both acute and chronic noise impacts be provided. It was suggested that nighttime baseline for ambient noise levels should be collected and used as bench mark for measuring incremental increases and total ambient noise levels during construction and operation.

7.1.2.9 Electric and Magnetic Fields (EMF)

Comments with respect to EMF generally fell under the following three subtopics: (1) adequacy of EMF impact studies on finfish, squid, sea turtles and aquatic mammals; (2) adequacy of DC fields impact assessment; and (3) West Yarmouth neighborhood EMF impacts. These are discussed in more detail below.

The majority of the concerns expressed in comment letters focused on the possibility of electromagnetic impacts on different aquatic life forms. Life forms specifically identified included sea turtles, finfish, squid, elasmobranch fish, and mammals. A majority of the comments claimed that the research provided on EMF impacts is insufficient to make proper determination of influence on these creatures. One commenter stated that the electromagnetic disruption that would likely occur has the potential to alter migratory patterns of fish and a second commenter recommended that the draft EIS include the magnitude and frequency spectrum of the electric fields near the buried cables.

One commenter requested that the draft EIS add information on the level of DC electric fields created by the towers and cables to permit a better assessment of the impacts on aquatic life. A second commenter cited concerns about the level of magnetic radiation hazards which may occur in the West Yarmouth neighborhoods where the cable makes landfall.

7.1.2.10 Avian and Bat Resources

Comments with respect to avian and bat issues generally addressed five categories of issues: (1) concerns about data collected during bird surveys; (2) the need for expanded discussion of mitigation measures and monitoring approach; (3) potential positive indirect impacts for birds; (4) the need for additional analysis of alternatives; and (5) the need for expanded discussion of the risk to bats.

Most of the comments were directed towards the accuracy and/or validity of conclusions made from the surveys conducted. Many stated that 3 years of surveys should be conducted to ensure adequate data are collected about piping plovers, terns, migrating songbirds, waterfowl (especially seaducks), and bats. Some comments stated that more extensive radar surveys were necessary, particularly during winter and inclement weather and at night, and that radar surveys should be accompanied by ground-truthing activities. Some commented on the limitations of aerial and boat surveys to accurately assess flight heights or population densities. Some comments raised questions about the methods used to calculate the population viability of, and risk to, piping plovers and roseate terns. Other comments suggested that seasonal variation was not adequately addressed; multi-year comparisons were necessary; and comparisons with inland survey sites and terrestrial wind projects may be inappropriate. Other comments suggested that some data should be recalculated to address inconsistent methods in calculating species density and risk of mortality.

Some comments suggested that the new draft EIS should elaborate on planned mitigation measures and the post-construction monitoring approach. In particular, an explanation was requested about why the lighting system differs from the USFWS guidelines and how the bird deterrent system would operate. Other comments suggested that an independent scientific advisory team should be responsible for monitoring, and an adaptive management plan should be adopted.

Some reviewers commented on the potential positive impact on birds, suggesting that the proposed action would reduce avian mortalities associated with oil spills or sea level rise.

A few comments stated that the alternative scenarios were not adequately evaluated with respect to the avian resources present at each alternative site. These reviewers suggested that an expanded discussion of the potential avian issues at these sites would be appropriate.

There were several requests that the new draft EIS include additional information about potential risk for bats, especially during migration.

7.1.2.11 Freshwater and Coastal Wetlands

The comments submitted for this section were few and fall under the following four categories: (1) construction BMPs; (2) reptile and amphibian usage of the wetlands; (3) short and long term effects on filling of the wetlands; and (4) pointing out that the installation of the cable leading to the substation would fall under local jurisdiction.

One of the main concerns from the commenters was protection of the wetlands during the construction phase. The dewatering and use of coffer dams were the main concerns in regards to draining the wetlands; and concern over unclean water (from the landfill) discharging into ground water and wetlands.

There was a comment made about the possible effects on the reptile and amphibian population using the wetlands and ponds in the area. This was mainly concerning the migration of these animals across the roads and the work site. The commenters stated that there was no discussion on the subject in the USACE draft EIS.

There was a comment made about the possible long term and short term effects on the wetlands being filled. The commenter stated that the USACE draft EIS failed to making factual determinations regarding potential short and long term effects of the proposed discharge and failed to consider other alternatives.

7.1.2.12 Wildlife

The comments submitted for this section fall under the following five categories: (1) need for individual assessment of seals; (2) need for more accurate base data on seals and harbor porpoises; (3) more details on life history; (4) monitoring plan for wildlife; and (5) concerns of harming wildlife not species specific.

One of the main concerns from the commenters expressed the need for individual assessments of harbor seals and grey seals. The breeding habits of the two species were a topic of concern. Information was requested on the southern extent of the grey seal. There were also concerns that the draft EIS did not address the seasonal movements of harbor seals.

Commenters stated that there was insufficient data and/or outdated data in the draft EIS regarding the harbor porpoise and seals. There were numerous comments about the age of the cited reports.

There were numerous comments requesting more monitoring plans for the wildlife in the area. Commenters said that NOAA should monitor construction by: (1) placing observers on supply vessels that transit the Sound; (2) conducting systematic aerial surveys around adjacent seal haul out sites; and (3) using satellite tags.

There were a number of comments stating that the proposed action would be harmful to wildlife (non-species specific) and calling for additional studies on wildlife impacts.

7.1.2.13 Fisheries – Socioeconomic Impacts to Commercial and Recreational Fishing

Regarding commercial and recreational fisheries, commenters expressed concern about the quality of the data presented and absence of data on private recreational fishing activity and its contribution to the economy. Commenters noted that total catch figures can understate actual catches and expressed concern that the DEIS/DEIR equated reported landings with relative abundance. Commenters noted that due to many gear types in use in Nantucket Sound, landings data should be analyzed in total for a given species for an accurate harvest estimate. Commenters pointed out that landings data have limitations in that fisherman working in Nantucket Sound might land their catch in ports outside the Sound.

Commenters recommended a more complete characterization of the current level of fishing (including finfish, squid and shellfish) in the proposed action area using methods proven as accurate assessments of existing uses, description of potential impacts, and proposed actions to minimize/mitigate unavoidable impacts. Some commenters suggested assessing fishing methods used (mobile gear, stationary gear and hook and line) to allow a better understanding of impacts caused by turbine structures and any associated use exclusion zones.

Commenters noted that information on activity from federally permitted vessels needs to take into consideration that not all fishing trips are reported by latitude and longitude. Therefore, numbers obtained are really a large sub-sample of all trips (numbers reflect the relative – not absolute – amount of fishing activity by gear in areas).

The comment was made that the comparison of fishing activity and landings at alternative sites has deficiencies such as incomplete and conflicting data, absence of data on private recreational fishing activity and contribution to economy. In addition, characterization of recreational fisheries in Nantucket Sound underestimate the amount of effort expended and fails to characterize the financial contribution made to the economics of Cape Cod, Nantucket and Martha's Vineyard by these fishermen. Also, comments noted that reporting of raw data from NOAA's MRFSS database and that obtained from directed telephone surveys may be inappropriate. Further, these data may represent a fraction of the total effort. Commenters pointed out that the data do not provide any estimates of number of passengers carried by commercial party and charter boats or geographic distribution of vessels surveyed.

Commenters suggested that directed and broader studies of commercial and recreational fishing activity in the proposed and alternative action areas are required to evaluate potential impacts from construction and operation of the facility. Further comments indicated that studies of fishing activity should be developed with MassDMF, NOAA, and Massachusetts Marine Fisheries Advisory Commission to quantify effort and landings by area and season in areas of interest. Also landings data reported by MassDMF and NOAA should be integrated into a unified format allowing comprehensive analysis of data by species and gear type. Others indicated that any studies should involve various state and local contacts (MassDMF, harbor masters, shellfish officers, tackle shops and others).

Commenters were concerned about the potential for post-construction exclusion of fishermen from the site of the proposed action; restricted maneuverability and potential hangs; handling of boats in strong eddies; difficulties with rescue activities. Commenters suggested identifying provisions in the event that target cable burial depths are not met or maintained. A commenter suggested some form of contingency planning should be addressed. It was noted that cables could become exposed due to natural events such as hurricanes and there is potential for fishing gear interactions with cables possibly excluding fishing activities from the 25 square miles (64.7 km²) turbine array area. Commenters suggested there should be an analysis of extreme scour projections for the inner-array of cables.

Commenters suggested an assessment of fishing gear utilized in the area, lengths of nets and lines, and anticipated tow speeds to determine any adverse impacts to commercial fishing navigation.

Commenters expressed concern that reliance on MassDMF research trawl data is an inappropriate method to assess shellfish abundance. Others commented that the assessment of commercial and recreational shellfisheries does not provide sufficient detail to assess impacts associated with construction. Further comments requested that a shellfish survey that accurately characterizes the resource should be developed in coordination with MassDMF and then conducted. A comment stated that the bay scallop fishery is a highly valuable resource but varies from year to year. The resource is important to the economies of Nantucket and Martha's Vineyard. There was a request for an example of the type of mitigation for impacts to recreational shellfish beds.

7.1.2.14 Fisheries – Environmental Impacts

Comments with respect to fisheries generally fell under the following subtopics: (1) data limitations of evaluation of finfish resources; (2) data limitations of evaluations of commercial and recreational fisheries; (3) shellfish resources; (4) alternatives evaluation; (5) vertical hard substrate – fish attracting devices; (6) EFH assessment; (7) interconnection of resources; (8) predator-prey evaluation; (9) construction and operation impacts; (10) construction timing; (11) sandy shoal environment change; (12) cable exposure; (13) gear usage; (14) noise; (15) EMF; (16) scour mats; (17) monitoring, restoration, and mitigation; (18) permitting recommendations; and (19) decommissioning. These are discussed in more detail below.

With respect to data limitations, one commenter noted near total dependence on existing data sets from MassDMF and NOAA resource surveys and reported landings. The commenter expressed concern that no effort was made to obtain comprehensive, representative, site-specific resource or habitat data. The commenter suggested directed resource surveys be conducted to characterize marine resources inhabiting the proposed and alternative sites as well as habitat functions and values. The commenter went on to indicate that these studies should be comprehensive in order to characterize use of areas by all life stages of relevant commercial and recreationally important species and those that serve as forage. The commenter noted that data from the directed studies should be integrated with existing data sets, landings data and physical/oceanographic characteristics to present characterization of diversity and abundance of finfish resources in Nantucket Sound.

Commenters requested development of an environmental baseline for purposes of measuring impacts and developing a mitigation and a monitoring plan. It was suggested that monitoring should include water quality testing to detect the leakage of toxic fluids into the water that could be entering the food chain.

With respect to shellfish, some comments noted that potential impacts to shellfish have not been adequately described and that a more thorough characterization of the shellfish resource in the area and

the level of shellfishing effort are necessary to evaluate the proposed action's impacts on the resource and use.

A commenter noted that there is no description of NOAA survey data used to describe the finfish resources for the alternative site south of Tuckernuck Island. A commenter further noted that information on comparison of fisheries resources between potential sites do not present the same level of data for each site and are not presented in a uniform manner.

A commenter requested that additional analysis be conducted to ascertain effects of introduced communities. It was suggested that effects of such alterations on migratory fish stocks such as striped bass and bluefish should be explored. It was further suggested that these obstructions (proposed action facilities) could change water circulation and thus impact migration, spawning, egg and larval transport and feeding habitats of fisheries resources. A commenter requested an evaluation of the possibility that availability of prey species and material on and around the WTGs could initiate cascade effects on higher trophic levels including game fish and other predators and whether there would be resulting changes in activities of commercial and recreational fishermen.

A comment was made that there was not concurrence with the USACE draft EIS conclusion that increasing the distance between monopiles would minimize effects of attracting colonizing and transient organisms, such as fish or invasive species. It was noted that this spacing is more likely to increase the area of change and spread this effect over a greater area of Nantucket Sound. Commenters expressed concern about the assessment of the potential of the monopile structures to act as fish aggregating devices and suggested that reference be made to MMS publications and other information developed as "Rigs to Reefs" to substantiate that monopiles are likely to become fish aggregating devices. Commenters suggested that the degradation to these resources that would result when monopiles are removed on decommissioning should be discussed.

Commenters requested that the potential for turbines and/or associated lighting to increase fish at the site of the proposed action needs to be assessed along with potential impacts on fishery resources from vibration, noise, electromagnetic fields, and heat output from transmission cables. Some commenters pointed out that new habitat would primarily be transient use habitat whereas benthic habitat it would replace has year round function. A commenter noted that these changes would benefit certain fisheries and have adverse impact on others.

Comments were made that the Essential Fish Habitat Assessment (EFHA) does not tie in EFH designation from the literature to actual occurrence and relative abundance of species documented by survey data and landings. A commenter requested this information be provided. A commenter recommended that more information should be presented on striped bass, bluefish and fluke and their contribution to high species diversity and ecology of Nantucket Sound. Comments noted that the EFHA does not discuss impacts to fisheries from temporary impacts during construction. Commenters also suggested that the habitat impact assessment focus on the ability of the area to continue providing essential ecological services necessary for spawning, breeding, feeding, or growth to maturity.

Some comments stated that the interconnection between benthic, fisheries and avian resources should be addressed. Commenters expressed concern that predator-prey investigations were not conducted to establish a baseline that could be used to predict and monitor impacts on marine life associated with disturbance, displacement, and habitat loss effects.

Commenters suggested that analysis of potential impacts on fisheries resources, habitat, and harvesting activities must include consideration of on-going and proposed construction activities (e.g., cable installation, dredging and sand mining). Some comments indicated that jet plowing should be timed

and located to avoid winter flounder spawning and that other appropriate time-of-year restrictions be considered. Other comments encouraged the applicant to arrange the construction schedule to avoid in-water work within Lewis Bay between January 15 and May 31 of any year in order to protect sensitive life stages of winter flounder.

Comments expressed concern that possible electromagnetic disruption may occur at the site of the proposed action and have the potential to alter migratory patterns of fish sensitive to such changes and that affect various life history stages of marine species. It was suggested that additional data be provided to demonstrate that EMF emissions have no effect on behavior or navigation of shark species and others sensitive to EMFs. Commenters noted studies in Europe seem to indicate such species would be able to detect EMF fields similar to those associated with the facilities but resulting effects on behavior are uncertain.

Some commenters wanted an independent fund established and independent consultants hired to conduct construction and post-construction monitoring. Some wanted post-construction monitoring to be paid for by proceeds of energy sales and an independent scientific expert review panel to be established.

7.1.2.15 Benthos and Eelgrass

Comments with respect to benthos generally fell under the following subtopics: (1) baseline data limitations; (2) benthic habitat mapping; (3) construction and post-construction monitoring; (4) anticipated impact and recovery rate; (5) compensatory mitigation; (6) vertical hard surface habitat – “reef effect”; (7) commercial and recreational shellfisheries; (8) dynamic components related to productivity and ecosystem functioning; (9) interconnection between benthic, fisheries and avian resources; (10) characterization of rocky substrate; (11) bay scallop fishery; (12) shellfish bed and aquaculture contamination; (13) alteration of accretion/erosion rates; (14) effects of pile driving; and (15) effects of scour mats and impacts to eelgrass. These are discussed in more detail below.

Several comments expressed concern that characterization of benthic resources and habitat lacked comprehensive data and consistent analysis. Some commented that results of limited benthic surveys indicate a need for more intensive sampling to better define habitats, associated flora and fauna and descriptions of their functions and values, as well as to evaluate environmental impacts, characterize alternatives or facilitate siting decisions. Further comments were that supplemental study design and analyses should be coordinated with appropriate state and Federal agencies.

Comments were made that the scale and frequency of benthic sampling should be such that microhabitats could be more accurately identified and mapped within the study area (including alternative sites). Some commented that the benthic habitat mapping could be used in conjunction with a sediment transport model to assess indirect impacts on benthic habitat.

