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BOEM 2018-060

Vineyard Wind Offshore Wind Energy Project
Draft Environmental Impact Statement

December 2018

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Office of Renewable Energy Programs

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ENVIRONMENTAL IMPACT STATEMENT
FOR THE VINEYARD WIND OFFSHORE WIND ENERGY PROJECT
DRAFT (X) FINAL ( )

Lead Agency:	U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs
Cooperating Federal Agencies:	U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement U.S. Coast Guard U.S. Army Corps of Engineers U.S. Environmental Protection Agency National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Cooperating Tribal Nation:	Narragansett Indian Tribe
Cooperating State Agencies:	Massachusetts Office of Coastal Zone Management Rhode Island Coastal Resource Management Council Rhode Island Department of Environmental Management
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Area:	Lease Area OCS-A 0501
Date for Comments:	January 22, 2019

Abstract:

This Draft Environmental Impact Statement (Draft EIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and decommissioning of an offshore wind energy facility southeast of Martha's Vineyard approximately 800 megawatts in scale. This Project is proposed by Vineyard Wind LLC and designed to serve demand for renewable energy in New England. The Draft EIS was prepared following the requirements of the National Environmental Policy Act (42 USC §§ 4321–4370f) and implementing regulations, and Executive Order (EO) 13807 *Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure*. EO 13807 establishes an approach called "One Federal Decision" for use with major infrastructure projects, which includes the preparation of a single EIS and Record of Decision for all federal permit and authorizations. The EIS will inform the Bureau of Ocean Energy Management (BOEM) in deciding whether to approve, approve with modifications, or disapprove the proposed Project. BOEM's action furthers U.S. policy to make the Outer Continental Shelf energy resources available for development in an expeditious and orderly manner, subject to environmental safeguards including consideration of natural resources and existing ocean uses (43 USC § 1332(3)).

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EXECUTIVE SUMMARY

This Draft Environmental Impact Statement (Draft EIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and future decommissioning of the proposed Vineyard Wind Offshore Wind Energy Project (Project) located more than 14 miles (23.6 kilometers [km]) southeast of Martha's Vineyard. This Draft EIS will inform the Bureau of Ocean Energy Management (BOEM) in deciding whether to approve, approve with modifications, or disapprove the proposed Project.

ES1. PURPOSE AND NEED FOR THE PROPOSED ACTION

Executive Order 13783 of March 28, 2017, establishes the federal policy of promoting clean and safe development of domestic energy resources, including renewable energy, to ensure national security and provide affordable, reliable, safe, secure, and clean energy. Vineyard Wind LLC's (Vineyard Wind) Construction and Operations Plan (COP) (Epsilon 2018a) proposes a commercial-scale offshore wind energy facility within Lease Area OCS-A 0501 that would generate approximately 800 megawatts (MW), and would serve New England's renewable energy demand. See Section 1.2 for more information on the proposed Project's purpose and need.

BOEM must determine whether to approve, approve with modifications, or disapprove the COP (and thus the Project) in furtherance of federal policy to manage the development of Outer Continental Shelf (OCS) energy resources in an expeditious and orderly manner, subject to environmental safeguards including consideration of natural resources and existing ocean uses (43 United States Code § 1332(3)).

ES2. PUBLIC INVOLVEMENT

Prior to preparation of this Draft EIS, BOEM held five public scoping meetings near the proposed Project area to solicit feedback and identify issues and potential alternatives for consideration. The topics most referenced in the scoping comments include commercial fisheries and for-hire recreational fishing, Lewis Bay, the Project description, socioeconomics, and alternatives. Additional public input opportunities occurred during the proposed Project's planning and leasing phases between 2009 and 2015. BOEM also consulted with state, federal, and tribal agencies. BOEM considered all of the resulting comments while preparing this Draft EIS. Publication of this Draft EIS initiates a 45-day comment period open to all, after which BOEM will use the comments received to inform preparation of the Final EIS. See Section 1.1 for additional information on public involvement.

ES3. ALTERNATIVES

This Draft EIS evaluates five action alternatives (one of which has two sub-alternatives) and the No Action Alternative (see Section 2.1 for additional information). The action alternatives are not mutually exclusive; BOEM may select a combination of alternatives that meet the purpose and need of the proposed Project (as described in Section ES1).

ES3.1. ALTERNATIVE A—PROPOSED ACTION

Alternative A would include up to 100 wind turbine generators (WTGs), each of which would have an 8 to 10 MW generation capacity, and up to two electrical service platforms (ESPs). The WTGs would be placed in a grid-like array (with WTGs in rows oriented northeast-southwest and northwest-southeast) within Vineyard Wind's lease area, referred to as the Wind Development Area (WDA), with typical spacing between WTGs of 0.75 to 1 nautical miles. Vineyard Wind has proposed the Project using a Project Design Envelope (PDE) framework, under which multiple aspects of the Project are potentially variable, but would remain within the limits defined in the PDE.

Offshore and onshore cables would transmit electricity to a proposed onshore substation. The Proposed Action would use one of two offshore and Onshore Export Cable Routes (OECRs). These options are referred to by the associated cable landfall site in Barnstable County, Massachusetts: Covell's Beach in the Town of Barnstable and New Hampshire Avenue in the Town of Yarmouth. Table ES-1 summarizes the key parameters of the Proposed Action, while Figure ES-1 shows the nominal offshore and onshore layout of the Proposed Action (including potential routes). See Section 2.1.1 for additional information on the Proposed Action.

Table ES-1: Proposed Action Design Envelope Parameters

Wind Turbine Generators (WTGs)		
	Minimum Turbine Size	**Maximum Turbine Size**
Turbine Generation Capacity	8 MW	10 MW
Number of Turbines Installed	100	80
Total Tip Height	627 ft (191 m) MLLW [a]	696 ft (212 m) MLLW [a]
Rotor Diameter	538 ft (164 m) MLLW [a]	591 ft (180 m) MLLW [a]
Tip Clearance	89 ft (27 m) MLLW [a]	102 ft (31 m) MLLW [a]
Tower Diameter for WTG	20 ft (6 m)	28 ft (8.5 m)
Electrical Service Platform (ESP)		
Dimensions	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)
Number of Conventional ESPs	1 (800 MW)	2 (400 MW each)
Number of Piles/Foundation	1	3 to 4
Monopile (WTG) Foundations	**Minimum Turbine Size**	**Maximum Turbine Size**
Diameter	25 ft (7.5 m)	34 ft (10.3 m)
Pile footprint	490 ft^2 (45.5 m^2)	908 ft^2 (84.3 m^2)
Penetration	66 ft (20 m)	148 ft (45 m)
Number of Piles/Foundation	1	1
Typical Foundation Time to Pile Drive [b]	approximately 3 hours	approximately 3 hours
Scour Protection for Foundations	**Minimum**	**Maximum**
Scour Protection Area at Each WTG [c]	up to 30,139 ft^2 (1,500 m^2)	up to 41,975 ft^2 (2,100 m^2)
Scour Protection Area at Each ESP [c]	up to 30,139 ft^2 (1,500 m^2)	up to 49,500 ft^2 (2,100 m^2)
Export and Inter-Link Cable (220 kV)	**Minimum**	**Maximum**
Burial Depth	5 ft (1.5 m)	8 ft (2.5 m)
Maximum Length (assuming two cables)	98 mi (158 km)	98 mi (158 km)
Total OECC Width for Export Cables [d]	2,657 ft (810 m)	3,280 ft (1,000 m)
Maximum Length of Inter-Link Cable	6.2 mi (10 km)	6.2 mi (10 km)
Export Cables Total Dredging Area	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)
Export Cables Total Dredging Volume	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)
Landfall and Onshore Components		
	Option 1, Western Route	**Option 2, Eastern Route**
Landfall Sites	Covell's Beach (Barnstable)	New Hampshire Avenue (Yarmouth)
Landfall Transition Method	Horizontal Directional Drilling (HDD)	HDD, Direct Bury via Open Cut
Length of Onshore Cable	5.4 mi (9 km)	6 mi (10 km)