Some comments advised that detailed construction and post-construction monitoring be performed to assess impact on benthic communities. Some wanted an independent fund established and independent consultants hired to conduct construction and post-construction monitoring. Some wanted post-construction monitoring to be paid for from proceeds of energy sales and an independent scientific expert review panel to be established.

Some comments were directed at the discussion of temporary and localized impacts to the benthic habitat during construction. Some noted that there was little discussion of the magnitude of anticipated impact and anticipated recovery rate and that this should be addressed. Further, commenters stated that proposed temporary impacts from jet-plowing/cable laying and anchor chain sweeps can adversely affect

the sand wave habitat. Comments were made that it is important to understand the lost function and value of this habitat from initial impact to time of full recovery to pre-construction contours.

Comments were made that there should be compensatory mitigation for permanent impacts to the benthic substrate from the wind towers and associated scour mats.

Comments noted that potentially significant changes in distribution and abundance of marine species as a result of introduction of a vertical hard surface substrate are not described. Commenters expressed concern over the potential colonization of these areas by colonizing and transient organisms and also potentially by invasive species. Commenters requested a discussion of possible changes from this habitat change based on current literature to assess impacts and possible avoidance or mitigation of these impacts. Concern was expressed that more information is necessary as to whether this “effect” is diminished because of spacing of the WTG or whether this serves to increase the area of biological change and spread the effect over a greater area.

Comments were directed at benthic resource impact analyses and indicated that these analyses did not consider dynamic components related to productivity and ecosystem functioning. Some comments stated that rocky substrate was not adequately characterized. Comments requested a more accurate and comprehensive estimate of the amount of existing rocky habitat. Benthic resource comments noted that the presence of *Crepidula* spp. suggests a more widespread amount of stable habitat, such as cobbles and rocks.

Commenters expressed concern that toxic dielectric transformer cooling oil could contaminate shellfish beds in Harwich and kill large numbers of fauna and flora. Some comments expressed concern about possible introduction of uncontrolled contaminants that could affect aquaculture efforts.

Some commenters noted a need for assessment of whether there would be alteration of accretion/erosion rates on adjacent islands and sand shoals and thus may affect benthic communities.

Some commenters were concerned about impacts to eelgrass beds. Commenters requested a survey of eelgrass beds in the area, information on if and where eelgrass would be affected, and mitigation if eelgrass were to be impacted.

7.1.2.16 Threatened and Endangered Species

The comments submitted for this section fall under the following seven categories: (1) vessel strikes; (2) noise; (3) forage/food sources; (4) data adequacy; (5) additional species; (6) monitoring plan; and (7) mitigation plan.

One of the main concerns from the commenters addressed vessel strikes. The increased traffic due to maintenance trips was a concern as whales and sea turtles are more at risk of being injured or killed by vessels. Another concern was the speed the vessels would be traveling. A request for more recent and informative data was made for vessel strike mortality.

There was a lot of skepticism about the noise that would be created from the construction and operation of the WTGs. Requests for more data were made, including graphics on levels in relation to the construction zone. The comments regarded the effects of the noise on the marine mammals and sea turtles. One comment mentioned that the noise section was insufficient and inaccurate. There were also concerns regarding the “soft start” approach and whether or not this technique would work. There was a concern that the mating call of gray seals would be masked by the frequency from operation of the

turbines and that this would hinder reproduction. The last concern was whether or not the acoustic harassment would cause habitat exclusion.

There were some comments that suggested suspended sediments would not allow sea turtles and any other species relying on sight to find food. Also, the loss of shoals could affect the species that forage in the sandy bottom habitats. Another concern was that small fish species could use the monopiles as aggregating areas creating a “fouling community” and that this may entice marine mammals and sea turtles that prey on these small fish to follow them into the proposed action area.

There were numerous comments about insufficient data and outdated data. There were requests for more species data for each of the threatened and endangered species. There was a request for a baseline survey to be conducted in order to assess the risk. Without this data the commenter indicated that accurate risk assessments cannot be made. Corrections to the gray seal data, including breeding habits were pointed out as necessary.

There were requests that more species be added to the discussions on impacts. Namely, it was suggested that green turtles, minke whales, spotted dolphins, Risso’s dolphins, and Kogia dolphins be added to the list. Also, it was noted that all whale species and sea turtle species do occur in Nantucket Sound.

Comments about the lack of a monitoring plan were made. Commenters wanted a monitoring protocol to be established. Any sea turtles occurring in the proposed action area should be tagged and monitored during and after construction processes. Also, a monitoring plan to assess the effect of electrical and magnetic fields on marine mammals and sea turtles was requested.

Mitigation comments requested avoidance devices on ships to minimize vessel strikes. Also, requests were made to move the safety zone from 1,640 to 3,281 ft (500 to 1000 m). In general, comments suggested that the mitigation plan needed to be more robust. There was one request that a fund be set up for a sea turtle stranding recovery program.

7.1.2.17 Socioeconomics

Comments with respect to socioeconomics generally fell under the following fifteen subtopics: (1) tourism; (2) dependency on foreign oil; (3) reduction in energy costs; (4) economic opportunities; (5) impacts to property values and other negative economic impacts; (6) economical feasibility without subsidies; (7) costs versus benefits; (8) no need for additional electricity; (9) natural gas issues; (10) who benefits from the proposed action; (11) environmental justice; (12) health benefits; (13) general operational issues with New England Power grid; (14) RPS; and (15) commercial fishing impacts. These are discussed in more detail below.

Several commenters requested that the draft EIS add discussions on tourism benefits based on other established wind energy projects. However, there were also people who believe the proposed action could potentially diminish tourism on the Cape and Islands. Some claim that the conclusion of “no adverse impacts” is not supported by enough data and that the actual impacts should be reviewed and updated with relevant studies and comparable existing data.

Several comments with respect to foreign fossil fuel reliance requested more quantitative data and to address and evaluate the fact that wind is not constant and requires a “back-up” energy source. There were concerns about the cost of backup power and how much the proposed action could actually reduce fossil fuel production within the region.

Some comments supported the proposed action, foreseeing the ultimate reduction in electricity costs, while other comments requested more evidence of how and how much energy costs would, in fact, be affected. Others commented that the proposed action would cost more to operate and maintain than it would save for consumers.

Some comments were directed at more accurately depicting and quantifying economic benefits and specifying what types of jobs would be created. Some concerns were raised in regard to the loss of jobs, as well. Some stated that if the proposed action would produce a certain percentage of the region's energy, then jobs would be lost at alternative power plants.

Comments expressed the concern that the draft EIS conclusion of "no adverse effect on property value" is not accurate. Some state that this conclusion was based on flawed studies. Commenters requested that the assessment of impacts to property and real estate be redone and supported by more adequate studies.

Commenters expressed concerns that the proposed action could only be economically viable with reliance on government subsidies. Others stated the required subsidies are excessive and go beyond what serves the public good.

Several requested that more accurate and extensive economic analyses be carried out given the change in energy costs from the time the studies were first conducted. Some stated that the limited amount of energy that the turbines would produce does not outweigh the magnitude of impacts and disturbance of the proposed action. Other commenters voiced the opinion that the USACE draft EIS failed to objectively address costs and benefits and have requested a more realistic assessment of economic and cultural impacts.

Comments with respect to energy needs stated that there is no shortage of power in New England as the region has a 30 percent excess generating capacity. Many commenters felt as though New England is not an efficient location for the farm since the region already has excess electricity. Other commenters said the Project and others like it are needed.

Some commenters stated that money could be better spent expanding the natural gas service and supply. Others said the Project has the potential to reduce natural gas prices and wanted updated estimates on consumer benefits to be included in the new draft EIS.

Several commenters addressed the issue of who the power from the Project actually benefits. Many wanted to know how much it would directly benefit the Cape and Islands and some stated that the Cape should absolutely reap the benefits rather than the entire "grid." There were also requests to include a factual discussion on where the energy produced by the Project would actually be consumed.

There were some requests that the new draft EIS address environmental justice.

Some comments advised that the calculated public health benefits should be considered indicative rather than precisely predictive. Others said that these calculations were not supported by enough explanation and the discussion should be expanded. A specific request with respect to the public health benefits of the proposed action was to address the annual reduction of mercury emissions and the significance of this reduction.

Some comments stated that the emission reduction was overestimated because the back-up operation of alternative plants was not factored in. Others wanted an explanation of the impact of turbine failure on stability of the grid and what would happen if promised power was not delivered.

Several commenters addressed the need for the Project in order to meet the requirements of New England's RPS. Others voiced that the proposed action would lift pressure off of REC prices and reduce ratepayer exposure to Alternative Compliance payments.

Socioeconomic comments with respect to fishing raised concerns that dragging may not be feasible or allowed in the proposed action area. Other concerns were whether commercial fisherman would be compensated for any damage the farm has on fisheries. Some requested that the new draft EIS address future shellfishing impacts and all commercial fishing impacts more thoroughly.

7.1.2.18 Transportation

Comments with respect to transportation generally fell under the following seven subtopics: (1) navigation hazards, including ice; (2) aviation hazards; (3) minimal or no navigational hazards expected; (4) marine and air radar effects; (5) restrictions on navigation and public access; (6) wind turbine towers may serve as a navigation aid; and (7) requests for additional navigational studies.

The majority of the concerns expressed in the comment letters were with respect to navigational hazards, including ice, waterway congestion, collisions with turbines, danger to recreational and commercial boating, and interference with search and rescue missions. Some commented that the aerial and surface navigation lighting on the towers would interfere with existing guides, while others thought the turbine structures could help serve as an aid to navigation and did not foresee navigation problems. Others expressed concern that the "proximity" of the Project to heavily traveled waterways is enough to put boaters at risk of collision with one another as well as with the towers. Some commenters requested further navigational impacts and studies, including, but not limited to, ice flow within the Sound, potential for fuel barges and other marine vessels to collide with wind towers, and the delays the wind turbine towers could cause to search and rescue missions. Some said that the proposed action would restrict or prohibit navigation and use of the waterway as a result of security concerns.

The main comments with respect to aviation had to do with the required safety lighting of the turbines, safety concerns regarding local airlines and private aircraft, and impacts the Project would have on search and rescue operations. Radar interference was also a concern. Questions arose about whether the EMF produced by turbines would influence aircraft radar, and several comment letters requested that the draft EIS refer to existing wind projects for radar interference data.

7.1.2.19 Communications

Some commenters were concerned about FAA/DOD radar impact leading to aircraft safety issues and the impact to other aircraft navigational services such as ILS, GPS and VOR.

According to the commenters, there are 400,000 flights per day in the Cape area that could be adversely affected by the proposed wind turbines. Comments were received urging that the FAA approval granted 4 years ago be rescinded. The commenters stated that revisiting the previous FAA approval is justified by the following new information: (1) the publishing of the UK CAA Policy Guidelines on Wind Turbines; and (2) the "Great Risk to Aircraft" associated with possible interference to radar, ILS, and other navigation aids. This possible interference is divided into the following modes:

- a. Receiver swamping;
- b. Defeat of target processing;
- c. Obstruction; and
- d. SSR reflections (false target).

In addition to re-visiting the FAA approval, commenters urged that the proposed action be placed upon “indefinite hold” to: (1) provide an opportunity for national standards to be developed, and for the “cumulative effects of multiple turbines” to be studied more exhaustively; (2) address presently unknown effects that may arise in the future; and (3) avoid restricting the future expansion options of the local airports, and possibly the local economy as well.

Other commenters stated that detailed information on electric fields, magnetic fields, and possible communications interference seemed to be lacking.

7.1.2.20 Cultural Resources

Comments with respect to cultural resources generally fell under the three main subtopics: (1) general need for Section 106 of the NHPA compliance; (2) inadequacy of previous USACE draft EIS for identifying historic properties potentially affected by the Project; and (3) concerns about adverse affects on historic properties.

The majority of concerns dealt with the need for MMS to ensure a thorough and open Section 106 process, referring to Section 106 of the NHPA, as implemented through 36 CRF 800. Some comments emphasized the need for MMS to identify and invite consulting parties to participate in the Section 106 process, and to carefully assess how adverse affects to historic properties can be avoided, minimized, or mitigated. The need to analyze a reasonable range of alternatives to the proposed action also was noted.

Related to the Section 106 process, some comments noted that the USACE determined (through prior studies) that some historic properties would be adversely affected by the proposed action, including two NHL, but stated the belief that the USACE effort to identify historic properties was inadequate. Concern was expressed that the USACE draft EIS conducted by the USACE only considered historic properties that were already determined eligible for listing or already listed on the NRHP, to the exclusion of properties that are eligible but have not been formally determined eligible. The MMS was encouraged to ensure that all eligible properties be considered under the Section 106 process.

Finally, some commenters indicated specific concerns about adverse effects to historic properties (i.e., properties eligible for or listed on the NRHP). Most of these concerns were related to how the visual and audible settings of historic properties would be impacted, although potential effects on submerged historic cultural resources were also mentioned.

7.1.2.21 Aesthetic/Landscape/Visual

The comments with respect to aesthetic impacts generally fall into the following subtopics: (1) the proposed action has positive or no impacts to aesthetics; (2) the proposed action has negative impacts to aesthetics; (3) visibility of lighting; (4) recreational impacts; (5) showing ESPs in visuals; and (6) providing visuals from other locations/distances to other locations/other comparisons/re-evaluation of view sheds.

Some commenters expressed the belief the proposed action would have a positive affect on aesthetics. They state that wind turbines are not a visual nuisance and that the turbine array could actually enhance the horizon. On the other hand, some comments addressed concerns with the negative visual impacts. Some believe that the turbines would disrupt the beauty of Nantucket Sound, permanently change the horizon and adversely affect the aesthetic value of the Sound. Others are concerned that the proposed action would detrimentally affect the view from historical sites, tourist sites and public and private beaches.

Several commenters noted that visual simulations were only done for the daytime and request that simulations be produced for night time, as well in order to show the lighting on the WTGs. Others are concerned with the light pollution and suggest/question if anything can be done to minimize it. Some commenters are also concerned that the lighting would confuse recreational boaters.

Comments were submitted noting that the simulations did not include the ESP and requested that they do so.

Several commenters request a more thorough evaluation of visual impacts and that the draft EIS explain in more detail the methodology of assessing those impacts. Some specifically suggest including all elements that influence aesthetic evaluation, including but not limited to, height, distance to shore, atmospheric conditions, elevation of the viewer, and perception. A few commenters request that a more quantitative explanation of visual impacts be provided, such as mileage/percentage of ocean-facing shoreline located within view of the wind turbine array. Lastly, some commenters suggest that the draft EIS should include visual simulations from additional locations, such as Craigsville, Hyannisport, Cotuit, and Osterville.

7.1.3 Comments Considered Out of Scope

Opinion Letters

A large portion of the comment letters were simple opinions such as “I don’t want the Project”, or I like the Project and want it approved.” Opinion letters such as these were not evaluated in determining the scope of the MMS draft EIS since they do not really provide input on what should be the content of the EIS or how the proposed action should be evaluated. Rather MMS considered comments that were substantive and either provided information on what should be included in the draft EIS or required an action, such as evaluation of a specific type of potential environmental impact.

In addition, some of the comments summarized under the regulatory heading are no longer applicable to review under the MMS’s jurisdiction. For instance, many comments were made that the USACE was not the appropriate review agency, and as the MMS is now reviewing the proposed action, this is no longer applicable. Similarly, concerns regarding objectivity of the preparer are also no longer applicable, as MMS, a public regulatory agency is preparing the new draft EIS using the services of an independent third-party contractor.

7.2 REQUIRED AGENCY CONSULTATIONS

Cooperating Agency meetings were held in Boston, Massachusetts on November 2, 2005; June 27, 2006; and February 28, 2007. Consultation correspondence is provided in [Appendix E](#) and a list of agencies consulted is provided in [Table 7.2-1](#). The following is summary information about each agency consulted and its jurisdiction:

Consultation with Advisory Council on Historic Preservation (AHP) (Section 106 of the NHPA, as Amended Through 2000)

Section 106 of the NHPA of 1966, as amended through 2000, requires that Federal agencies consider the effects of their undertakings (as defined in 36 CFR § 800.16(y)) on properties included in or eligible for inclusion in the NRHP (known as historic properties per 36 CFR Part 800. The MMS would fulfill the requirements set forth in the NHPA, including consultation with the SHPO in accordance with the implementing regulations.

An undertaking has an effect on a historic property when that undertaking has the potential to alter the characteristics of the property that qualified the property for inclusion in the NRHP. Effects can include

physical disturbance, noise, or visual effects. If an adverse effect on historic properties is found, the MMS would notify the ACHP, consult with the SHPO, and encourage the applicant to avoid, minimize or mitigate the adverse effect(s). Ground-disturbing activities associated with construction, as well as visual effects of the aboveground WTGs, are subject to Section 106 review.

The regulations at 36 CFR Part 800 require the identification of historic properties in the project's Area of Potential Effect. This process has been completed along the proposed onshore transmission route; submarine cable system located within state waters, and is currently under review for those portions of the proposed action located in Federal waters. Studies included development of a predictive model for the presence of potentially significant submerged archaeological resources, which may exist in the offshore portions of the proposed action area and a marine reconnaissance archaeological survey, as requested by the cooperating state agency MHC (which includes the SHPO and State Archaeologist) and also the MBUAR. Historic properties within the viewshed of the wind turbine array have been identified on Cape Cod, Nantucket and Martha's Vineyard. Visual simulations of the built turbine array from representative locations have been completed (see Section 5.3.3.4.2 for more details).

Consultation and Coordination with Indian Tribal Governments (i.e., Wampanoag Indians of Mashpee and Wampanoag Indians of Gay Head) Executive Order 13175 (Applicable Regulatory Agency: Lead NEPA Agency i.e., MMS)

The MMS works on a government-to-government basis with Native American Tribes. As a part of the government's Treaty and Trust responsibilities, the government-to-government relationship was formally recognized by the Federal government on November 6, 2000.

The MMS has formally met at the headquarters of the Wampanoag Indians of Gay Head and the Wampanoag Indians of Mashpee in both June and July of 2007. Consultation included explanation of the proposed action and its potential impacts on tribal government. Comments made by the tribal groups are addressed in this draft EIS. Impacts on tribal governments are discussed under the Environmental Justice section of this draft EIS (Section 5.3.3.3).

Consultation with NOAA (NOAA Fisheries) (Fish and Wildlife Coordination Act; 16 U.S.C. 1801-1882 - Magnuson-Stevens Fishery Conservation and Management Act of 1976; 16 U.S.C. 1531-1543; Pub. L. 93-205, as amended - Endangered Species Act of 1973; and 16 U.S.C. 1361-1421; Pub. L. 92-522, as amended; reauthorized in 1994 (Pub. L. 103-238) - Marine Mammal Protection Act of 1972

NOAA Fisheries (formerly NMFS) is a division of the Department of Commerce and is responsible for the management, conservation and protection of living marine resources within the United States' Exclusive Economic Zone (water 3 to 200 miles [5.6 to 370.4 km] offshore). It also has regulatory review and responsibilities for the management and protection of EFH as well as responsibilities under the Endangered Species Act and the Marine Mammal Protection Act.

NOAA Fisheries is responsible for providing an assessment of the likelihood to cause adverse impacts on species or habitats under their jurisdiction. They can also provide recommendations to the Federal agency for mitigation actions to reduce or compensate for proposed action impacts, or can recommend that the Federal agency deny the permit. For the Project, NOAA Fisheries review falls into four categories: fish and wildlife species and habitats regulated under the Fish and Wildlife Coordination Act, EFH regulated under the Magnuson-Stevens Act, marine species and habitats regulated under the Endangered Species Act, and species regulated under the Marine Mammal Protection Act.

MMS has been informally consulting with NOAA Fisheries regarding the applicant's proposal since January 2006. This has included individual phone calls and emails between MMS and NOAA Fisheries.

MMS recommends that the applicant contact NMFS to determine if an Incidental Harassment Authorization (IHA) under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may “take” marine mammals. MMS has prepared a draft Biological Assessment and formal consultation under the ESA will commence following the issuance date of this DEIS.

Consultation with the USFWS: (Endangered Species Act and Migratory Bird Treaty Act, Fish & Wildlife Coordination Act)

The USFWS works with landowners, private organizations, government agencies and other partners to conserve fish and wildlife resources. Through Federal action and by encouraging the establishment of state programs, the 1973 Endangered Species Act provided for the conservation of ecosystems upon which T&E species of fish, wildlife, and plants depend. The ESA authorizes the determination and listing of species as endangered and threatened; prohibits unauthorized taking, possession, sale, and transport of endangered species; provides authority to acquire land for the conservation of listed species, using land and water conservation funds; authorizes establishment of cooperative agreements and grants-in-aid to States that establish and maintain active and adequate programs for endangered and threatened wildlife and plants; authorizes the assessment of civil and criminal penalties for violating the ESA or regulations; and authorizes the payment of rewards to anyone furnishing information leading to arrest and conviction for any violation of the ESA or any regulation issued there under.

The MBTA prohibits taking any migratory bird except as permitted by regulations issued by the DOI. Another, more recent mandate regarding the conservation of migratory birds, is Executive Order (E.O.) 13186, signed January 2001, by President Clinton. This E.O. requires every Federal agency that takes action(s) likely to have a measurable negative impact on migratory birds to enter into a MOU with the USFWS, which has Federal jurisdiction over managing and conserving seabirds. The MOU outlines how an agency would promote the conservation of migratory birds. Additional obligations under E.O. 13186 include supporting other conservation efforts already underway and incorporating bird conservation into agency planning.

MMS has been informally consulting with both the FWS and NOAA regarding the applicant’s proposal since January 2006. This has included individual phone calls and emails between MMS and USFWS/NOAA as well as the following efforts which are also considered as part of the informal consultation and ultimately the development of the formal consultation package:

- During 2006 and 2007, MMS has regularly convened conference calls with USFWS-ESA-listed bird experts, state bird experts and private scientists (selected by the USFWS). These efforts were meant to get everyone on the same page and share expertise on: (1) information available on the proposed action as it relates to potential impacts on ESA-listed birds and (2) development of the risk assessment model and population viability analyses.
- A face-to-face meeting of these and other experts was also held on January 30, 2007 to discuss potential impacts to ESA-listed birds associated with current and conceptual offshore wind projects and identify data gaps and information needs.
- An additional face-to-face meeting was held September 13, 2007 with the same and additional individuals to discuss potential mitigation and monitoring activities that may possibly be built into the proposed action for the ESA consultation on the applicant’s proposal.

MMS has prepared a draft Biological Assessment and formal consultation under the ESA will commence following the issuance date of this DEIS.

Consultation with United States Coast Guard (USCG) (U.S. Coast Guard Regulations at 33 CFR part 66.0, Subpart 66.01)

Pursuant to 33 CFR part 66.0, Subpart 66.01, the USCG has jurisdiction over projects located in navigable waters of the United States. The proposed action constitutes fixed structures in navigable waters of the United States which therefore require private aids to navigation marking. A permit application to establish and operate Private Aid-to-Navigation to a Fixed Structure has not yet been filed.

All 130 WTGs and the ESP are subject to USCG review for authorization to mark and light the WTGs and ESP. The USCG has safety and regulatory jurisdiction over projects located in navigable waters of the United States. The USCG Marine Safety Office for the Port of Providence, Rhode Island, which has jurisdiction over general navigation in the proposed action area, has coordinated a Navigational Risk Assessment. This Risk Assessment was prepared at the direction of, and in consultation with, the U.S. Coast Guard Marine Safety Office at the Port of Providence in order to provide a qualitative assessment of navigational risks related to the proposed action. The analyses required by the USCG were outlined in a letter to the USACE dated February 10, 2003 ([Appendix E](#)). Subsequent to the release of the USACE draft EIS/ DEIR in November of 2004, the applicant was required to revise the 2003 Navigational Risk Assessment to incorporate design changes and new information and to address topics requested by the USCG in its letter of February 14, 2005. The revised Navigational Risk Assessment has been incorporated into this DEIS.

8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Should the proposed action be licensed and constructed, there would be some irreversible or irretrievable commitments of resources. Irreversible or irretrievable commitments are those that cannot be reversed, except perhaps in the extremely long-term. A commitment of resources involves the use or destruction of nonrenewable resources, as well as the effects that loss would have on future generations. If a species becomes extinct as a result of a proposed action, for example, that loss is permanent. If wetland is filled to build a parking lot, that habitat loss is irretrievable as long as the parking lot remains. Construction and operation of the proposed action involves the irreversible and irretrievable commitment of material resources, energy (though small), and biological resources.

Material resources used for the proposed action include building materials for new structures, cables, and other facilities. Construction would also require use of fossil fuels, a nonrenewable natural resource, by vessels transporting workers and materials to and from the site of the proposed action.

Construction and operation of the proposed action would result in an irreversible or irretrievable loss of some biological resources, including the irretrievable loss of approximately 0.67 acres (2,711 m²) of soft bottom habitat due to the ESP and monopiles. Vessel traffic, vehicle traffic, facility construction and monopile driving could permanently displace some fauna and flora species from favorable to unfavorable habitats. Displacement and habitat loss may result in the reduction of some local populations and become irretrievable habitat permanently maintained. However, for this proposed action the degree of displacement and amount of habitat loss should represent a transitory and negligible effect to the overall populations of species.

The presence of the monopiles and ESP would also result in a permanent loss of certain human uses of these immediate areas. For example, it would not be possible to navigate through a monopile or the ESP. However, these impacts are negligible as the size of the ESP is small relative to the area of Nantucket Sound, and the monopiles are spaced far apart from each other so that mariners would be able to safely navigate around them. Commercial fishing vessels towing mobile gear would have to avoid the monopiles and ESP, but as with general navigation, this loss of navigation space is negligible. Ultimately, after decommissioning, this restriction on use would be removed.

During construction there would be irretrievably lost area to the fishing industry due to the enforcement of the safety setbacks of small water sheet areas around the turbines and ESP. These safety areas are limited, however, and would only be enforced temporarily around the piles being constructed. In addition, given the abundance of other available area that can be fished, there should be no lost opportunity days or revenue. The creation of these safety areas around the turbines and ESP during construction would also result in the irretrievable loss of recreation, but again this would be negligible because of the short duration and small fraction of the Horseshoe Shoal area that would be involved at any one time.

9.0 MONITORING AND MITIGATION

This section provides information on monitoring and mitigation applicable to the proposed action. If the proposed action were selected, MMS would require that these items be incorporated into an Environmental Management System (EMS), as a condition of its authorization. Since neither MMS nor any other federal or state agency has past experience evaluating how projects such as the proposed action will interact with the marine environment, MMS requested and the applicant agreed to prepare and implement an EMS tailored to the proposed action. The EMS would remain in effect throughout the life of the project, from construction through decommissioning, and would allow for an adaptive management approach in dealing with the environmental impacts arising throughout this timeframe. The EMS would set forth the monitoring efforts the applicant would undertake during construction, operation and maintenance, and decommissioning. In addition, the EMS would contain mitigation measures for unavoidable adverse impacts that the MMS requires as a result of its consultation process with Native Americans and agencies, as well as the environmental review process occurring under NEPA. Additional mitigation measures may be implemented by the applicant as a condition of other permits and approvals that it receives. The discussion below focuses first on an overview of the EMS, then lessons learned from existing offshore wind energy projects, followed by draft monitoring and mitigation associated with the major categories of resources: physical, biological, socioeconomic and land use, and transportation and navigation, and finishing with a presentation of mitigation derived from state environmental review and permitting processes that have already been completed.

9.1 OVERVIEW OF PROPOSED ENVIRONMENTAL MANAGEMENT SYSTEM

One widely recognized international EMS is the International Organization of Standards ISO 14001, used to systematically identify, manage, control, and monitor environmental impacts. An EMS is a system that sets up a structure for continuous improvement in the area of managing and minimizing potential environmental impacts. As a continuous improvement process, an EMS is expected to be reviewed and updated periodically to reflect changing circumstances with respect to environmental policies, construction, operation and decommissioning technologies, actual environmental impacts and their effects, and the effectiveness and viability of mitigation and monitoring programs.

An EMS requires:

1. considering policies and regulations applicable to an action;
2. planning how to undertake the action in compliance with the applicable regulations;
3. implementing the action according to a plan;
4. monitoring and measuring the effects of the action;
5. reviewing the effectiveness of the plan with respect to applicable requirements;
6. where warranted, revising plans to reflect the reality of what is occurring during the implementation of the action; and
7. documenting the applicant's environmental policy, key responsibilities, and procedures to carry out and report the results of numbers 1 - 6 above.

The applicant has agreed to implement an EMS for the project. The applicant would develop an EMS that focuses on three key commitments: complying with environmental legislation, preventing impacts to local resources, and continually striving to improve environmental performance. There are a number of resources within the proposed action location that would be impacted during construction, operation and maintenance, and decommissioning. The EMS would be designed to address each activity within each

phase, and identify the approximate severity of the impacts to each resource associated with that activity. The applicant would use the EMS as a tool in ensuring that it meets its post-decision mitigation and monitoring obligations. Mitigation and monitoring commitments made in a ROD may be incorporated into the EMS, and carried through the system. The ROD states what the decision is, identifies the alternatives considered, including the environmentally preferred alternative, and discusses mitigation plans, including any enforcement and monitoring commitments (40 C.F.R. § 1505.2, [2005]).

MMS has identified four categories of impacts to define the magnitude of effects of an action: negligible, minor, moderate, and major. Negligible impacts are non-measurable or nonexistent impacts to the resource, and therefore no mitigation steps are needed to be discussed. Minor impacts are those that could be avoided with proper mitigation; if impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated. Moderate impacts include impacts to the affected resource which are unavoidable; either the viability of the affected resource is not threatened (although some impacts may be irreversible) or the affected resources would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated. Major impacts are those impacts to the affected resource which are unavoidable; the viability of the affected resource may be threatened and the affected resource would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

As commitments and mitigation measures established in the ROD are implemented, tracked and monitored through the EMS, the applicant would document the implementation, tracking and monitoring of commitments and mitigation measures. This documentation can facilitate their internal training, internal auditing, identification of appropriate corrective actions and communication with interested parties. The documentation should be effective and sufficient to provide MMS with details of how well the applicant conforms to its plan, information on compliance with legal standards and requirements, permits, and authorizations, results of internal audits and reviews, and details of deficiencies and corrective and preventative actions.

In the EMS documentation, each of the three phases would be presented in its own part, and each major division of activity would be presented in its own section. Component activities of the major divisions would then be presented in subsections. The resources that may be impacted by each component activity would be listed under their respective subsections. Each resource would be carefully considered; potential impacts to the affected resources would be discussed in detail for each component activity. The EMS would document the applicant's process to incorporate the concept of adaptive management, in that, if unexpected impacts arise, they would be evaluated and addressed as needed.

The EMS documentation would be structured to address the three phases of the proposed action:

1. Construction would include installation of the cable system on shore, installation of the foundation monopiles, erection of the WTGs, installation of the cables in the seabed, and installation of scour protection. Construction activities are expected to have the most substantial impacts per unit time on local resources.
2. Operation and maintenance would include the actual existence of the facilities, and activities such as periodic boat traffic from maintenance vessels. This phase is expected to have the least impact per unit time on potentially affected resources.
3. Decommissioning would include activities involved with deconstructing the WTGs and infrastructure. The impacts are generally similar to, but less intense than, those of the construction phase; consequently, most of the activities and resource impacts refer back to the construction part of the document.