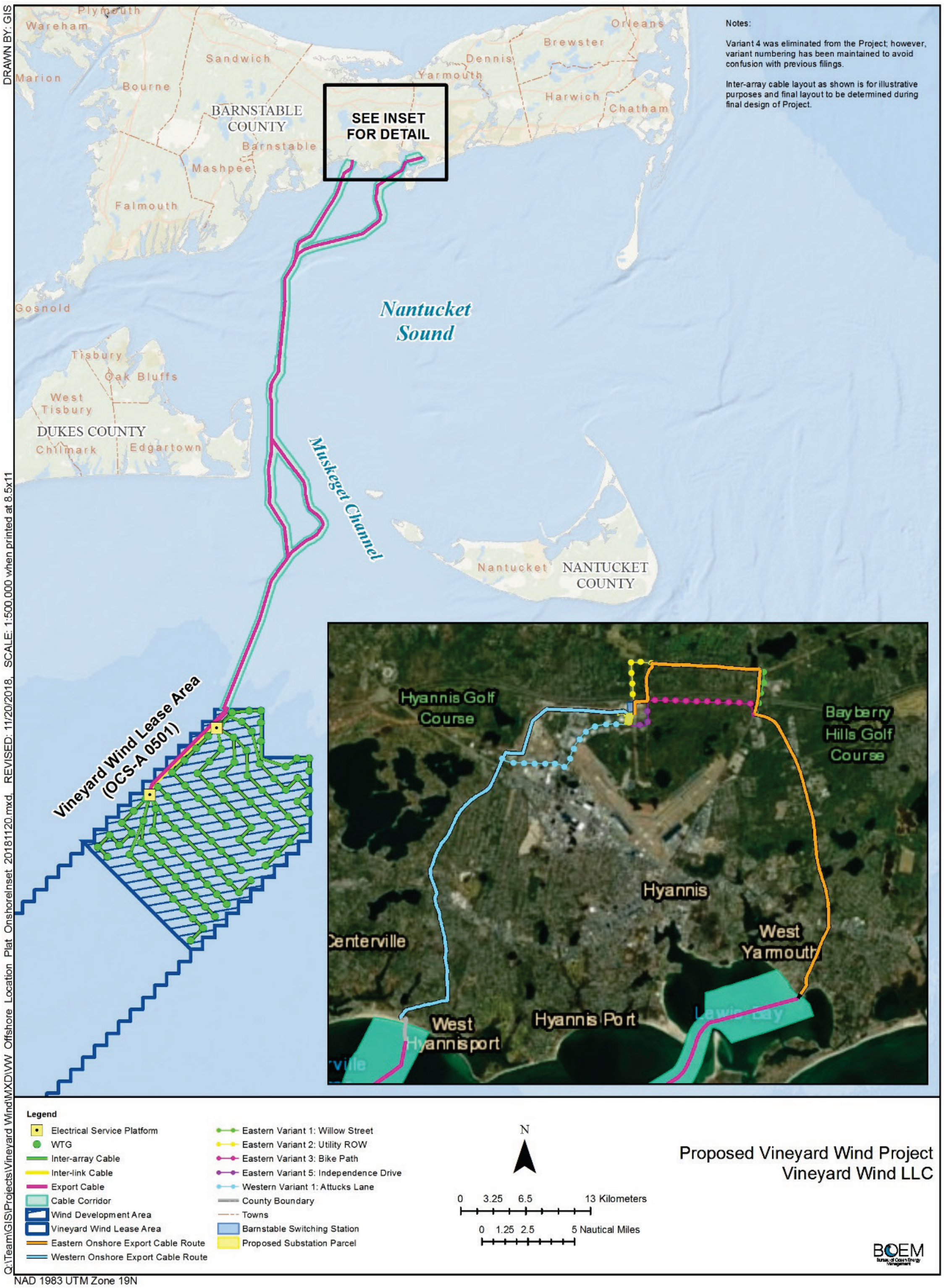
cy = cubic yards; ft = foot; ft^2 = square feet; ft^3 = cubic feet; HDD = horizontal directional drilling; km^2 = square kilometers; kV = kilovolt; m = meter; m^2 = square meters; m^3 = cubic meters; mi = mile; MLLW = mean lower low water; MW = megawatt

[a] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.

[b] Vineyard Wind has estimated that typical pile driving for a monopile would take less than approximately 3 hours to achieve the target penetration depth, and that pile driving for the jacket foundation will take approximately 3 hours to achieve the target penetration depth. Different hammer sizes are used for installation of the monopile and jacket foundations.

[c] Includes scour protection for each WTG or ESP and each, WTG or ESP jacket.

[d] Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and would directly disturb an approximately 6.4-foot (2-meter) wide corridor.



Note: The inter-array cable layout shown is an example. The final cable layout and location would be within the approved PDE.

Figure ES-1: Proposed Project Elements

ES3.1.1. Construction and Installation

Construction and installation of the Proposed Action would begin late 2019 and complete in 2022. Vineyard Wind anticipates beginning onshore construction before the offshore components. The majority of onshore construction activities would occur outside of the summer tourist season.

Onshore elements of the Proposed Action would include the landfall site, the onshore export cables, the onshore substation site, and the connection from the proposed substation site to the existing bulk power grid (Figure ES-1). The proposed Project contemplates two OECRs, with alternative options within each route. The western OECR would begin at the Covell's Beach landfall site in Barnstable, while the eastern OECR would begin at the New Hampshire Avenue landfall site in Yarmouth. The majority of the two proposed OECRs would pass through already developed areas, primarily paved roads and existing utility right-of-ways, and would be entirely underground. The onshore export cables would terminate at the proposed substation, which would occupy approximately 7 acres (28,328 square meters [m^2]) on a currently forested site adjacent to an existing electrical substation and other commercial and industrial uses.

Offshore Project elements would include WTGs and ESPs and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cable that connects the ESPs, and the Offshore Export Cable Corridor (OECC) to the landfall location. The proposed offshore Project elements are located within federal waters, with the exception of a portion of the OECC located within state waters.