9.2 LESSONS LEARNED FROM EUROPEAN WIND FARMS

In order to identify possible lessons learned from other offshore wind energy projects, MMS reviewed the monitoring results from a recent study on two demonstration wind farms in Denmark (Horns Rev and Nysted), which have been the subject of research and monitoring programs to examine the potential environmental impacts of offshore wind farm projects. Horns Rev, constructed during the summer of 2002, is sited 8.7 to 12.4 miles (14 to 20 km) off the coast of Denmark in the North Sea, and consists of 80 turbines totaling 160 MW. Nysted was constructed between 2002 and 2003 approximately 6.2 miles (10 km) offshore in the Baltic Sea, and incorporates 72 wind turbines placed in 8 rows of 9 turbines each, with a total installed capacity of 165.5 MW. The monitoring data at both sites consist of 3 years of baseline monitoring, monitoring during construction, and 3 years of monitoring during operation.

The environmental monitoring program focused primarily on the effects of construction and operation of the offshore wind farms on the infauna, epifauna, and vegetation of the benthic community; on fish, marine mammals and birds; and on peoples' attitudes towards offshore wind farms locally and nationally. Overall, the results from the Danish wind farms suggest that with proper siting and placement of turbines, offshore wind farms can be engineered and operated without significant damage to the marine environment and vulnerable species. In general, the monitoring results show that the wind farms seem to pose a low risk to birds, mammals, and fish. The studies stress that appropriate siting is an essential precondition for ensuring limited impact on nature and the environment, and that careful spatial planning is necessary to avoid damaging cumulative impacts. Important differences between the two sites were observed in the results of some studies, suggesting that environmental impacts are likely to vary by location even with careful site planning. Therefore, it is difficult to generalize the results of this monitoring program to potential environmental impacts at other offshore wind sites including the proposed action.

Research on the benthic communities at Horns Rev and Nysted focused on the effects of the introduction of hard foundation structures. Changes observed include increased abundance and biomass in the benthic community at the turbine sites associated with increased habitat heterogeneity and structural complexity, and a change in community composition. This may have a positive environmental impact if the increased biomass provides additional food resources for fish and birds. There was no clear evidence of impacts associated with changes in the hydrodynamic regime on the surrounding native benthic communities, seabed sediment structure, or established fouling communities. Many of these results are dependent on the particular benthic community and substrate types present, the level of natural scouring action, the salinity, and the species in the water column available for colonization. However, the rapid colonization and long-term establishment of a hard-surface community on turbine foundations was similar to what is observed on other artificial reefs, and may be representative of what would occur in other locations, including the proposed action.

Potential long-term impacts of offshore wind farms on fish may likewise be associated with the creation of artificial reefs and the establishment of the new hard-surface benthic communities at wind turbine sites. It was expected that fish would be attracted to these areas at the Danish wind farms, resulting in a positive effect on fish abundance and diversity, since artificial reefs may provide additional food, shelter, spawning areas, and a refuge from fishing activities that occur outside the wind farm area. To date, no effect has been observed on fish species composition, distribution and abundance at the Danish wind farm sites; however, it has been suggested that because it can take years for the full reef community to become established, sufficient time may not yet have passed to observe long-term effects on fish distribution or abundance.

The study at Nysted also looked for effects on fish and fish behavior that might be caused by the EMFs created by submarine cables during the operation phase of the wind farm. The Nysted study was

not conclusive on this point, but suggests that there is no strong effect. There was some evidence of either avoidance or attraction to the magnetic fields depending on the fish species. The data, however, did not rule out the possibility that physical conditions, not EMFs, along the cables might have caused the observations. Only one species, flounder, showed a correlation between the inferred strength of the EMF and increased avoidance of the cable. It may be invalid, however, to assume that other species do not feel an effect of the EMFs; a weakness of this study was that the EMFs around the cables were not measured directly, and the strength of the fields was inferred from turbine output only, which may not be sensitive enough to produce a correlation.

Construction activity did seem to have an effect on marine mammal behavior and abundance. Other than a reaction to pile-driving and ramming activities, construction and operation of the wind farms had no noticeable effect on seals. Decreases in porpoise abundance were found at both sites during construction, only a slight decrease at Horns Rev, and a much stronger decrease at Nysted, with clear effects from the pile driving and ramming activities. At Horns Rev, there was no observed effect of wind farm operation, while at Nysted; the decrease in porpoises observed during construction has persisted during the first 2 years of operation, with indications of a slow recovery. The conclusions in these studies are that most effects of the wind farms on mammals are temporary and related to construction noise, but the reasons behind the slow recovery at Nysted are unclear.

Radar, infra-red video monitoring, and visual observations confirmed that at the Danish offshore wind farms most of the more numerous species of birds showed avoidance of wind farm areas, although responses were highly species specific. Birds tended to avoid the vicinity of the turbines and move along the periphery of the wind farm. Slightly extended migration distances for seasonal migrations are unlikely to have negative consequences for any species. The energetic costs of avoidance behavior could be much higher for wind farms located near nesting sites, which the Danish projects are not, if the avoidance interferes with daily foraging trips, affecting breeding success.

Post-construction studies showed an almost complete absence of loons and scoters within the Horns Rev wind farm, and reductions in long-tailed duck densities within the Nysted wind farm. This suggests displacement of these birds from feeding areas, probably due to avoidance of the turbines rather than a decrease in food resources. A few species such as cormorants and gulls may have increased their use of the wind farm areas, mostly as resting ground.

Low collision rates of migrating birds with turbines were predicted by computer simulation. Comparing model predictions for common eider to observed levels from one of the turbines using an infra-red monitoring system, collision rates for this species' migration through the Danish wind farm areas appear to be very low. It should be noted, however, that the assessments from this study were primarily focused on waterbird behavior and collision, and potential effects on other kinds of migrating birds were not addressed. This study also made no attempt to quantify the effects of weather conditions, such as areas with fog, on potential collision rates.

The final study conducted on Nysted and Horns Rev looked at the attitudes of neighboring local populations and the national population towards offshore wind farms. Results suggested the national population was favorably inclined to offshore wind farms, with this sentiment represented in the local Horns Rev population. The Nysted population was more critical of offshore wind farms, suggesting there may be substantial differences in local attitudes. Results of the study clearly showed that people expressed a willingness to pay for future wind farms to be located at distances from the shore where their visual impact is reduced. Willingness to pay to place wind farms completely out of sight was limited, but the local population at Nysted had a higher willingness to pay for this than Horns Rev or the national population.

Conclusions reached from the Danish offshore wind farms, therefore, showed generally minimal environmental impacts over the long term at these sites, but enough differences between sites to recommend caution in generalizing too much from these limited studies. New benthic habitats were colonized fairly rapidly, without strong observed effects on the surrounding soft bottom communities. The effects of the offshore wind farms were neutral with regard to fish density, species composition and abundance, showing neither positive nor negative effects. Results from the study on the potential effects of EMFs were inconclusive. Marine mammals, in general, were affected during construction temporarily, but their use of wind farm areas recovered during the operation phase, with the exception of the porpoises at Nysted, which exhibited long-term avoidance of the area. Bird studies showed general avoidance of wind farm areas for migration in most species, as well as avoidance by some species that otherwise use the area as a feeding ground. Collision rates with turbines for a large diving duck, the common eider, during migration, were predicted and observed to be very low.

9.3 PHYSICAL RESOURCES MITIGATION

9.3.1 Noise

Proposed mitigation specific to noise includes performing all construction activities associated with the onshore cable installation during normal daytime work hours only. In addition, noise barrier walls are proposed and would be constructed at the edge of the HDD pit to shield nearby residences at 32 and 49 New Hampshire Avenue.

Mitigation measures to reduce underwater noise impacts include but are not limited to the use of underwater sound monitoring to confirm pile driving noise levels and the use of soft start pile driving.

During operation, potential operational sound effects would be minimized to the extent practicable by site selection offshore and through the selection of state-of-the-art, very low noise wind turbines.

9.3.2 Water Quality

MMS requires a draft O&M Plan that details standard operating and maintenance protocols to ensure proper operation of offshore facilities. The draft O&M Plan specifies operating guidelines, maintenance schedules, and materials approved for maintenance activities. The maintenance program would include preventive and emergency maintenance functions including shore-based predictive maintenance analysis of the WTGs and ESP. The O&M Plan would be incorporated into the EMS. The applicant would be responsible for developing and implementing an OSRP and a stormwater pollution prevention plan (SWPPP) covering all phases of the proposed action.

OSRP

The OSRP would be prepared in accordance with the DOI's MMS regulations at 30 CFR 254, "Oil Spill Response Requirements for Facilities Located Seaward of the Coastline." These regulations require owners/operators of oil handling, storage, or transportation facilities located seaward of the coastline to submit a spill response plan to MMS for approval prior to facility operation.

In the event of a release of oil to the ocean, the applicant's employees, its contractors, and its responders would refer to the OSRP to ensure that the appropriate spill response actions are taken in a timely manner to minimize impacts to sensitive receptors and the environment.

Emergency Response Plan

The applicant has prepared an Emergency Response Plan that would be incorporated into the EMS. The purpose of this ERP is to describe procedures to be followed by the applicant's personnel in

responding to emergencies, including those involving releases of hazardous substances (see Section 5.2.2.1), fires, medical emergencies, severe weather, etc. Impacts to humans and the environment would be reduced through application of this plan. This facility would be subject to MMS and Occupational Safety and Health Administration (OSHA) regulations with respect to emergency response.

9.3.3 Electro Magnetic Fields

The proposed action design incorporates economically viable and prudent measures to reduce EMF. The use of three-conductor cables – rather than a flat arrangement of single conductor cables in separate trenches – minimizes the spacing between phases, which in turn, reduces the magnetic flux density. The cable is proposed to be buried at a depth of 6 ft (1.8 m) to reduce the magnetic flux density on the sea floor. Since all of the proposed transmission cables contain grounded metallic shields, no or minimal electric fields should exist beyond the cable itself.

As a result of designing the proposed action to: (1) effectively prevent the creation of electric fields; (2) employ viable, economic and environmentally safe measures to reduce magnetic flux densities; and (3) comply with established guidelines or standards for EMF, no additional mitigation has been proposed at this time.

9.4 BIOLOGICAL RESOURCES MITIGATION

9.4.1 Coastal and Intertidal Vegetation

The applicant has proposed to avoid or minimize direct impacts to coastal and intertidal vegetation through the avoidance of seagrass beds along the electric transmission cable, and installation of the onshore transmission line across the intertidal zone using HDD methods.

9.4.2 Avifauna

The applicant has included anti-perching devices into the ESP and WTG design. In addition, as part of the state permitting process, the applicant has committed to a number of other avian impact mitigation measures, as presented in Section 9.7.

9.4.3 Subtidal Offshore Resources

The applicant has proposed the use of midline buoys on anchor cables to reduce the amount of area that would be impacted by anchor cable sweep; and use of a cofferdam when constructing the HDD to minimize the dispersal of disturbed sediments and any released drilling fluid. A drilling fluid fracture or overburden breakout monitoring program would be part of the overall HDD operation in Lewis Bay. This monitoring program would serve to minimize the potential for significant impacts associated with a drilling fluid breakout in Lewis Bay.

9.4.4 Marine Mammals

Specific to marine mammals, the applicant has proposed to adopt *NOAA Fisheries Regional Viewing Guidelines-Northeast Region* (NMFS and NOS, 2006), as well as several other measures which are relevant to marine mammals due to their protection under the Marine Mammal Protection Act, and are discussed below under Threatened & Endangered Species. Ultimately, the applicant would be required to abide by any measures required by NOAA Fisheries under the terms of its review and approval process under the ESA and the MMPA.

9.4.5 Fish and Fisheries

Measures proposed by the applicant to minimize or avoid potential impacts to the commercial fishing industry include: no restrictions on fishing activities within the turbine array during operations; marking the WTGs with USCG-approved lighting to ensure safe vessel operation; and burying the inner-array cables and two submarine cable circuits to a minimum of 6 ft (1.8 m) below the seabed to avoid the potential for conflicts with fishing vessels and gear operation.

9.4.6 Essential Fish Habitat

At this time, the applicant has proposed pre- and post-construction documentation and monitoring of the eelgrass bed, a productive habitat designated as EFH, and if it is determined that eelgrass has been lost, replanting would occur. The post-construction monitoring plan would be developed to document potential indirect impacts from cable embedment and subsequent habitat recovery. Should the habitat not recover naturally, the disturbance would be mitigated by replanting. Additionally, an eelgrass survey would be performed for two consecutive years following construction to document the change in density. Ongoing consultation with resource agencies could result in modifications to this Plan.

9.4.7 Threatened & Endangered Species

Specific mitigation measures to minimize the potential for vessel collisions, vessel harassment and acoustic disturbance to MMPA and ESA/MESA protected marine species include requiring vessels to follow *NOAA Fisheries Regional Viewing Guidelines-Northeast Region* (NMFS and NOS, 2006) while in transit to and from the site of the proposed action so as to minimize harassment or harm of any individuals that may be in the area. NOAA Fisheries consultations under the ESA Section 7 are ongoing, and the ultimate decision on the adequacies of these measures or the need for additional measures are dependent on concluding the consultation process. These NOAA Fisheries regional viewing guidelines are explained below.

Measures to Avoid Collision

When in sight of whales:

2 miles to 1 mile (3.2 to 1.6 km) away:

- Reduce speed to 13 knots (6.7 m/s)
- Post a dedicated lookout to assist the vessel operator in monitoring the location of all marine mammals
- Avoid sudden changes in speed and direction
- Aircraft should maintain a minimum altitude of 1,000 ft (305 m) over water

1 mile to ½ mile (1.6 to 0.8 km) away:

- Reduce speed to 10 knots (5.1 m/s)

½ mile (0.8 km) or less:

- Reduce speed to 7 knots (3.6 m/s)
- Maneuver to avoid head-on approach

Close Approach Procedure:

600 ft (183 m) or closer:

- Parallel the course and speed of moving whales up to the designated speed limit within that distance
- Do not attempt a head-on approach to whales
- Approach and leave stationary whales at no more than idle or "no wake" speed, not to exceed 7 knots (3.6 m/s)
- Do not intentionally drift down on whales
- Vessels in multi-vessel approaches should maintain communication with each other (via VHF channels 9, 13, or 16 for hailing) to coordinate viewing
- Take into account the presence of obstacles (vessels, structures, fishing gear, or the shoreline). All vessels in close approach must stay to the side or behind the whales so they do not box in the whales or cut off their path

Standby Zone

300 ft to 600 ft (91 to 183 m) away:

- Two vessel limit within the 300 to 600 ft Stand-By Zone at any one time

Close Approach Zone

100 ft to 300 ft (30.5 to 191 m) away:

- One vessel limit
- Other vessels stand off (up to two vessels in Stand-By Zone – others outside 600 ft [183 m])
- If more than one vessel is within 600 ft (183 m), the vessel within 300 ft (91.4 m) should limit its time to 15 minutes in close approach to whales

No Intentional Approach within 100 ft (30.5 m)

- Do not approach within 100 ft of whales. If whales approach within 100 ft of your vessel, put engines in neutral and do not re-engage propulsion until whales are observed clear of harm's way from your vessel

Departure Procedure

- All vessels should leave the whales following the same speed and distance procedures described above
- In order for vessels to be clear of whales before dark, vessels should cease whale watching and begin their return to port 15 minutes before sunset

Right Whale Sighting

- All sightings of a right whale should be called in to the NMFS Sighting Advisory System: 978-585-8473 (pager)

Entangled Whale

- Any sighting of an entangled whale should be reported. Vessels should stand-by and keep the whale in sight until help arrives (an estimated 45 minutes or more) or arrange for another vessel to maintain contact with the whale
- Disentanglement HOTLINE (weekdays): 800-900-3622 or Disentanglement pager: 508-307-5300 or NMFS Stranding & Entanglement HOTLINE: 978-281-9351 or USCG on VHF CH-16

Entangled Right Whale

- Maintain 500 yards. To report or get authorization to approach, call: Disentanglement Hotline (weekdays): 800-900-3622 or Disentanglement pager: 508-307-5300 or NMFS Stranding & Entanglement Hotline: 978-281-9351

Dead Whale

- Any sighting of a dead whale should be reported to the NMFS Stranding & Entanglement Hotline: 978-281-9351

Potential Violations

Any activity that appears to be an intentional or negligent action leading to a collision or harassment incident should be reported to the NOAA Enforcement HOTLINE: 800-853-1964.

In addition, vessel operators would follow guidelines implemented for the Gulf of Mexico oil and gas lease industry for vessel strike avoidance (MMS, 2003). These guidelines are summarized below:

- (1) Vessel operators and crews should maintain a vigilant watch for marine mammals and sea turtles and slow down or stop their vessel to avoid striking protected species.
- (2) When whales are sighted, maintain a distance of 295 ft (89.9 m) or greater from the whale.
- (3) When sea turtles or small cetaceans are sighted, attempt to maintain a distance of 148 ft (45.1 m) or greater whenever possible.
- (4) When cetaceans are sighted while a vessel is underway, attempt to remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until the cetacean has left the area.
- (5) Reduce vessel speed to 10 knots (5.1 m/s) or less when pods or large assemblages of cetaceans are observed near an underway vessel. Cetaceans at the surface may indicate the presence of submerged animals near the vessel.
- (6) Whales may surface in unpredictable locations or approach slowly moving vessels. When you sight animals in the vessel's path or in close proximity to a moving vessel, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.

Vessel operators and crew would be required to undergo training to ensure they are familiar with NOAA regional viewing guidelines and MMS guidelines for vessel strike avoidance to minimize encounters and interactions with marine mammals and sea turtles. These training requirements would be written to contractor agreements/contracts. Additional federal mitigation requirements may be added as

well through the federal ESA Section 7 consultation process, the MMPA authorization process for marine mammals, and/or by the MMS through any permits issued.

Measures to Reduce Likelihood of Acoustic Harassment

Mitigation of noise impacts would occur through utilization of the following measures:

Underwater Sound Monitoring

Underwater sound monitoring is proposed by the applicant during the installation of the first three monopiles. The monitoring would be conducted in order to confirm that actual pile driving noise levels do not exceed the levels utilized for conducting the analysis presented.

NMFS Approved Observer

The applicant has proposed to utilize a marine mammal observer to insure that no marine mammals, sea turtles or other protected species are within the 1,640 ft (500 m) safety radius during pile driving. If protected marine species are observed within the 1,640 ft (500 m) Safety Zone by the NMFS approved observer, the observer would ensure that work ceases until the animal is clear of the work area and safety zone.

Soft Start Pile Driving

The applicant has proposed to utilize a “soft-start” of pile driving equipment in order to allow any marine life not visible from the surface to move away from the monopiles.

9.5 SOCIOECONOMICS AND LAND USE MITIGATION

9.5.1 Cultural Resources

The following is a summary of the applicant’s proposed mitigation for potential impacts to Historic/Archaeological Resources:

- All submerged potentially archaeologically sensitive areas identified during marine archaeological investigations have been avoided by redesign of the proposed action, including relocation of eight WTGs and associated cable arrays.
- The interpreted limits of three submerged potential historic resources on the seafloor within the offshore site of the proposed action would be extended by a 100 ft (30 m) perimeter that would constitute a no-activity buffer zone. The no-activity zones would be demarcated on plans provided to contractors and detailed in construction specifications; compliance would be overseen by an environmental inspector.
- In addition, Procedures Guiding the Unanticipated Discovery of Cultural Resources and Human Remains would be provided to construction contractors, outlining measures to be taken in the event that previously unidentified submerged and upland historic/archaeological resources are discovered during construction. Compliance with the procedures, which would be overseen by an environmental inspector, would ensure that potential resources are identified and assessed in accordance with applicable regulations and in consultation with the appropriate agencies.

The consultation process under Section 106 of the NHPA is ongoing and while the applicant has provided these measures, the final determination of adequate mitigation remains pending, until the consultation process is concluded.

9.5.2 Visual

The applicant proposes the following mitigation for impacts to the visual setting of the proposed action area: eliminating daytime lighting and reducing nighttime lighting on the WTGs; and changing the color of the WTGs from white to off-white to reduce contrast with the landscape. Because some of these measures could affect safety of air traffic and vessel traffic, which fall under the jurisdiction of the FAA and USCG, respectively, adoption of these design elements is only preliminary, and would ultimately depend upon approval or a determination of adequacy by the FAA and USCG.

9.6 TRANSPORTATION AND NAVIGATION MITIGATION

9.6.1 Onshore Transportation

The applicant has proposed the following mitigation specific to overland transportation arteries: installation of the onshore cable system would occur outside of the height of the summer tourist season to minimize any vehicular disruption; trenchless technologies would be used at major intersections and railroad crossings in order keep traffic disruptions to a minimum.

The applicant has proposed to develop a Construction Traffic Management Plan to be prepared in consultation with local and state officials to ensure that safe access is maintained for vehicular traffic during onshore cable system installation, once the final route has been determined. This plan would typically include the following mitigation measures:

- Construction zone signage;
- Police officer details to provide traffic control in work zones;
- Areas to maintain ingress to and egress from off-street facilities;
- Temporary pavement marking, barriers or other means, as may be required, to ensure safe traffic flow;
- Notice of construction schedules and locations to minimize local inconvenience;
- Coordination with the Town Department of Public Works for any roadway construction projects to minimize multiple construction periods in the same areas; and
- Maintenance of safe pedestrian flow through construction zones.

9.6.2 Port Facilities

The applicant has proposed mitigation measures specific to navigation including the notification of registered fishermen regarding the timeframe and location of construction activities in advance of mobilization; and daily broadcasted updates providing information on marine channel 16 to provide current information on construction activities as well as information for following days; the lighting of monopoles and construction vessels; and the spacing and placement of monopoles to allow for safe navigation. Since jurisdiction over navigation and port safety as well as rules and regulations for navigation of vessels in U.S. waters lies with the USCG, ultimate decisions about the adequacy of these measures, the ability to implement them, or the requirement for different procedures or design features lies with the USCG, not MMS. MMS is continuing to consult with the USCG as part of the NEPA process, and would incorporate any Terms & Conditions (introduced below) into its lease agreement with the applicant.

Other mitigation proposed with respect to navigation is as follows:

- The applicant would have its work vessels that are working in the area assist vessels in distress within the proposed action area upon receiving a request for assistance from the vessel or the USCG.
- The applicant would work with the USCG to develop information that could be provided to mariners to educate them regarding the potential effects of the WTGs on marine radar.

USCG Terms and Conditions (see [Appendix E](#))

The USCG has provided Terms and Conditions requiring that the design and construction of the proposed action shall not impede navigation and that the applicant shall ensure that maritime navigation safety is maintained. The Terms and Conditions require the WTGs and ESP to be marked with private aids to navigation such as clearly visible, unique, alpha-numeric identification characters, in accordance with guidelines set by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA); and safety lines, mooring attachments and access ladders must be placed on each WTG and a plan for placement and design must be approved by the USCG. The Terms and Conditions also require the applicant to submit a research analysis before the start of construction, concerning whether or not the WTGs as designed would interfere with marine communication or navigation systems or produce any adverse impacts to navigational safety. In addition, the applicant is required under the Terms and Conditions to provide status reports to the USCG monthly throughout the construction activities, including information regarding the current status, any changes to the construction schedule, a description of any complaints received during construction, and copies of any correspondence between the applicant and federal, state, and local agencies. The full Terms and Conditions are provided in [Appendix E](#).

9.6.3 Communications: Electromagnetic Fields, Signals and Beacons

The applicant proposes the following mitigation to minimize impacts to communications: construction crews would be required to avoid the frequencies listed in [Table 5.3.4-1](#). VHF radios used for construction should be tested for output to ensure that they are not inadvertently tuned to any of these frequencies, and to ensure that they have no spurious emission within +/-50 KHz.

As a precaution, watercraft would be advised by the applicant or its contractors to respect a two-wavelength distance from the cranes at the lowest frequency of interest, which would be approximately 4,000 ft (1,219.5 m) on 500 KHz.

9.7 STATE MITIGATION

In addition to the mitigation discussed above, the applicant has committed to mitigation as part of the MEPA process to address concerns of regulatory agencies and to minimize impacts on the environment. This mitigation is included in the MEPA FEIR Certificate (Refer to the Certificate on the Final EIR in [Appendix E](#)) but the commitments are presented below using the language of the FEIR Certificate (as denoted by the italicized text). This State mitigation is independent of any MMS mitigation proposed or to be proposed.

9.7.1 MEPA FEIR Certificate Compensatory Mitigation

The proponent has voluntarily offered compensatory mitigation as part of the MEPA process. Details are presented below.

9.7.1.1 Bird Island

The proponent would provide \$780,000 towards the restoration of Bird Island, off the town of Marion in Buzzards Bay, with funds to be managed by the Department of Fish and Game, Natural Heritage and Endangered Species Program.

At 1.5 acres in size, Bird Island supports an average of 750 pairs of Roseate Terns, and is the second or third largest Roseate Tern colony in North America, supporting an average of 22 percent of the North American population. It is also the third largest Common Tern colony in Massachusetts, and supports an average of 1,900 pairs of Common Terns. Bird Island is conservation land owned by the Town of Marion and managed by the Harbormaster and Conservation Commission.

While Bird Island provides prime nesting habitat, the island is subject to significant and accelerating erosion. As a result, former Common Tern nesting areas adjacent to the seawall have turned into salt marsh, which is unsuitable for nesting. Common Terns have moved into interior nesting areas, forcing Roseate Terns out. The objective of the local, state, and federal partnership that is managing the restoration is to restore tern nesting habitat and protect the historic lighthouse by rebuilding the revetment to reduce erosion, fill eroded areas, and revegetate appropriate areas to provide suitable nesting habitat. Based on consultation with the Natural Heritage and Endangered Species Program, the enhancement of tern nesting habitat on Bird Island would directly benefit the same tern population that is subject to potential impacts from the WTG array. The project has a total cost of \$3.775 million, the balance of which would be borne by the US Army Corps of Engineers, who is also providing planning, design, and construction services. If the proposed restoration project does not go forward, for whatever reason, the proponent shall coordinate with EOE and state agencies and develop an alternative vehicle of equal value for mitigating avian impacts.

9.7.1.2 Natural Resource Preservation, Marine Habitat Restoration, and Coastal Recreation Enhancement Projects

The proponent would provide \$4.22 million in annual payments prorated over the life of the project towards natural resource preservation, marine habitat restoration, and coastal recreation enhancement projects in the area of Cape Cod, Nantucket, and Martha's Vineyard, with funds to be managed by the Coastal Zone Management Office, in consultation with state agencies and the Cape Cod Commission.

9.7.2 Other Environmental Mitigation Proposed Under the MEPA FEIR Certificate

Other mitigation the applicant would be committed to under the MEPA FEIR certificate is as follows:

Air Quality

- The power produced would reduce demand on fossil-fuel fired facilities and reduce air emissions from these facilities. The project would also reduce the need to construct additional fossil fuel-fired electric generation facilities as energy demand increases, facilitating the Commonwealth's and the region's air quality goals.

Avian

- The proponent has committed to working with MMS to design and implement postconstruction monitoring which would be guided by an EMS currently under

development as required by MMS. The EMS would be subject to adaptive management as the results of the monitoring are evaluated. The EMS would include the involvement of a technical advisory group.

Marine Resources

- Vessels transporting construction materials to the project site in Nantucket Sound would travel at slow speeds, usually at 10 knots or below.
- Potential vessel impacts (collisions and harassment) to marine mammals and sea turtles would be minimized by requiring that project vessels follow National Oceanic & Atmospheric Administration (NOAA) Fisheries Regional Viewing Guidelines - Northeast Region (NMFS and NOS, 2006) while in transit to and from the site so as not to disturb any individuals that may be in the area.
- The use of state-of-the-art hydraulic jet plow technology for cable installation to minimize sediment transport and suspended sediments.
- The use of monopile foundations for the WTGs.
- Implementing post-construction monitoring to document habitat disturbance and recovery.
- Potential impacts to marine mammals and sea turtles associated with underwater sound levels created by pile driving would be minimized by conducting a "soft-start" to each piling event.
- Underwater sound monitoring would be performed during initial monopile construction (the first three monopiles).
- A NMFS approved observer would be posted on-site during all pile driving activities to monitor the area during construction. If protected marine species are observed within the 500 m (1,640 ft) Safety Zone by the NMFS approved observer, the observer would ensure that work would cease until the animal is clear of the work area and safety zone.

Fisheries

- Utilization of a state-of-the-art hydraulic jet plow for cable installation, monopile foundations for WTG towers, HDD installation at the nearshore area, and post-construction monitoring to document habitat disturbance and recovery.
- The pile driving hammer and jet plow technology that would be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum.
- The proponent has agreed to work with commercial/recreational fishing agencies and interests to ensure that the construction and operation of the project would minimize potential impacts to commercial and recreational fishing interests.
- Measures proposed to minimize or avoid potential impacts to the commercial fishing industry include: no restrictions on fishing activities within the site; marking the WTGs with USCG-approved lighting to ensure safe vessel operation; and burying the inner-array cables and two submarine cable circuits to a minimum of 6 ft (1.8 m) below the seabed to avoid the potential for conflicts with fishing vessels and gear operation.

- Notification of fishermen well in advance of mobilization as to the location and timeframe of project construction activities, as well as a daily broadcast on VHS marine channel 16 as to the construction activities for that and upcoming days.
- Cable burial depth would be inspected periodically during project operation to ensure adequate coverage is maintained so as not to interfere with fishing gear/activity or with the safe operation of the cable.
- To protect sensitive fish species such as winter flounder, the proponent has committed to avoid in-water construction in Lewis Bay between January 1 and May 1 of any year. No submarine installation or cofferdam/HDD installation would occur during this timeframe.

Benthic and Shellfish

- Utilizing state-of-the-art hydraulic jet plow for cable installation in order to minimize seabed disturbance and sediment dispersion during cable embedment.
- Utilizing monopile foundations for WTG towers which minimize the seabed footprint and sediment disturbance while also minimizing opportunities for benthic organism colonization or fish habitat creation.
- Post construction monitoring to document habitat disturbance and recovery.
- The use of mid-line buoys on anchor lines in order to minimize the impacts from anchor line sweep.
- The duration and sequencing of construction has been designed to minimize the period of disturbance.
- Impacts to benthos and benthic habitat in Lewis Bay within 200 ft (61 m) of shore would be minimized by using HDD methodology to transition the submarine cable system to the shore.
- The proponent has committed to working with the Town Shellfish Constable to appropriately avoid or minimize impacts to designated shellfish areas from installation of the submarine cable. The proponent would provide the Town of Yarmouth with funds to mitigate for the direct area of impact within the Town's designated recreational shellfish bed in accordance with the Town's mitigation policies.

Aquatic Vegetation

- The proponent would not anchor vessels or perform cable installation work in the area near Egg Island where eelgrass beds are located.
- A dive survey would be conducted to confirm the limits of the eelgrass bed near Egg Island (verifying the limits of submerged aquatic vegetation [SAV] previously surveyed in July 2003) prior to the commencement of cable installation in the same calendar year preceding construction, and divers would also be used to confirm correct placement of work vessel anchors.
- If during installation of the submarine cable the eelgrass beds are disturbed, the proponent has committed to replanting eelgrass.