As part of the PDE, Vineyard Wind has proposed several cable route installation methods for the inter-array cables, inter-link cables, and offshore export cables. Vineyard Wind would bury the cables using a jet plow, mechanical plow, and/or mechanical trenching, as suited for the bottom type in the immediate area. Dredging may be necessary in some areas, especially where large sand waves occur.

Vineyard Wind would use vessels, vehicles, and aircraft during construction, operations and maintenance, and decommissioning. The majority of vessels and vehicles would be based out of the New Bedford, Massachusetts, Marine Commerce Terminal and smaller purpose-built Operations and Maintenance Facilities in Vineyard Haven, Massachusetts.

ES3.1.2. Operations and Maintenance

The proposed Project would have an operational life of 30 years[1], and would include a comprehensive maintenance program, including preventive maintenance. In addition, Vineyard Wind would implement an Oil Spill Response Plan, Emergency Response Plan, and Safety Management System. Onshore components would require minimal maintenance.

Offshore WTGs and ESPs would operate by remote control, so personnel would not be required on site except to inspect equipment and conduct repairs. Vineyard Wind estimates that routine maintenance would generate approximately 392 vessel trips in a typical year.

ES3.1.3. Decommissioning

Vineyard Wind would remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 Code of Federal Regulations [CFR] § 585.910(a)). Decommissioning plans are subject to an approval process that includes public comment and government agency consultation. Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension if it wanted to operate the proposed Project for longer than the operating term.

ES3.2. Alternative B—Covell's Beach Cable Landfall

This alternative would be identical to the Proposed Action, except it would eliminate the New Hampshire Avenue cable landfall option and OECC route, thus limiting landfall to the Covell's Beach location. See Section 2.1.2 for additional information on Alternative B.

[1] Vineyard Wind's lease with BOEM (Lease OCS-A 0501) has an operations term of 25 years that commences on the date of COP approval (see https://www.boem.gov/Lease-OCS-A-0501/ at Addendum B; see also 30 CFR § 585.235(a)(3)). Vineyard Wind would need to request an extension of its operations term from BOEM to operate the proposed Project for 30 years. For purposes of the maximum-case scenario and to ensure National Environmental Policy Act coverage if BOEM grants such an extension, however, the Draft EIS analyzes a 30-year operations term.

ES3.3. Alternative C—No Surface Occupancy in the Northern-Most Portion of the Project Area

This alternative would prohibit surface occupancy in the northern/northeastern-most portion of the WDA, resulting in the relocation of the six northernmost WTGs to the southern portion of the WDA. See Section 2.1.3 for additional information on Alternative C.

ES3.4. Alternative D—Wind Turbine Layout Modification

Alternative D includes two sub-alternatives, both of which would involve different WTG layouts. See Section 2.1.4 for additional information on Alternative D. Neither sub-alternative would have a designated transit corridor; both sub-alternatives would increase the WDA area by approximately 22 percent. Prior to COP approval, BOEM would require substantial additional survey work to resolve data gaps, potentially resulting in schedule delays.

- **Alternative D1** would require a minimum spacing of 1 nautical mile between WTGs.
- **Alternative D2** would arrange the WTG layout in an east-west orientation, and would require a minimum spacing of 1 nautical mile between WTGs.

ES3.5. Alternative E—Reduced Project Size

This alternative would limit the proposed Project to up to 84 WTGs. Vineyard Wind could achieve its intended 800 MW Project capacity by using 9.5 MW capacity WTGs, the largest currently commercially available. See Section 2.1.5 for additional information on Alternative E.

ES3.6. Alternative F—No Action Alternative

Under the No Action Alternative, BOEM would not approve the proposed Project, and none of the environmental consequences or benefits of the proposed Project would occur. This would not preclude BOEM from considering other proposals in this area or similar proposals in other areas. See Section 2.1.6 for additional information on Alternative F.

ES4. ENVIRONMENTAL IMPACTS

This Draft EIS uses a four-level classification scheme to characterize the potential negative or beneficial impacts as either **negligible**, **minor**, **moderate**, or **major.** Table ES-2 summarizes the impacts under each action alternative. Under the No Action Alternative, the environmental and socioeconomic impacts and benefits of the action alternatives would not occur. See Section 3.1 for additional information on impact levels, and Sections 3.2 through 3.4 for detailed descriptions of the impacts for each resource under each alternative.

National Environmental Policy Act implementing regulations (40 CFR § 1502.16) require that an EIS evaluate the potential unavoidable adverse impacts associated with a proposed action. Adverse impacts that can be reduced by mitigation measures but not eliminated are considered unavoidable. The same regulations also require that an EIS review the potential impacts on irreversible or irretrievable commitments of resources resulting from implementation of a proposed action. Irreversible commitments occur when the primary or secondary impacts from the use of a resource either destroy the resource or preclude it from other uses. Irretrievable commitments occur when a resource is consumed to the extent that it cannot recover or be replaced.

Chapter 5 describes potential unavoidable adverse impacts. Most potential unavoidable adverse impacts associated with the Proposed Action, such as disturbance of habitat or incremental disruption of typical daily activities, would occur during the construction phase, and would be temporary. Chapter 6 describes irreversible and irretrievable commitment of resources by resource area. The most notable such commitments could include effects on habitat or individual members of protected species, as well as potential loss of use of commercial fishing areas.

Table ES-2: Summary and Comparison of Impacts by Action Alternatives with No Mitigation Measures [a,b]

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Air Quality	**Minor** temporary impacts from construction vessel and equipment emissions, but a net benefit over the life of the Project [c]	Similar to the Proposed Action	Similar to Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Water Quality	**Minor** temporary impacts from sediment suspension and vessel discharges, but **negligible** impact over the long-term	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Terrestrial and Coastal Fauna	**Minor** short-term impacts from direct mortality, temporary habitat alteration, and risk of affecting wetlands and streams; **minor** to **moderate** impacts due to land clearing (permanent habitat loss)	Similar to the Proposed Action, but **minor** impacts due to land clearing (permanent habitat loss); less risk of affecting wetlands and streams	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Birds	**Negligible** to **minor** short-term impacts from onshore construction; **negligible** to **minor** long-term impacts from offshore operations	Similar to the Proposed Action, potentially to a lesser degree onshore	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Bats	Likely **negligible** but possibly **minor** short-term impacts due to forest clearing; **negligible** long-term impacts on migrating bats during offshore operation	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Coastal Habitats	**Negligible** to **minor** short-term impacts at landfall site; **minor** to **moderate** short-term impacts from vessel anchoring, dredging and cable installation; **negligible** to **minor beneficial** long-term impact of hard protection atop cables; overall impact likely **negligible**	Similar to the Proposed Action, but less impact at landfall site	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Benthic Resources	**Minor** short-term impacts from direct mortality and sedimentation; **moderate** short-term impacts from dredging and entrainment; **minor** long-term impact from scouring; possible long-term **moderate beneficial** effect of scour protection and cable protection	Similar to the Proposed Action, but no impact would occur in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree in the WDA