- Pre and post-construction monitoring of the eelgrass bed would be performed and if it is determined that eelgrass has been lost as a result of project activities, replanting would occur.
- The proponent has committed to aerially photograph the entrance to Lewis Bay in the month of July immediately prior to jet-plowing, under conditions conducive to documenting the extent of eelgrass beds, to use the photographs in finalizing the exact location of jet-plowing, and to provide such photographs to the Energy Facilities Siting Board.
- The proponent would denote the edge of the eelgrass bed at the water surface with buoys near Egg Island. In addition, the proponent would implement a No Wake Zone for its construction vessels at a distance of 200 ft (61 m) from the edge of the eelgrass bed.
- An eelgrass survey will be performed for the two consecutive years following construction to document the change in density which would be coordinated with the appropriate state and federal agencies.

Visual

- The proponent has removed daytime FAA lighting on the WTGs, formerly proposed in the DEIR.
- Potential nighttime visual impacts have been lessened by the reduction in FAA nighttime lighting (from the originally proposed 260 lights down to 57).
- Revisions to the layout have narrowed the breadth of the visual impact as seen from certain areas around the Sound.
- The WTGs would be an off-white color, to reduce contrast with the sea and sky.
- The upland transmission route would be located entirely below ground within paved roads and existing utility ROWs to avoid visual impacts and impacts to potential unidentified archaeological resources.
- If MMS determines there would be an adverse effect (due to visual impacts) MMS would direct a formal consultation process under the requirements of the NHPA, to develop measures to help mitigate these impacts on historic properties.
- The proponent and MMS would continue to consult with MHC, the Wampanoag Tribe of Gay Head Aquinnah (WTGHA) and other consulting parties to address and resolve issues concerning potential visual effects of the project on historic properties.

Historical/Archaeological

- All submerged potentially archaeologically sensitive areas identified during marine archaeological investigations have been avoided, including relocation of eight WTGs and associated cable arrays.
- The interpreted limits of three submerged potential historic resources on the seafloor within the site would be extended by a 100 ft (30.5 m) perimeter that would constitute a no-activity buffer zone. Compliance would be overseen by an environmental inspector.
- In addition, Procedures Guiding the Unanticipated Discovery of Cultural Resources and Human Remains would be provided to construction contractors, outlining

measures to be taken in the event that previously unidentified submerged and upland historic/archaeological resources are discovered during Project construction. Compliance with the procedures would be overseen by an environmental inspector.

- The proponent has reduced lighting on the WTGs and revised the layout such that the breadth of visual impact of the array as seen from certain areas is reduced. If the MMS determines that the offshore above water components of the project would result in adverse effects to certain onshore aboveground historic properties due to visual impacts, then the MMS would direct a formal consultation process under the National Historic Preservation Act (NHPA) to develop mitigation measures that would be detailed in a Programmatic Agreement.

Noise

- The proponent has selected state-of-the-art, very low noise wind turbines.
- Construction noise impacts would be temporary, unavoidable, and are primarily associated with the laying of the Onshore Transmission Line from the transition vault at the shore of Lewis Bay along existing roadways to the Barnstable Switching Station using standard roadway construction equipment. Noise mitigation for this onshore activity would consist of scheduling activities during normal working hours and ensuring that all equipment has properly functioning noise mufflers.
- Onshore construction activities (which include the HDD at the landfall), would be temporary, lasting 4 to 6 weeks, and would be audible to persons near the cable corridor. Sound levels would be similar to roadway construction equipment. Noise barrier walls would be constructed at the edge of the HDD pit to shield nearby residences at 32 and 49 New Hampshire Avenue.

Land Alteration

- Scour mats and or rock armoring (rip-rap) would be placed at the foundation of each WTG and each support pile of the ESP to minimize sediment scour.
- The use of state-of-the-art hydraulic jet plow for offshore cable embedment that minimizes sediment disturbance.
- Restoration of the dredged cofferdam area using originally dredged material supplemented with imported clean sandy backfill material if necessary to restore preconstruction contours.

Wetlands/Drainage

- The proposed submarine and onshore transmission cable route would be designed to fully comply with all applicable local, state and federal wetland performance standards.
- Direct wetland impacts would be minimized through the use of hydraulic jet plowing, HDD, and installation of the upland transmission line within existing paved roadways or disturbed electric ROWs.
- The proponent has committed to coordinate with the Yarmouth and Barnstable Conservation Commissions, the DEP, and Natural Heritage Endangered Species Program (NHESP) to prevent impacts to state-listed species as part of the project.

- The project would use best management practices for sedimentation and erosion control and stormwater management.
- A pre-construction survey would be performed to document the occurrence of state-listed rare species along the NSTAR Electric ROW route. If a state-listed species is located within the proposed transmission line route, a Conservation Permit under Massachusetts Endangered Species Act (MESA) would be obtained and efforts would be made to eliminate, minimize, or mitigate for any potential impacts.
- Post-construction monitoring would document habitat disturbance and recovery.
- The upland transmission line system has been sited below grade within existing roadways and maintained ROW.
- Sediment and erosion controls would be installed prior to construction, and would be inspected and maintained throughout the construction activities.
- A Dewatering Plan would be prepared to address the procedures for handling of any water encountered during excavation.
- The transmission line would not contain any fluids, petroleums, oils, or lubricants.
- The project would not result in any direct discharge of untreated stormwater into wetlands and waterbodies. Once installed, the paved areas would be restored to preconstruction conditions and the NSTAR Electric ROW would be restored to pre-construction contours and revegetated using a suitable upland seed mixture. The existing stormwater collections and management systems for these roadways would remain intact.

Water Quality

- An Oil Spill Response Plan (OSRP), a Stormwater Pollution Prevention Plan (SWPPP), and an Operation & Maintenance (O&M) Plan would be implemented during project construction/decommissioning and operation to prevent potential impacts to water quality from spills and erosion/sedimentation.
- The proponent would work with the Yarmouth Shellfish Constable to mitigate for any short-term impacts to shellfish productivity and would provide the Town with funds to mitigate for the direct area of impact.
- To minimize the release of bentonite drilling fluid into Lewis Bay during HDD, freshwater would be used as a drilling fluid to the extent practicable prior to the drill bit or the reamer emerging in the pre-excavation pit.
- Scour protection, in the form of scour control mats and/or rock armor, would be installed around monopiles and ESP piles in order to prevent scouring.

Construction

- Use of state-of-the-art low-impact hydraulic jet plow installation for the marine cables.
- Use of HDD cable installation techniques at the landfall to avoid impacts to the intertidal zone and shoreline in Lewis Bay.
- A temporary cofferdam would be used during construction to minimize sediment resuspension at the interface between the HDD conduit and submarine cable system.

- Use of hollow monopile foundations for WTG towers.
- Installation of scour protection mats and/or rock armor to reduce scour potential near the WTGs.
- Post-construction monitoring including regular visual inspection of inner array cable routes in areas of migrating sand waves, to ensure the cables remain properly buried.

Navigation and Transportation

- Direct communication would be established between Air Station Cape Cod Search and Rescue (SAR) personnel and the proponent's operation center (manned 24/7) in order to facilitate rapid remote WTG shut down, at the request of the USCG, in the event of bad weather SAR by air.
- The proponent would implement procedures outlined by the USCG to deconflict the areas around ongoing construction activities.
- The proponent has designed the WTG monopiles to withstand the forces of up to six (6) inch (15 cm) thick ice floes impacting the monopile.
- The proponent has committed to initiate manual shutdown of WTG(s) experiencing icing conditions if conditions warrant such a shutdown.
- The proponent would use either Seabed Scour Control Mats or rock armor for scour protection to limit changes to bottom contours in the vicinity of the WTGs.
- The proponent would provide private aids-to-navigation (ATONs) (lights and sound signals) within the site to assist mariners.
- The proponent would mark each WTG with its alphanumeric designation to serve as a point of reference for mariners.
- The proponent would provide the USCG; other local, state, and federal agencies and commercial sailors with a plan showing the designations of each WTG.
- The proponent has committed to continue coordinating with the USCG and NOAA regarding inclusion of the project site on NOAA nautical charts covering the area.
- The proponent has committed to immediately shutting down all or a portion of the WTGs upon notification from the USCG that SAR aircraft have been ordered to respond to an incident within or immediately adjacent to the project site.
- The proponent would work with the USCG to develop information that could be used to provide mariners to educate them regarding the potential effects of the WTGs on marine radar.
- The submarine cable system would be buried 6 ft below the present sea bottom. Installation of the upland cable system will occur outside of the height of the summer tourist season to minimize any vehicular disruption.
- Trenchless technologies would be used at major intersections and railroad crossings in order keep traffic disruptions to a minimum.
- Impacts to land-based transportation would be limited and temporary in nature. A Construction Traffic Management Plan would be prepared in consultation with local and state officials to ensure that safe access is maintained for vehicular traffic during onshore cable system installation, once the final route has been determined.

Telecommunication

- The potential does exist for interference to vessel mounted radar operating within or in close proximity to the proposed project site. The proponent would work with the USCG to develop information and training opportunities that could be provided to local mariners in order to raise awareness if interference does occur.

9.7.3 Mitigation Required Under the Massachusetts Energy Facility Siting Board Decision

In addition, at the conclusion of the Massachusetts Energy Facility Siting Board proceedings, the applicant was required to provide mitigation measures relative to the electric transmission cable. MMS is not requiring this mitigation at this time, but has provided it to show other measures that the applicant must implement in order to minimize or mitigate impacts on the environment as a result of the state review and permitting process completed to date.

As presented in the EFSB Final Decision, the applicant has agreed to the following measures to protect vegetation:

- The applicant would not anchor vessels or perform cable installation work in the area near Egg Island where eelgrass beds are located.
- A dive survey would be conducted to confirm the limits of the eelgrass bed near Egg Island (verifying the limits of SAV previously surveyed in July 2003) prior to the commencement of cable installation in the same calendar year preceding construction, and divers would also be used to confirm correct placement of work vessel anchors.
- If during installation of the submarine cable the eelgrass beds are disturbed, the applicant has committed to replanting eelgrass.
- The applicant has committed to aerially photograph the entrance to Lewis Bay in the month of July immediately prior to jet-plowing, under conditions conducive to documenting the extent of eelgrass beds, to use the photographs in finalizing the exact location of jet-plowing, and to provide such photographs to the EFSB.

The applicant is committed to the minimization and/or mitigation that was presented in the draft EIR and EFSB record and has since committed to the following additional items.

- The applicant would denote the edge of the eelgrass bed at the water surface with buoys near Egg Island. In addition, the applicant would implement a No Wake Zone for its construction vessels at a distance of 200 ft (61 m) from the edge of the eelgrass bed.
- The scope of work to perform the dive survey at the eelgrass bed within Lewis Bay would be coordinated with the appropriate state and Federal agencies.
- Development of a BACI Plan for Eelgrass
- Pre and post-construction monitoring of the eelgrass bed would be performed; if it is determined that eelgrass has been lost as a result of project activities, replanting would occur. The post-construction monitoring plan would be developed to document potential indirect impacts from cable embedment and subsequent habitat recovery. Habitat recovery would be considered successful, if it is found that SAV

has migrated back to the site of disturbance. Should the habitat not recover naturally, the disturbance would be mitigated by replanting.

An eelgrass survey would be performed, in the same timeframe as the pre-construction surveys, for the 2 consecutive years following construction to document the change in density.

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11.0 LIST OF PREPARERS

NAME	CONTRIBUTION
<u>MMS</u>	
Ahlfeld, Dr. Thomas	Oceanography
Boatman, Dr. Mary C.	Chemical Oceanography
Bornholdt, Maureen	Reviewer
Cluck, Dr. Rodney	Project Manager
Coffman, Kim F.	Regional Economics
Downes, David R.	Reviewer
Herkhof, Dirk C.	Meteorology & Air Quality
Hill, Maurice	NEPA compliance
Johnson, Dr. Walter	Physical Oceanography, Oil Spill Trajectory Analysis
Klingon, Richard	Geophysical
Lewandowski, Jill	T&E, Avian, Marine Mammals
Mense, Robert S.D.	Alternatives, economic analysis
Morin, Michelle V.	NEPA compliance
Obiol, Barry	NEPA Coordinator/ QA
Price, Dr. James Michael	Oceanography
Rouse, R. Mark	Oceanography
Schmidbauer, Gabriel	Cartographer
Scholten, Terry	CZMA and Meteorology
Smith, Charles	Geotechnical
Stright, Dr. Melanie J.	Federal Preservation Officer/Archaeologist
Valdes, Dr. Sally J.	Fisheries, EFH Assessment
Woodworth, Thomas C.	Reviewer

NAME	CONTRIBUTION
<u>TRC</u>	
Agresti, Anthony	Noise
Berg, Lauren	Project Description, Recreation; Impact-producing factors, Competing Uses, Mitigation, and Cumulative Impacts
Brandt, Jeff	Deputy Project Manager; Socio-economics, Visual resources, Cumulative Impacts, Alternatives
Cormier, Kenneth	Geology and Sediments
de la Flor, Laura	Alternatives
Estey, Dave	EMF and Transmission Interconnection
Fleischauer, Pat	Economics, Cost Benefit Analysis
Lenseth, Elizabeth	Marine Mammals and Threatened and Endangered Species
Martin, Paul	Project Manager; Impact-producing Factors, Environmental Management System, Biological Resources, Irretrievable and Irreversible Commitment of Resources, Threatened and Endangered Species
Mills, Margaret	Benthos, Fisheries, and EFH
Smith, Matt	Wildlife, Vegetation
Snyder, Jay	Air and Climate
Sparks, Sean	Oceanography and Water Quality
<u>Evans Associates</u>	
Evans, Ralph	Communications
<u>KSEAS</u>	
Kichner, JJ	Navigation
<u>Stantec (formerly Woodlot Alternatives)</u>	
Annand, Elizabeth	Avian Resources, T&E Birds
Costa, Jess	Avian Resources, T&E Birds
Lortie, John	Avian Resources, T&E Birds

12.0 GLOSSARY

Acoustic backscatter device: Instrument that uses sound waves to collect measurement data to generate images (e.g., of the seafloor).

Airgun: A device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.

Air quality: Assessment of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed levels of substances in the outside air that cannot be exceeded during a specific time in a specified area.

Alternating current (AC): A flow of electrical current that increases to a maximum in one direction, decreases to zero, and then reverses direction and reaches maximum in the other direction. The cycle is repeated continuously. The number of such cycles per second is equal to the frequency, measured in Hertz (Hz). U.S. commercial power is 60 Hz.

Alternative energy: For the purposes of this EIS, alternative energy is defined as energy derived on the OCS from other than what are generally considered conventional sources of energy (e.g., nuclear, fossil fuels). Possible sources include wind, solar, biomass, wave, ocean current, hydrogen, and tidal energy. The term is often used interchangeably with *renewable energy*.

Ambient noise level: Environmental background noise composed of contributions from various sources at both near and far distances.

Ambient ocean noise: The sound profile within the ocean composed of both far and near sound sources of both natural and anthropogenic origin. Ambient ocean noise is also referred to as *environmental background noise*.

Amplitude: The maximum absolute value of a periodic curve measured along its vertical axis. For sound waves, it is the maximum amount that the wave's pressure differs from ambient pressure in the medium through which the sound wave is propagating.

Anadromous: Pertaining to fish that spawn in freshwater after spending most of their lives in saltwater.

Anthropogenic: Human made; produced as a result of human activities.

Anticline: A fold in layers of rock caused by deformation. The older strata are found toward the center of the fold.

Anticyclone: Clockwise-rotating eddies in oceans of the northern hemisphere. Anticyclones generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf.

Aquaculture: Farming of organisms, such as fish, shellfish, and algae that live in water.