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Finfish, Invertebrates, and Essential Fish Habitat	**Minor** short-term impacts from turbidity, sedimentation, direct mortality, and installation noise; **minor** long-term impact from operational noise and electromagnetic frequencies; **moderate** impacts from temporary habitat disturbance and permanent habitat conversion; **moderate beneficial** long-term reef effect from piles and scour protection	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Marine Mammals	**Minor** to **moderate** short-term impacts from survey noise, pile driving noise, vessel noise, and vessel strikes; **negligible** to **minor** short-term impacts from turbidity and decommissioning noise; **negligible** to **minor** long-term impacts from electromagnetic frequencies and avoidance of the WDA; **moderate** long-term impact of increased vessel traffic; possible **minor** beneficial long-term impacts to seal habitat by hard protection.	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Sea Turtles	**Minor** short-term impacts from pile driving noise, vessel noise, and vessel strikes; **minor** long-term impacts from habitat alteration and increased vessel traffic	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Demographics, Employment, and Economics	**Minor beneficial** long-term effects of creating jobs and generating revenue	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Environmental Justice	Likely **moderate**, but potentially **major** short-term impacts on commercial fishing, subsistence fishing, and disruption of marine businesses in Lewis Bay	**Moderate** short-term impacts related to commercial fishing, subsistence fishing; no disruption in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Cultural, Historical, and Archaeological Resources	**Minor** short-term impacts on onshore and offshore archaeological sites; **minor** long-term visual impacts on historic properties	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Recreation and Tourism	**Minor** to **moderate** short-term impacts from construction and decommissioning activities onshore, offshore, and at public beaches and boating areas adjacent to landfall sites; **minor** long-term impacts on recreational vessel traffic and tourism	Less impact in the Lewis Bay area; **Minor** short-term impacts at public beaches and boating areas adjacent to landfall sites; **minor** long-term impacts on recreational vessel traffic and tourism	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Commercial Fisheries and For-Hire Recreational Fishing	**Minor** short-term effects of increased vessel traffic; m**inor** long-term effects on fishing trip distances and routes; **moderate** to **major** short-term effects from areas of temporarily restricted access; **moderate** to **major** long-term impacts on target populations or locations, loss or damage of gear	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree [d]	Similar to the Proposed Action, potentially to a lesser degree [d]	Similar to the Proposed Action, potentially to a lesser degree [d]
Land Use and Coastal Infrastructure	**Minor beneficial** long-term effects at ports due to increased compatible uses of existing facilities and areas; **moderate** short-term adverse impacts due to onshore construction noise, dust, and traffic flow disturbances	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Navigation and Vessel Traffic	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; potential temporary **major** impacts in Lewis Bay	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; no impact in Lewis Bay	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree
Other Uses	**Negligible** long-term impacts on radar signals; **minor** long-term impacts on cables and pipelines, offshore energy and mineral use, aviation and air traffic, and military or national security uses; **minor** long-term adverse and beneficial impacts on scientific research in this area	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

[a] This table is adapted from Table 2.4-1 in Chapter 2 of the Draft EIS. Table 2.4-2 in Chapter 2 of the Draft EIS provides a summary and comparison of the impacts under each action alternative assessed in Chapter 3, assuming effective implementation of all potential mitigation measures mentioned in Chapter 3 and Table D-1 (Appendix D).

[b] Impact Rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. Where impacts are presented as a range, the color representing the highest level of impact has been applied.

[c] The No Action Alternative would likely result in moderate long-term adverse impacts on air quality, as new fossil fuel-fired power plants would be required to meet future power demands.

[d] Although the impact rating levels are equal, the Rhode Island Coastal Resources Management Council and the Rhode Island Department of Environmental Management Marine Fisheries Section have commented that Alternatives D1, D2, and E would be less impactful than the Proposed Action.

ES5. CUMULATIVE IMPACTS

Cumulative impacts are the effects of the Proposed Action, when added to other past, present, or reasonably foreseeable future actions (40 CFR 1508.7). The timespan for evaluating cumulative impacts extends from the start of construction in 2019 to the completion of decommissioning no later than 2052. Cumulative projects and activities include:

- Other offshore wind energy development activities;
- Undersea transmission lines, gas pipelines, and other submarine cables (e.g., telecommunications);
- Tidal energy projects;
- Marine minerals use and ocean-dredged material disposal;
- Military use;
- Marine transportation;
- Fisheries use and management;
- Global climate change;
- Oil and gas activities; and
- Onshore development activities in central Cape Cod.

Appendix C describes past, present, and reasonably foreseeable future actions, and the resource-specific cumulative impacts assessment is provided in Chapter 3.

ES6. MITIGATION MEASURES

As part of the Proposed Action, Vineyard Wind would self-implement measures to avoid or reduce potential impacts on the resources discussed in Chapter 3. However, BOEM considers only those measures that Vineyard Wind has committed to in its COP to be part of the Proposed Action and action alternatives. Table ES-3 summarizes these measures. BOEM may select alternatives and/or require additional mitigation measures to further protect these resources and other mitigation measures may be required through reviews under several environmental statutes. Mitigation measures presented below and described in detail in Appendix D may not all be within BOEM's statutory and regulatory authority to be required; however, other governmental entities could potentially impose them. Potential mitigation measures are listed in Appendix D, and are discussed in each resource section in Chapter 3.

Table ES-3: Mitigation Measures

Measure	Resource Area(s) Addressed	Project Phase(s) [a]
Dust-control plans for onshore construction and laydown areas	Air Quality	C
Tree cutting time-of-year restriction	Terrestrial and Coastal Fauna; Birds; Bats	C
Covell's Beach landfall time-of-year restrictions and horseshoe crab time-of-year restrictions	Birds; Fish [b]; Commercial Fisheries and For-Hire Recreational Fishing	C
Lewis Bay nearshore low-tide cable laying time-of-year restriction	Birds	C
Lewis Bay horseshoe crab, shellfish, winter flounder time-of-year restrictions	Benthic Resources; Fish [b]; Commercial Fisheries and For-Hire Recreational Fishing	C
Bird deterrent devices	Birds	C
Landfall site construction method	Water Quality; Coastal Habitats; Benthic Resources; Fish [b]	C
Dredging methods	Coastal Habitats	C
Adaptive management	Benthic Resources; Fish [b]; Marine Mammals; Sea Turtles	C
Pile driving	Fish [b]; Marine Mammals; Sea Turtles	C
Long-term passive acoustic monitoring	Fish [b]; Marine Mammals; Sea Turtles	C
Sunrise and sunset prohibition on pile driving	Marine Mammals; Sea Turtles	C
Daily pre-construction surveys	Marine Mammals; Sea Turtles	C
Avoidance/ investigations of submerged resources and terrestrial resources or properties	Cultural, Historical, and Archaeological Resources	C
OECC installation to avoid navigation channel	Recreation and Tourism; Land Use and Coastal Infrastructure	C

Measure	Resource Area(s) Addressed	Project Phase(s) [a]
Onshore installation outside of summer peak tourism season	Demographics, Employment, and Economics; Environmental Justice; Recreation and Tourism; Land Use and Coastal Infrastructure	C
OECC burial to minimum depth of 5 feet (1.5 meters) to avoid hangs, and cable burial inspections	Commercial Fisheries and For-Hire Recreational Fishing	C
Disruption payment for fishing industry during construction	Commercial Fisheries and For-Hire Recreational Fishing	C
Dynamic Squid Fishing Avoidance Plan	Commercial Fisheries and For-Hire Recreational Fishing	C
Automatic Identification System on all Project Vessels	Sea Turtles; Navigation and Vessel Traffic	C
Use of fuel efficient engines for marine vessels and equipment	Air Quality	C, O
Anchor buoys to reduce impact of anchor line sweep	Coastal Habitats; Benthic Resources	C, O
Ecological monitoring	Benthic Resources; Fish [b]; Marine Mammals; Sea Turtles	C, O
Regional monitoring initiative for protected species	Fish [b]; Marine Mammals; Sea Turtles	C, O
Local hiring plan	Demographics, Employment, and Economics; Environmental Justice	C, O
Fishing gear loss or damage compensation	Commercial Fisheries and For-Hire Recreational Fishing	C, O
Regional monitoring initiative for fishery impacts	Commercial Fisheries and For-Hire Recreational Fishing	C, O
Vessel safety practices	Navigation and Vessel Traffic	C, O
Implementation of Fisheries Communication Plan, including use of Fisheries Liaisons and Fisheries Representatives	Commercial Fisheries and For-Hire Recreational Fishing	C, O
Aircraft Detection Lighting System	Cultural, Historical, and Archaeological Resources; Recreation & Tourism	O
Annual remotely operated underwater surveys, reporting, and monofilament and other fishing gear clean up around WTG foundations	Fish [b]; Marine Mammals; Sea Turtles	O
Long-term monitoring of cable placements	Commercial Fisheries and For-Hire Recreational Fishing	O
Compensation for lost income due to Project operations and maintenance	Commercial Fisheries and For-Hire Recreational Fishing	O

OECC = Offshore Export Cable Corridor; WTG = wind turbine generator
[a] C = Construction and Installation; O = Operations and Maintenance
[b] Fish = Finfish, Invertebrates, and Essential Fish Habitat

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ABBREVIATIONS AND ACRONYMS

Acronym	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
µM	micromolar
µPa	micropascal
$\mu Pa^2 s$	micropascal squared second
AC	alternating current
ADLS	Aircraft Detection Light System
AIS	Automatic Identification System
AMSL	above mean sea level
APE	area of potential effect
ASMFC	Atlantic States Marine Fisheries Commission
ATON	aids to navigation
B.P.	before present
BA	Biological Assessment
BBA	Breeding Bird Atlas
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BSW	Bay State Wind Farm
CAA	Clean Air Act
Call	Call for Information and Nominations
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulation
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
COP	Construction and Operations Plan
CVOW	Coastal Virginia Offshore Wind
CWA	Clean Water Act
CZM	Massachusetts Office of Coastal Zone Management
Deepwater WLA	Deepwater Wind Lease Area
dB	decibel
DEM	Rhode Island Department of Environmental Management
DO	dissolved oxygen
DPS	distinct population segments
DWT	deadweight tons
EA	Environmental Assessment
ECC	Export Cable Corridor
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFSB	Energy Facilities Siting Board
EIS	Environmental Impact Statement
EMF	electromagnetic field
ENF	Environmental Notification Form
EO	Executive Order

Acronym	Definition
EPAct	Energy Policy Act of 2005
ESA	Endangered Species Act
ESP	electrical service platform
FAA	Federal Aviation Administration
FMP	Fisheries Management Plan
FTE	full time equivalent
GDP	gross domestic product
HAPC	Habitat Area of Particular
HCA	Host Community Agreement
HDD	horizontal directional drilling
HFC	high frequency cetacean
HRG	High Resolution Geophysical
HVDC	high-voltage direct current
Hz	hertz
IFR	Instrument Flight Rules
IHA	Incidental Harassment Authorization
kHz	kilohertz
kJ	kilojoule
km^2	square kilometers
kph	kilometers per hour
kV	kilovolt
LE_{24}	cumulative sound exposure over 24 hours
LFC	low frequency cetacean
LME	Large Marine Ecosystem
LOA	Letter of Authorization
m^2	square meters
MA DMF	Massachusetts Division of Marine Fisheries
MA WEA	Massachusetts Wind Energy Area
MassDFW	Massachusetts Division of Fisheries and Wildlife
MBUAR	Massachusetts Board of Underwater Archeological Resources
MCT	New Bedford Marine Commerce Terminal
MDEP	Massachusetts Department of Environmental Protection
MDOT	Massachusetts Department of Transportation
MDPU	Massachusetts Department of Public Utilities
MEPA	Massachusetts Environmental Policy Act
mg/L	milligrams per liter
MFC	mid-frequency cetacean
MHC	Massachusetts Historical Commission
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act

Acronym	Definition
mph	miles per hour
MRIP	Marine Recreational Information Program
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
NA	not applicable
na	not available
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NARW	North Atlantic Right Whale
NARWC	North Atlantic Right Whale Consortium
Navy	United States Navy
NEFSC	New England Fishery Science Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NHESP	Massachusetts Natural Heritage and Endangered Species Program
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOAA NSFC	National Oceanic and Atmospheric Administration Northeast Fisheries Science Center
NOI	Notice of Intent
NRA	Navigational Risk Assessment
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NTU	nephelometric turbidity unit
O_3	ozone
OCS	Outer Continental Shelf
OECC	Offshore Export Cable Corridor(s)
OECR	Onshore Export Cable Route
PAM	passive acoustic monitoring
PATON	private aids to navigation
Pb	lead
PBR	potential biological removal
PDE	Project Design Envelope
$PM_{2.5}$	particulate matter smaller than 10 microns
PM_{10}	particulate matter smaller than 2.5 microns
ppb	parts per billion
PPW	pinnipeds in the water
ProvPort	Port of Providence
psu	practical salinity units
PTS	permanent threshold shift
RFI	Request for Information

Acronym	Definition
RI DEM	Rhode Island Department of Environmental Management
ROD	Record of Decision
ROV	remotely operated vehicle
ROW	right-of-way
RSA	rotor swept area
SO_2	sulfur dioxide
SPL	sound pressure level
SPUE	sightings per unit effort
SSU	special, sensitive, and unique
TBF	to be filed
THPO	Tribal Historic Preservation Officer
TSHD	trailing suction hopper dredge
TSS	Traffic Separation Scheme
UME	unusual mortality event
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USD	U.S. dollars
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VFR	Visual Flight Rules
VIA	visual
Vineyard Wind	Vineyard Wind LLC
VMS	Vessel Monitoring System
VOC	volatile organic compound
WDA	Wind Development Area
WEA	Wind Energy Area
WLA	Wind Lease Area
WMA	Wildlife Management Area
WNA	Western North Atlantic
WNS	White Nose Syndrome

1. INTRODUCTION

This chapter introduces the offshore wind energy project proposed by Vineyard Wind LLC (Vineyard Wind) and the process used to assess its potential environmental, social, economic, historic, and cultural impacts and the subsequent decision process. This Draft Environmental Impact Statement (Draft EIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and future decommissioning of the proposed Vineyard Wind Offshore Wind Energy Project (Project) southeast of Martha's Vineyard, which would be approximately 800 megawatts (MW) in scale. The Project is designed to serve demand for renewable energy in New England. This Draft EIS was prepared following the requirements of the National Environmental Policy Act (NEPA; 42 United States Code [USC] §§ 4321–4370f) and implementing regulations. This Draft EIS will inform the Bureau of Ocean Energy Management (BOEM) in deciding whether to approve, approve with modifications, or disapprove the proposed Project. Publication of this Draft EIS initiates a 45-day comment period open to all. BOEM will use the comments received to inform preparation of the Final EIS.