Areas of Special Concern: Areas managed by the Bureau of Land Management (BLM) and defined by the Federal Land Policy and Management Act of 1976 as having significant historical, cultural, and scenic values; habitat for fish and wildlife; and other public land resources, as identified through the BLM's land-use planning process.

Array: The layout or arrangement of objects in a specific pattern, often in rows and columns.

Attenuation: Reduction; in this document, reduction of the level or intensity of sound.

Attenuator: Wave energy conversion device with a long, multisegment floating structure oriented parallel to the direction of the waves. The differing heights of waves along the length of the device causes flexing where the segments connect, and this flexing is connected to hydraulic pumps or other converters.

Bathymetry: Topography of the ocean floor indicated by depth contours drawn at regular intervals.

Bathypelagic: Pertaining to the subzone of the pelagic zone that generally includes waters deeper than 1,000 m (3,300 ft). At this depth, there is little to no light, and photosynthesis is not possible. Consequently, there are no living plants, and most animals survive by consuming detritus falling from the pelagic zones above or by preying on other animals.

Benthic: Of, relating to, or occurring at the bottom of a body of water.

Biota: The combined flora and fauna of a region.

Bureau of Land Management (BLM): An agency of the U.S. Department of the Interior responsible for managing public lands.

Bycatch: Nontarget organisms caught in fishing or other harvest operations and usually discarded.

Candidate species: Plants and animals for which the U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but for which development of a listing regulation is precluded by other higher-priority listing activities.

Capacity factor: The actual energy output of an electricity-generating device divided by the energy output that would be produced if it operated at its rated power output for the entire year.

Cape (spit): A type of sand bar or beach that is built out from the shore by deposition of sediment (typically sand) carried in the longshore current; these landforms have a characteristic “hook” shape when viewed from above (e.g., Cape Cod).

Carbon monoxide (CO): A colorless, odorless gas formed when carbon in fuel is not burned completely. Motor vehicle exhaust is a major contributor to nationwide CO emissions, followed by nonroad engines and vehicles. CO interferes with the blood’s ability to carry oxygen to the body’s tissues and results in numerous adverse health effects. CO is listed as a criteria air pollutant under Title I of the Clean Air Act.

Catadromous: Term used to describe fishes that spend most of their adult lives in freshwater but migrate to the marine environment to spawn.

Cavitation: The sudden formation and subsequent collapse of low-pressure bubbles of air in fluids that are moving as a result of applied mechanical forces. The phenomenon of cavitation is the single largest contributor to underwater sound from ship propellers.

Cetacean: Any of various aquatic, chiefly marine mammals of the order Cetacea, including the whales, dolphins, and porpoises, which are characterized by a nearly hairless body, anterior limbs modified into broad flippers, vestigial posterior limbs, and a flat notched tail.

Clastic: Sediments composed of pieces of pre-existing rock.

Clathrate: Layer of frozen gas hydrate on the seafloor.

Clean Air Act (CAA): An act that establishes National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: sulfur oxides (SO_x), nitrogen dioxide (NO₂), carbon monoxide (CO), ozone (O₃), particulate matter (PM₁₀ and PM_{2.5}), and lead (Pb). Collectively, the criteria pollutants are indicative of the quality of the ambient air. The Act requires facilities to comply with emission limits or reduction limits stipulated in State Implementation Plans (SIPs). Under this Act, construction and operating permits, as well as reviews of new stationary sources and major modifications to existing sources, are required. The Act also prohibits the Federal Government from approving actions that do not conform to SIPs.

Clean Water Act (CWA): An act that requires National Pollutant Discharge Elimination System permits for discharges of effluents to surface waters, permits for stormwater discharges related to industrial activity, and notification of oil discharges to navigable waters of the United States.

Coastal: An imprecise area of land and water located at the interface between the shore and the ocean, where physical, chemical, and biological processes occur as interactions between these two ecosystems or because of their proximity to each other.

Coastal State: A State bordering the Atlantic or Pacific Oceans, or the Gulf of Mexico.

Coastal Zone Management Act (CZMA): 16 USC 1451 et seq. The CZMA regulates development in coastal areas to protect their unique resources.

Coastal Zone Management Act Consistency Determination: A finding that an activity that affects land or water uses or natural resources in a State's coastal zone is in compliance with that State's Federally approved Coastal Zone Management Act Program. Federal Agencies must be consistent to the maximum extent practicable.

Code of Federal Regulations (CFR): A compilation of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the United States. Each volume of the CFR is updated once each calendar year and is issued quarterly.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): The Federal law that guides cleanup of hazardous waste sites. Also known as Superfund.

Continental margin: A collective term referring to the continental shelf and continental slope.

Continental rise: A broad, gently dipping depositional plain that extends from the base of the continental slope from a depth of about 2,000 m (6,600 ft) to more than 5,000 (16,400 ft).

Continental shelf: The shallow, gradually sloping seabed around a continental margin, usually no deeper than 200 m (660 ft) and formed by the submergence of part of a continent.

Continental slope: Region of the outer edge of a continent between the generally shallow continental shelf and the deep ocean floor, usually demarcated by the 200-m (660-ft) isobath (the line on a map or chart that connects all points having the same depth below the surface of a body of water).

Criteria air pollutant: A group of very common air pollutants whose presence in the environment is regulated by the U.S. Environmental Protection Agency (EPA) on the basis of certain criteria (information on health and/or environmental effects of pollution). Criteria air pollutants are widely distributed all over the United States.

Critical habitat: The specific area within the geographical area occupied by a species at the time it is listed as an endangered or threatened species. The area in which physical or biological features essential to the conservation of the species is found. These areas may require special management or protection.

Cumulative impacts: In an environmental impact statement, cumulative impacts are impacts that result from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal), private industry, or individual undertakes these actions. They are impacts that can result from individually minor but collectively significant actions over a period of time.

Decibel (dB): A standard unit for the measure of the relative loudness or intensity of sound. The relative intensity is the ratio of the intensity of a sound wave to a reference intensity. In general, a sound doubles in loudness with every increase of 10 dB. By convention, the intensity level of sound at the threshold of hearing for a young healthy individual is 0 dB.

Decibel A-weighted: A sound measurement scale biased toward sounds with frequencies within the average auditory range of humans.

Decibel B-weighted: A sound measurement scale biased toward loud high and middle frequency sound.

Decibel C-weighted: A sound measurement scale biased toward very loud frequency sound.

Decibel D-weighted: A sound measurement scale biased toward very loud sounds particularly associated with aircraft.

Decommissioning: The activities necessary to take out of service and dispose of a facility after its useful life.

Delta: An area formed from the deposition of sediments at the mouth of a river.

Demersal fishes: Those fishes that spend at least the adult portion of their life cycle in association with the ocean bottom.

Dendritic drowned river valleys: River valleys, currently under water, that have a multibranching, tree-like form when viewed from above (e.g., Chesapeake Bay).

Depauperate fauna: A fauna, especially common on islands, lacking many species found in similar habitats elsewhere.

Deposition: The laying down of matter by a natural process (e.g., the settling of particulate matter out of air or water onto soil or sediment surfaces).

Detritus: Dead, decaying plant material.

Dewater: To remove or drain water from an area.

Diadromous fishes: Those fishes that spend a portion of their life cycle in freshwater and a portion in saltwater.

Diapir: Intrusion of fluid rock (e.g., molten rock, salt, or mud) caused by the difference in buoyancy and pressure between it and the overlying rock.

Direct current (DC): Electric current that flows in one direction only.

Dissolved oxygen concentration: The concentration of oxygen in a water sample.

Distinct Population Segment (DPS): “Population” or “distinct population segment” are terms with specific meaning under the Endangered Species Act when used for listing, delisting, and reclassification purposes to describe a discrete vertebrate stock that may be added or deleted from the list of threatened and endangered species.

Diurnal: Having a daily cycle or occurring every day.

Domestic: Produced in or indigenous to a particular country.

Earthquake: A sudden ground motion or vibration produced by a rapid release of stored energy; may occur on land or on the seafloor (submarine).

Easement: Authorization for the use, for a specified purpose, of land that is not owned by the user. For the OCS, a right of use and easement usually refer to the authorization by the Minerals Management Service (MMS) to an operator for the construction and maintenance of a structure or structures on OCS lands not subject to a lease granted to the operator.

Echolocation: The use of reflected sound waves by some animals to gather critical information such as the location of obstructions, predators, or food, or for purposes of reproduction.

Ecoregion: A geographically distinct area of land that is characterized by a distinctive climate, ecological features, and plant and animal communities.

Ecosystem: A group of organisms and their physical environment interacting as an ecological unit.

Eolian sediments: Sediments or structures (sand dunes) deposited by wind.

Electromagnetic field (EMF): The field of energy resulting from the movement of alternating electric current (AC) along the path of a conductor, composed of both electrical and magnetic components and existing in the immediate vicinity of, and surrounding, the electric conductor. Electromagnetic fields exist in both high-voltage electric transmission power lines and in low-voltage electric conductors in homes and appliances.

Embayment: A small bay or any small semi-enclosed coastal water body in which the opening to a larger body of water is restricted.

Endangered Species Act of 1973 (ESA): An act that requires consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service to determine if endangered or threatened

species or their habitats would be affected by a proposed activity and what, if any, mitigation measures are needed to address the impacts.

Endangered species: Any species, plant or animal, that is in danger of extinction throughout all or a significant part of its range. Requirements for declaring a species endangered are found in the Endangered Species Act.

En-echelon fold: The steplike configuration of folded rock units at the continental margin formed by compressional tectonic forces.

Energy Policy Act of 2005: A bill passed in August 2005 that includes new authority (Section 388) for the MMS to regulate alternative energy resources on the Outer Continental Shelf.

Energy: The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy) or heat.

Environmental Impact Statement (EIS): A document required of Federal agencies by the National Environmental Policy Act for major proposals or legislation that would or could significantly affect the environment.

Environmental Justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Epibenthic: Living on the bottom surface of lakes or the ocean.

Epifaunal: A community of marine organisms that live attached to hard substrates or move around and live on hard substrates

Epipelagic: Pertaining to a subzone of the pelagic zone where there is enough light for photosynthesis. Generally includes waters from the surface to approximately 200 m (660 ft) in depth.

Essential Fish Habitat (EFH): Waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. The term is specifically associated with the Magnuson-Stevens Fishery Conservation and Management Act.

Estuary: A transitional zone along the coastline where ocean saltwater mixes with freshwater from the land. Two prominent estuaries in the mid-Atlantic region are the Chesapeake and Delaware Bays.

Eutrophication: A condition in an aquatic ecosystem where high nutrient concentrations stimulate blooms of algae (e.g., phytoplankton). Algal decomposition may lower dissolved oxygen concentrations. Although eutrophication is a natural process in the aging of lakes and some estuaries, it can be accelerated by both point and nonpoint sources of nutrients.

Evaporite: A sedimentary rock formed when a saline solution evaporates. Evaporites are typically formed when a saline lake dries up or evaporation occurs in tidal marshes in hot, arid climates.

Executive Order 12898: An executive order, signed in 1994, establishing environmental justice as a Federal Government priority and directing all Federal agencies to make environmental justice part of their mission. Environmental justice calls for fair distribution of environmental hazards.

Executive Order 13158: An executive order, signed in 2000, establishing the National Marine Protected Areas Initiative.

Extralimital: Known on the basis of only a few records that probably resulted from unusual wanderings of animals into the region.

Fault: A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Fluvial: Pertaining to rivers. Fluvial sediments are deposited by rivers.

Fouling: A generic term for the invertebrate community that grows attached to hard substrates, including such organisms as sponges, tunicates, hydroids, bryozoans, serpulid worms, etc.

Frequency (pitch): For sound waves, frequency is the rate at which the source-producing sound wave is vibrating or the rate at which the sound-producing body completes one vibration cycle. Frequency is expressed in units of Hertz (Hz), where one Hz is equal to one complete vibration cycle per second.

Gas hydrates: Gas molecules (e.g., methane) trapped in water-ice "cages" in subsea deposits.

Gauss: Unit of magnetic induction; pronounced "gows," abbreviated "G."

Geology: The study of the materials, processes, environments, and history of the earth, including rocks and their formation and structure.

Gulf Stream: The powerful, warm, and swift Atlantic Ocean current that is the western boundary current of the North Atlantic subtropical gyre (the clockwise circulation pattern produced by the earth's rotation). After passing Cape Hatteras, the Gulf Stream flows northeast toward Europe.

Habitat: The place where a plant or animal lives.

Haulout: An area where marine mammals such as seals regularly come out of the water to rest. These typically occur on beaches, offshore rocks, and islands. In urban areas, structures such as docks may be used. Once established, haulouts may be used on a seasonal or year-round basis by up to several thousand individuals, depending on the species.

Hazardous materials: Materials, including nonwaste substances, that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare or the environment if they are improperly managed or released into the environment. Such materials may be transported to and from, stored at, and/or used at alternative energy and alternate use project sites approved on the OCS.

Hummock-and-hollow microtopography: A feature of tidal swamp habitats where areas above the highest tide level provide stable substrates for the establishment of trees and microhabitats for forest herbs adapted to moderately moist environments.

Hydrocarbon: Any compound or mix of compounds—solid, liquid, or gas—composed of carbon and hydrogen (e.g., coal, crude oil, and natural gas).

Hypoxia: The condition of having low dissolved oxygen concentration; in water, it is caused by excessive nutrients and other oxygen-demanding contaminants.

Infrasound: Low-frequency sound, including frequencies below the lower limit of human auditory response; by convention, sound with frequencies of less than 16 Hz.

Intensity: For sound, intensity is the measure of the amount of energy that is transported over a given area per unit of time. Sound intensity is expressed in units of W/m^2 .

Intertidal zone: The area of the foreshore and seabed that is exposed at low tide and submerged at high tide (i.e., the area between tide marks).

Invertebrate: An organism lacking a backbone or spinal column. Any animal other than a fish, amphibian, reptile, bird, or mammal.

Inverse Square Law: The mathematical expression describing the decrease in the mean square pressure level of a sound wave over distance. Under ideal conditions, sound pressure levels decrease by 6 dB for every doubling of distance from the sound source.

Jacketed Structure: Steel framed tubular structure attached to the seafloor with piles that are driven into the seafloor.

Jetting: The process of injecting high pressure water into sediments to loosen and liquefy them as a means of creating seafloor conditions that allow a cable or pipeline to sink below the bottom as an alternative to dredging a trench.

Lacustrine: Pertaining to the sedimentary environment of a lake.

Lead (Pb): A gray-white metal that is listed as a criteria air pollutant. Health effects from exposure to lead include brain and kidney damage and learning disabilities.

Lease: A legal document executed between a landowner, as lessor, and a company or individual (as lessee) that conveys the right to exploit the premises for minerals or other resources for a specified period of time over a given area.

Liquefaction: Process by which wet sediments are transformed into an unstable, dense fluid during an earthquake.

Littoral: Of or pertaining to the shore, especially of the sea; coastal.

Logarithmic: A mathematical term for the ratio of values expressed by the base 10 or e. If the base is 10, the logarithm is called *common*. If the base is e, the logarithm is called *natural*. Human perception of the amplitude or “loudness” of sound follows a logarithmic, rather than a linear, relationship. For every increase in sound loudness perceived as a simple additive quantity, the loudness or amplitude actually increases as a multiplier of the initial amplitude.

Longitudinal wave: A wave in which the deformation of the medium through which the wave is passing involves motion of individual particles comprising the medium only in the direction in which energy wave is moving. Sound propagates through liquids and gases primarily as longitudinal waves.

Longshore (littoral) current: A current generated by waves intersecting the coastline at an oblique angle. It travels along the coastline.

Longshore (littoral) drift: Material (e.g., gravel, sand, and shell fragments) that is moved along the shore by a littoral current.

Loop Current: The principal current in the Gulf of Mexico.

Marine Protected Area (MPA): A marine area established as protected under Executive Order 13158.