1.1. BACKGROUND

BOEM began evaluating Outer Continental Shelf (OCS) wind energy offshore Massachusetts in 2009 by establishing an intergovernmental renewable energy task force comprised of elected officials from state, local, and tribal governments and affected federal agency representatives. After extensive consultation with the task force, BOEM removed some areas from further consideration for offshore wind leasing. BOEM then conducted the following activities concerning planning and leasing:

- In December 2010, BOEM published a Request for Interest (RFI) in the Federal Register to determine commercial interest in wind energy development in an area offshore Massachusetts (Commercial Leasing for Wind Power on the Outer Continental Shelf [OCS] Offshore Massachusetts – Request for Interest [RFI], 75 Fed. Reg. 82055 [December 29, 2010]). BOEM invited the public to provide information on environmental issues and data for consideration in the RFI area and also to express interest in offshore wind energy development. BOEM re-opened the comment period in March 2011 in response to requests from the public and the Commonwealth of Massachusetts. BOEM received 260 public comments and 11 indications of interest from ten companies interested in obtaining a commercial lease. BOEM made the planning area 50 percent smaller than noticed in the RFI, responding to those comments and considering navigation and commercial fisheries concerns.
- In February 2012, BOEM published a Call for Information and Nominations (Call) in the Federal Register to solicit industry interest in acquiring commercial leases for developing wind energy projects in the Call area (Commercial Leasing for Wind Power on the Outer Continental Shelf Offshore MA – Call for Information and Nominations, 77 Fed. Reg. 5821 [February 6, 2012]). In the same month, BOEM published a Notice of Intent (NOI) to prepare an Environmental Assessment (EA) for commercial wind leasing and site assessment activities offshore Massachusetts. The comment period for the Call yielded 32 comments and ten nominations of commercial interest.
- In May 2012, BOEM publicly identified a Wind Energy Area (WEA) offshore Massachusetts, excluding additional areas from commercial leasing addressed in comments from the Call, including an area of high sea duck concentration and an area of high-value fisheries. After conducting an EA, BOEM issued a "Finding of No Significant Impact," which concluded that reasonably foreseeable environmental effects associated with the activities that would likely be performed following lease issuance (e.g., site characterization surveys in the WEA and deployment of meteorological towers or buoys) would not significantly impact the environment. The Revised Massachusetts Environmental Assessment (BOEM 2014a) more fully describes the development of the WEA.
- In June 2014, BOEM published a Proposed Sale Notice identifying 742,974 acres (3,007 square kilometers [km^2]) offshore MA in federal waters would be available for commercial wind energy leasing.
- In January 2015, BOEM held a competitive lease sale pursuant to 30 Code of Federal Regulations (CFR) § 585.211 for the lease areas within the Massachusetts Wind Energy Area (MA WEA). Offshore MW LLC (subsequently renamed to Vineyard Wind LLC) won the competition for Lease Area OCS-A 0501 in the auction (Figure 1.1-1). This lease area is 166,886 acres (675 km^2).
- In December 2017, Vineyard Wind submitted to BOEM an initial Construction and Operations Plan (COP) for the proposed Project. BOEM provided comments on the initial COP, and Vineyard Wind updated the COP and resubmitted it on March 15, 2018. After addressing additional comments from BOEM, Vineyard Wind resubmitted a further updated COP on October 22, 2018. The COP can be viewed at BOEM's project-specific website.[1] The COP proposes to develop approximately 800 MW of wind energy capacity in the northern portion of the Vineyard Wind lease area (see Figure 1.1- 1), referred to as the Wind Development Area (WDA) and amounting to 75,614 acres (306 km^2). Additional details regarding the proposed Project are set forth in Chapter 2.

[1] The Draft COP is available at https://www.boem.gov/Vineyard-Wind/.