Marine transgression: The influx of seawater over previously exposed land.

Mass movement: The geomorphic process by which soil or rock move down slope under the force of gravity; examples include slumping or landslides.

Meander: To wander between two points; to not follow a straight line.

Megawatt: A unit of power equal to 1,000 watts.

Meiofauna: A nontaxonomic term for invertebrates larger than microfauna but smaller than macrofauna. Generally defined as organisms that can pass through a 1-mm mesh sieve but would be retained by a 45- μ m mesh, interstitial meiofauna are those invertebrates that live between (i.e., within the interstices of) sediment particles.

Mesoscale variability: Variability that occurs within a time frame of one to two months, with a horizontal scale of a few hundred kilometers.

Meteorological tower: A tower containing equipment designed to measure wind speeds and determine whether a site is suitable for a wind turbine.

Monopile: A long, hollow, steel tube driven into the seabed to support a wind turbine or current generator.

Moratorium: Delay; a period during which certain proceedings or obligations are suspended.

Mysticetes: The suborder of whales that includes baleen whales.

Nacelle: The housing of a wind turbine that protects the major components (e.g., generator and gear box).

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the Clean Air Act, as amended. The primary NAAQS specify maximum outdoor air concentrations of criteria pollutants to protect public health within an adequate margin of safety. The secondary NAAQS specify maximum concentrations that would protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act of 1969 (NEPA): An act requiring Federal agencies to prepare a detailed statement on the environmental impacts of proposed major actions significantly affecting the quality of the environment.

National Historic Preservation Act: A Federal statute that established a Federal program to further the efforts of private agencies and individuals in preserving the nation's historic and cultural foundations.

National Marine Fisheries Service (NMFS): A Federal agency that is a part of the U.S. National Oceanic and Atmospheric Administration, or NOAA. NMFS is responsible for the management,

conservation, and protection of living marine resources within the United States' Exclusive Economic Zone. NMFS is currently referred to as NOAA Fisheries.

National Oceanic and Atmospheric Administration (NOAA): A Federal agency that manages commercial and recreational fisheries within Federal waters and designates Essential Fish Habitat to help conserve Gulf fishery resources.

Nitrogen dioxide (NO₂): A reddish-brown gas that is a strong oxidizing agent, produced by combustion (as of fossil fuels). The reactive oxides of nitrogen in the atmosphere are largely NO and NO₂, known together as NO_x. During the day, there exists a rapid interconversion of NO and NO₂ (see "Nitrogen oxides [NO_x]"). NO₂ is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Nitrogen oxides (NO_x): Nitrogen oxides include various nitrogen compounds, primarily nitric oxide (NO) and nitrogen dioxide (NO₂). They form when fossil fuels are burned at high temperatures and react with volatile organic compounds to form ozone, the main component of urban smog. They are also precursor pollutants that contribute to the formation of acid rain and to impairment of visibility.

Noise: Unwanted sound; a subjective term reflective of societal values regarding what constitutes unwanted or undesirable intrusions of sound.

Nonattainment area: The EPA's designation for an air quality control region (or portion thereof) in which ambient air concentrations of one or more criteria pollutants exceed National Ambient Air Quality Standards.

Nonhazardous waste: Routinely generated waste, including general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble. Nonhazardous waste is segregated and recycled whenever possible.

Nonlisted species: Species that are not listed as threatened or endangered by State or Federal agencies.

Ocean current: Continuous forward movement of ocean water driven by wind and solar heating of the waters near the equator, although some ocean currents result instead from variations in water density and salinity.

Outer Continental Shelf (OCS): The part of the continental shelf beyond the line that marks State ownership; that part of the offshore lands under Federal jurisdiction.

Outer Continental Shelf (OCS) lands: Offshore lands located outside of State coastal waters. Generally, OCS lands begin approximately 3.3 geographical mi offshore with respect to coastal States, except in the cases of Texas and the west coast of Florida, where OCS lands begin approximately 10.2 geographical mi offshore.

Outer Continental Shelf Lands Act (OCSLA), as amended: An act authorizing the U.S. Department of the Interior to regulate activities related to the development of mineral resources on the OCS.

Outfall: Structure (e.g., pipe) that discharges wastewater to a natural water body.

Overtopping device: A wave energy conversion device with reservoirs that are filled by incoming waves to levels above the average surrounding ocean. The water is then released, and gravity causes it to fall back toward the ocean surface. The energy of the falling water is used to turn hydroturbines.

Ozone (O₃): A strong-smelling, reactive gas consisting of molecules composed of three oxygen atoms. It is formed in the atmosphere by chemical reactions involving nitrogen oxides and volatile organic compounds in sunlight. A major constituent of smog, it can impair the respiratory system and damage plants and ecosystems. Ozone is a criteria air pollutant under the Clean Air Act.

Pascal (Pa): A unit of pressure equivalent to one newton of force applied evenly over 1 m². The unit is named after Blaise Pascal, the eminent French mathematician, physicist, and philosopher.

Pelagic: Living or growing near the surface of the ocean.

Pelagic fishes: Fish that spend most of their lives swimming in the water column, as opposed to on or near the bottom.

Pelagic muds: Marine sediments derived from floating organic matter (e.g., plankton) that accumulates on the seafloor.

Photovoltaic: The process of converting sunlight into electricity.

Physical oceanography: The scientific study of ocean physics, including ocean currents, waves, and tides.

Physiographic: Pertaining to the physical features of the land, in particular its slope and elevation.

Pinnipeds: An order of carnivorous marine mammals, including harbor seals, sea lions, walruses, and elephant seals.

Pitch: A property of sound; sound wave frequency as perceived by the receptor. In music, two tones whose frequencies make a 2:1 ratio are said to be separated by an octave interval; a frequency ratio of 5:4 ratio defines a third; a frequency ratio of 4:3 defines a fourth; a frequency ratio of 3:2 defines a fifth.

Pitch Regulated: A cross flow wind turbine comprising a rotor mounted for rotation about a vertical axis and a plurality of blade assemblies mounted on the rotor.

PM₁₀: Particles with an aerodynamic diameter of less than or equal to 10 micrometers (0.0004 in.). These can be inhaled through the upper airways and deposited in the lower airways and gas-exchange tissues in the lung. PM₁₀ is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

PM_{2.5}: Particles with an aerodynamic diameter of less than or equal to 2.5 micrometers (0.0001 in.). A greater fraction of particles in this size range can penetrate and be deposited deep in the lungs, and smaller portions of PM_{2.5} (e.g., < 0.1 micrometer) can enter the bloodstream. PM_{2.5} is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Pneumatic: Operated by pressurizing air.

Point absorber: A wave energy conversion device with a floating structure and components that move relative to each other because of wave action (e.g., a floating buoy inside a fixed cylinder). The relative motion is used to drive electromechanical or hydraulic energy converters.

Polychlorinated biphenyls (PCBs): A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment. PCBs are highly toxic to aquatic life and, in the environment,

exhibit many of the characteristics of dichloro-diphenyl-trichloroethane (DDT). PCBs persist in the environment for a long time and accumulate in animals.

Polynuclear aromatic hydrocarbons (PAHs): A group of organic compounds, some of which are known to be potent human carcinogens.

Population: A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.

Prevention of Significant Deterioration (PSD): An EPA program, specified in the Clean Air Act and required by State and/or Federal permits. The goal of the program is to prevent air quality from deteriorating significantly by restricting emissions from new or modified sources of pollutants in areas that are presently meeting the ambient air quality standards.

Pro Forma: An economic analysis that captures the revenues and the expenditures associated with an undertaking to determine the level of profitability.

Raptor: Bird of prey, such as an eagle, owl, or hawk.

Rebound: The rise of a land mass that was depressed by the weight of ice sheets during the last glacial period.

Red tides: Blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans and are a natural phenomenon in the Gulf of Mexico, occurring primarily off southwestern Florida and Mexico.

Region: In this document, geographic areas on the OCS off the coast of the United States where the MMS has jurisdiction to regulate actions, including oil and gas development and development of mineral resources.

Relict: A remnant or fragment of the vegetation of an area that remains from a period when the vegetation was more widely distributed.

Renewable energy: Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydrological, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Rift zone: A long, narrow trough bounded by normal faults, often associated with volcanism.

Rifting: A geologic process involving the pulling apart (extension) of the earth's crust, which creates a linear series of faults along which the central portion is dropped relative to either side (forming a rift valley).

Right-of-Way (ROW): In property law, an easement to use another's land for passage. For the OCS, a right-of-way is most commonly used for pipelines that cross lands that the operator does not control entirely by lease.

Rigs-to-Reef Program: A program under which obsolete gas and oil structures are converted to artificial reefs. The owners of the structures may make financial donations to the States from any savings related to avoided disposal costs.

Riverine: Relating to or associated with a river or other flowing freshwater body.

Rock armor: Pieces of rock, sized according to the anticipated erosional force, placed around a structure to prevent erosion of looser sediments.

Rugosity: Roughness or three dimensional relief of a surface

Salinity: A measure of the salt content of water, usually expressed in parts per thousand (ppt).

Salt diapirism: The phenomenon of salt intrusion into rock caused by the difference in buoyancy and pressure between the salt and overlying rock.

Salt marshes: Intertidal wetlands that occur on the margins of estuaries, protected bays, and the landward side of barrier islands.

Sand Wave: A sediment formation that forms underwater ridges and troughs because currents are sufficient to physically cause sediments to move in a consistent manner. The size can range from a few inches to many feet tall.

Scouring: The rapid erosion of sediment caused by the movement of water.

Scour mats: Typically square or rectangular sheets of an artificial material with vertical relief features intended to trap sediments when anchored on the seafloor, in an attempt to prevent scour.

Sediment: Materials that sink to the bottom of a body of water, or materials that are deposited by wind, water, or glaciers.

Sedimentary basin: A geologically (but not necessarily topographically) depressed area with thick sediments (sedimentary rocks) in the interior and thinner sediments at the edges.

Seeps: Natural releases of material from the sediment to the water column, often in discrete locations.

Seismic: Of, subject to, or caused by an earthquake or earth vibration.

Shoal: The sandy elevation of the bottom of a body of water, constituting a hazard to navigation; a sandbank or sandbar.

Solid wastes: In this document, wastes classified as either hazardous or nonhazardous under the Resource Conservation and Recovery Act (RCRA) that may be generated by technology testing, site characterization, construction, operation, and decommissioning activities associated with alternative energy or alternate use projects likely to be proposed on the OCS.

Sound power level (SPL): The level of a sound wave's power relative to a reference value, expressed in decibels and averaged over time. The SPL represents the total sound power emitted by a source in all directions. Sound power is measured in watts, and SPLs are traditionally given in decibels with 1 dB of sound power equaling one picowatt (represented as: 1 dB re 1 pW). Whereas the sound pressure level represents the pressure of the sound wave reaching a receptor at a specific distance and in one direction from the sound source, the SPL represents all of the sound emanating from the source in all directions. To avoid confusion between the two terms, SPLs are often expressed in "bels" rather than decibels where one bel = 10 dB.

Sound pressure level: The relative magnitude of a sound wave's pressure compared to a reference pressure value. The pressure of the sound wave is proportional to the square of the sound's intensity and is measured in decibels.

Species of (Special) Concern: A species that may have a declining population, limited occurrence, or low numbers for any of a variety of reasons.

Stratification: The formation, accumulation, or deposition of materials in layers, such as layers of fresh water overlying higher salinity water (saltwater) in estuaries.

Submarine bank (shoal): A shallow place in a body of water.

Subtidal: That portion of the ocean that occurs below the low tide elevation, and therefore is continuously under water.

Sulfur dioxide (SO₂): A pungent, colorless gas formed when a fossil fuel containing sulfur, such as coal and oil, is burned. Of SO_x, only SO₂ is found at appreciable levels in the ambient gas phase (see also "sulfur oxides [SO_x]").

Sulfur oxides (SO_x): A collective term for oxides of sulfur, of which the principal air pollutants are sulfur dioxide (SO₂), sulfur trioxide (SO₃), and sulfur mist generated by the combination of the sulfur oxides with water in the air. These gases are formed primarily by fossil fuel combustion. SO_x contributes to respiratory illness, particularly in children and the elderly, and aggravates existing heart and lung diseases. It also contributes to the formation of acid rain and to visibility impairments. SO_x is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Surficial: Pertaining to or lying on the surface of the earth.

Syncline: A fold in the layers of rock caused by deformation of the earth's crust; younger strata are found toward the center of the fold.

Talus: Small, broken rock found on mountain slopes and at the base of cliffs as a result of mass movement (e.g., a landslide).

Tectonic: Pertaining to forces within the earth that cause the earth's plates to move relative to one another; these include extension (when plates move apart), subduction (when plates converge and one plate is pushed below the other, and transverse movement (when plates move past each other, as along the San Andreas Fault).

Terminator: A wave energy conversion device that extends perpendicular to the direction of wave travel and captures or reflects the power of the wave. These devices are typically installed onshore or near shore; however, floating versions have been designed for offshore applications. The oscillating water column is a form of terminator in which water enters through a subsurface opening into a chamber with air trapped above it. The wave action causes the captured water column to move up and down like a piston to force the air through an opening connected to a turbine.

Terrace: A flat, wave-cut platform of various unconsolidated sedimentary deposits.

Terrestrial biota: Plant, animal, or other life living in or on land.

Terrigenous: Pertaining to sediments derived from land sources.

Terrigenous clastic sediments: Sediments derived from pre-existing, land-derived sources, delivered to the ocean by rivers and streams.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act.

Topography: The elevation or slope of the land surface.

Transverse wave: Wave in which the deformation of the medium through which an energy wave is passing involves motion of individual particles composing the medium in directions that are perpendicular to the direction in which energy wave is moving. Sound propagates in solids as transverse waves.

Tsunami: An ocean wave generated when an earthquake displaces the seafloor.

Turbine: A device in which a stream of water or gas turns a bladed wheel, converting the kinetic energy of the flow into mechanical energy available from the turbine shaft. Turbines are considered the most economical means of turning large electrical generators. They are typically driven by steam, fuel vapor, water, or wind.

U.S. Environmental Protection Agency (EPA): The independent Federal agency, established in 1970, that regulates Federal environmental matters and oversees the implementation of Federal environmental laws.

Upwelling: The process by which warm, less-dense surface water is drawn away from a shoreline by offshore currents and replaced by cold, denser water brought up from the subsurface.

Velocity: For acoustics, the speed at which a sound wave (a longitudinal wave) travels through a medium. Velocity is measured in units of distance/time. The velocity or speed of a sound wave in any medium is dependent on both the inertial and elastic properties of the medium. In air, the speed of sound is dependent on the air's pressure (a measure of its inertial property of density) and its temperature (a measure of the air's elastic property of deformation in response to an applied force—in this case, the sound wave). At one atmosphere of pressure and a temperature of 20°C (68°F), the speed of sound is approximately 343 m/s (750 mph).

Vibratory: Operated by causing rapid, small movement in a back and forth manner.

Visual impact: The creation of an intrusion or perceptible contrast that affects the scenic quality of a landscape.

Water quality: The condition of water with respect to the amount of impurities in it.

Watt: An International System unit of power equal to one joule per second.

Wavelength: The distance from any point in the wave to the corresponding point in the next cycle of the wave. Longer wavelengths are perceived by the human ear as low tones, shorter wavelengths as high tones.

Wetlands: Areas that are soaked or flooded by surface or groundwater frequently enough or long enough to support certain species of plants, birds, animals, and aquatic life. Wetlands generally include swamps, marshes, bogs, estuaries, and other inland and coastal areas and are Federally protected.

Yaw: The wind turbine yaw mechanism is used to turn the wind turbine rotor against the wind.

Zonation: Distribution of plants or animals arranged in zones or bands, caused by gradations of biotic (living) and/or abiotic (e.g., physical and chemical) factors.



The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.



The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.