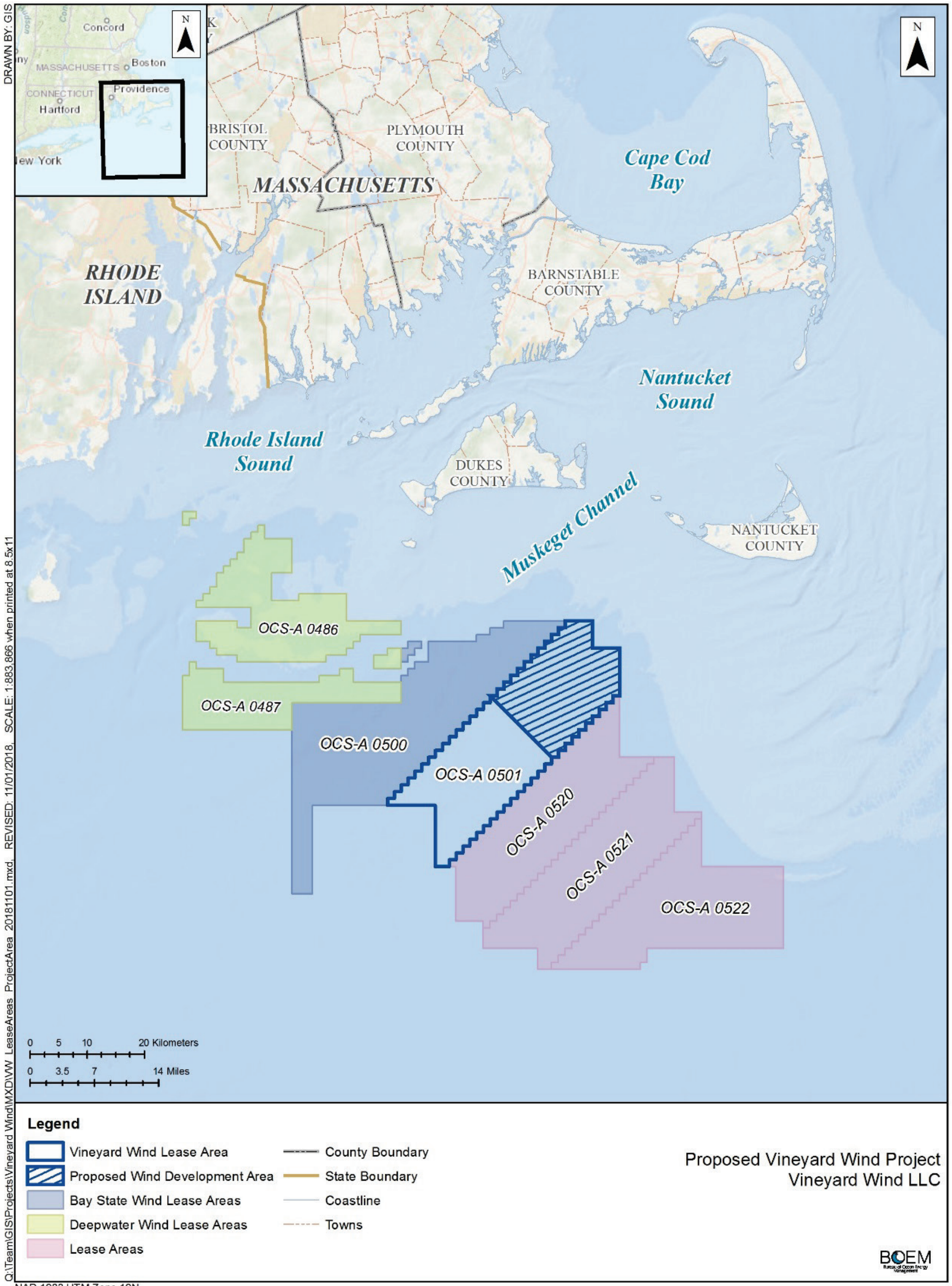

Figure 1.1-1: Proposed Project Area Relative to Massachusetts and Rhode Island Lease Areas

1.2. Purpose and Need for the Proposed Action

It is the policy of the United States to promote clean and safe development of domestic energy resources, including renewable energy, to ensure the nation's geopolitical security and provide electricity that is affordable, reliable, safe, secure, and clean (Executive Order [EO] 13783 of March 28, 2017). Through a competitive leasing process pursuant to 30 CFR § 585.211, Vineyard Wind was awarded Lease Area OCS-A 0501 offshore of Massachusetts and the exclusive right to submit a COP for activities within the lease area. Vineyard Wind has submitted a COP (Epsilon 2018a) proposing the construction, operation, maintenance, and conceptual decommissioning of a commercial-scale offshore wind energy facility within Lease Area OCS-A 0501. Vineyard Wind plans to begin construction as early as late 2019.

The purpose of the federal agency action in response to the Vineyard Wind Project COP (Epsilon 2018a) is to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and decommission an approximately 800 MW commercial-scale wind energy facility within Lease Area OCS-A 0501 to meet New England's demand for renewable energy. More specifically, the proposed Project would deliver power to the New England energy grid to contribute to Massachusetts's renewable energy requirements, particularly, the commonwealth's mandate that distribution companies jointly and competitively solicit proposals for offshore wind energy generation (220 Code of Massachusetts Regulation [CMR] 23.04(5)). BOEM's decision on Vineyard Wind's COP is needed to execute its duty to approve, approve with modifications, or disapprove the proposed Project in furtherance of the United States' policy to manage the development of OCS energy resources in an expeditious and orderly manner, subject to environmental safeguards including consideration of natural resources and existing ocean uses (43 USC § 1332(3)).

1.3. Regulatory Framework

This section outlines BOEM's authority and regulatory decision-making process, as well as other permits and authorizations required for the proposed Project.

1.3.1. BOEM Authority and Regulatory Decision-Making Process

The Energy Policy Act of 2005 (EPAct), Public Law 109-58, added Section 8(p)(1)(c) to the Outer Continental Shelf Lands Act. The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way (ROW) in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR part 585) were promulgated on April 22, 2009. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Vineyard Wind's COP. The analyses in this EIS will inform this decision, pursuant to 30 CFR § 585.628.

The Revised Massachusetts Environmental Assessment (BOEM 2014a) gives a more comprehensive description of BOEM's regulatory authority and decision-making process, and is incorporated by reference in Chapter 3 where appropriate. BOEM is required to coordinate with federal agencies and state and local governments and ensure that renewable energy development occurs in a safe and environmentally responsible manner. Chapter 4 provides a description of BOEM's consultation efforts in the development of the Draft EIS.

EO 13807 on *Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects* states that it is the policy of the Federal Government to complete all federal environmental reviews and authorizations for major infrastructure projects, such as the proposed Project, within 2 years of the publication of the NOI.[2]

1.3.2. Other Permits and Authorizations

Table 1.3-1 below outlines the federal, state, regional, and local permits and authorizations required for all action alternatives and provides the status of each. Consultations are addressed in Chapter 4.

Table 1.3-1: Required Environmental Permits and Consultations for the Proposed Project

Agency/Regulatory Authority	Permit/Approval	Status
Federal		
Bureau of Ocean Energy Management (BOEM)	COP Approval	COP filed with BOEM December 19, 2017.

[2] https://www.federalregister.gov/documents/2017/08/24/2017-18134/establishing-discipline-and-accountability-in-the-environmental-review-and-permitting-process-for

Agency/Regulatory Authority	Permit/Approval	Status
U.S. Environmental Protection Agency (USEPA)	National Pollutant Discharge Elimination System (NPDES) General Permit for Construction Activities	Application TBF
	OCS Air Permit	NOI to apply for an air permit filed on December 11, 2017; Initial Clean Air Act OCS Permit submitted August 17, 2018.
U.S. Army Corps of Engineers (USACE)	Clean Water Act (CWA) Section 404/Rivers and Harbors Act of 1899 Section 10 Individual Permit	TBF
U.S. National Marine Fisheries Service (NMFS)	Incidental Harassment Authorization (IHA) or Letter of Authorization (LOA)	Application for LOA or IHA for pile-driving activities will be submitted.
U.S. Coast Guard (USCG)	Private Aids to Navigation authorization	TBF
Federal Aviation Administration (FAA)	Determination of No Hazard to Air Navigation	TBF
State (Portions of the Project within State Jurisdiction)		
Massachusetts Environmental Policy Act (MEPA) Office	Certificate of Secretary of Energy and Environmental Affairs on Final Environmental Impact Report	Environmental Notification Form (ENF) filed on December 15, 2017; Secretary's Certificate on ENF issued February 9, 2018. Draft Environmental Impact Report (DEIR) filed on April 30, 2018; Secretary's Certificate on DEIR pending.
Massachusetts Energy Facilities Siting Board (EFSB)	Massachusetts General Law Chapter 164, § 69J Petition for Approval to Construct	Petition filed December 18, 2017
Massachusetts Department of Public Utilities (MDPU)	Massachusetts General Law Chapter 164, § 72, Approval to Construct Massachusetts General Law Chapter 40A, § 3 Zoning Exemption (if needed)	Section 72 and Section 40A petitions filed with the MDPU on February 15, 2018, together with a request for consolidated review by EFSB, which was granted on April 5, 2018.
Massachusetts Department of Environmental Protection (MDEP)	Chapter 91 Waterways License and Dredge Permit CWA Section 401 Water Quality Certification Approval of Easement (Drinking Water Regulations)[a]	TBF
Massachusetts Office of Coastal Zone Management	Federal Coastal Zone Consistency Review	Initiated Under the DEIR
Massachusetts Department of Transportation (MDOT)	Road Crossing Permits Rail Division Use and Occupancy License	TBF
Massachusetts Board of Underwater Archeological Resources (MBUAR)	Special Use Permit	Provisional permit issued May 23, 2017, final permit issued September 28, 2017
Massachusetts Natural Heritage and Endangered Species Program (NHESP)	Conservation and Management Permit (if needed)	TBF (if needed)
Massachusetts Historical Commission (MHC)	Field Investigation Permits (980 Code of Massachusetts Regulations § 70.00)	Reconnaissance survey application filed November 14, 2017
Rhode Island Coastal Resources Management Council	Coastal Zone Management Act Consistency Certification	Consistency Certification Request submitted April 6, 2018; Public Hearing to be held November 27, 2018
Regional (Portions of the Project within Regional Jurisdiction)		
Cape Cod Commission	Development of Regional Impact (DRI) Review	TBF
Martha's Vineyard Commission	DRI Review	TBF

Agency/Regulatory Authority	Permit/Approval	Status
Local (Portions of the Project within Local Jurisdiction)		
Yarmouth and Barnstable Conservation Commissions	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws)	TBF
Yarmouth Department of Public Works and/or Board of Selectmen	Street Opening Permits/Grants of Location	TBF
Barnstable Department of Public Works and/or Town Council	Street Opening Permits/Grants of Location	TBF
Barnstable Planning/Zoning	Zoning approvals as necessary	TBF
Edgartown, Nantucket, and/or Mashpee Conservation Commissions	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws, if needed as dictated by final submarine route	TBF

COP = Construction and Operations Plan; NOI = Notice of Intent; OCS = Outer Continental Shelf; TBF = to be filed
[a] Required because the onshore route will pass through a Zone I area

1.3.3. Executive Order 13807

Presidential EO 13807 on *Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure* addresses the need for a coordinated, predictable, and transparent federal environmental review and authorization process for infrastructure projects while protecting public health, safety, and the environment. EO 13807 establishes an approach called "One Federal Decision" for use with major infrastructure projects. The Memorandum of Understanding Implementing One Federal Decision Under Executive Order 13807 outlines the roles and responsibilities of the lead, cooperating, and participating agencies.

- The lead agency (BOEM) is responsible for organizing the federal environmental review and authorization processes for a proposed project, including the preparation of a single EIS and Record of Decision (ROD) for the project in coordination with the other federal cooperating agencies.
- Cooperating agencies are those federal agencies with authorizations, and are coordinating and synchronizing their authorization reviews with the lead agency's development of the EIS and issuance of the ROD.
- Participating agencies are other federal agencies participating in the EIS and/or other authorizations for the proposed Project.

Authorizations and permits are listed above in Table 1.3-1, and consultations are described in Chapter 4.

1.4. Relevant Existing NEPA and Consulting Documents

BOEM previously prepared the following NEPA and consulting documents, which BOEM used to inform preparation of this Draft EIS and which have been incorporated by reference where appropriate. Additional, non-NEPA documents related to environmental studies performed in Massachusetts to support decisions concerning offshore wind energy development are available on BOEM's website[3].

- Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, October 2007[4] (MMS 2007)
- Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts – Revised Environmental Assessment, May 2013[5] (BOEM 2013)
- Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts – Revised Environmental Assessment, June 2014[6] (BOEM 2014a)
- Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York—Revised Environmental Assessment, June 2016[7] (BOEM 2016)

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3 https://www.boem.gov/Massachusetts-Environmental-Studies/
4 https://www.boem.gov/Guide-To-EIS/
5 https://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/State_Activities/BOEM%20RI_MA_Revised%20EA_22May2013.pdf
6 https://www.boem.gov/Revised-MA-EA-2014/
7 https://www.boem.gov/NY-EA-FONSI-2016/

1.5. THE FACILITY DESIGN REPORT AND FABRICATION AND INSTALLATION REPORT

If the COP is approved, Vineyard Wind must then submit a Facility Design Report and a Fabrication and Installation Report. The Facility Design Report provides specific engineering details of the design of all facilities, including structural drawings, environmental and engineering data, a complete set of calculations used for design, Project-specific geotechnical studies, and a description of loads imposed on the facility. The Facility Design Report must demonstrate that the design conforms to the responsibilities under the lease. The Fabrication and Installation Report describes how the facilities would be fabricated and installed in accordance with the design criteria identified in the Facility Design Report, the COP, and generally accepted industry standards and practices. Both of these reports must be reviewed and certified by a BOEM-approved Certified Verification Agent prior to submittal. BOEM has 60 days to review these reports and provide objections to Vineyard Wind. If BOEM has no objections to the reports—or once any BOEM objections have been resolved—Vineyard Wind may commence construction of the Project.

1.5.1. Methodology for Assessing the Project Design Envelope

Vineyard Wind would implement a Project Design Envelope (PDE) concept. This concept allows Vineyard Wind to define and bracket proposed Project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility for selection and purchase of Project components such as wind turbine generators [WTGs], foundations, submarine cables, and offshore substations.[8]

BOEM invited Vineyard Wind and other lessees to submit COPs using the PDE concept–providing sufficiently detailed information within a reasonable range of parameters to analyze a “maximum-case scenario” within those parameters for each affected environmental resource. BOEM identified and verified that the maximum-case scenario based on the PDE provided by Vineyard Wind and analyzed in this Draft EIS could reasonably occur if approved. This approach is intended to provide flexibility for lessees and allow BOEM to analyze environmental impacts in a manner that minimizes the need for subsequent environmental and technical reviews. In addition, the PDE approach may enable BOEM to expedite review by beginning NEPA evaluations of COPs before a lessee has finalized all of its design decisions.

This Draft EIS assesses the impacts of the reasonable range of Project designs that are described in the Vineyard Wind COP and presented in Appendix G by using the “maximum-case scenario” process. The maximum-case scenario analyzes the aspects of each design parameter that would result in the greatest impact for each physical, biological, and socioeconomic resource. This Draft EIS evaluates potential impacts of the Proposed Action and each alternative using the maximum-case scenario to assess the design parameters or combination of parameters for each environmental resource. This Draft EIS considers the interrelationship between aspects of the PDE rather than simply viewing each design parameter independently. For example, since Vineyard Wind is only proposing up to an 800 MW facility with turbines ranging from 8 to 10 MW, this Draft EIS does not analyze 100 10-MW turbines because this would result in a 1,000-MW project. The Draft EIS also analyzes the cumulative impacts of the maximum-case scenario alongside other past, present, and reasonably foreseeable future actions.

Certain resources may have multiple maximum-case scenarios, and the most impactful design parameters may not be the same for all resources. For example, larger (10 MW) WTGs could be more impactful for aviation (because they are taller), whereas smaller (8 MW) WTGs could be more impactful to cultural resources, visual resources, birds, and bats (because there would be a greater number). Appendix G presents a detailed table outlining the most impacting design parameter by resource area.

1.5.2. Methodology for Assessing Cumulative Impacts

Cumulative impacts are those impacts that could result from the incremental impact of a specific action, such as the proposed Project, when combined with other past, present, or reasonably foreseeable actions or other projects. Cumulative impacts can occur from individually minor but collectively significant actions that take place over time. Appendix C describes the methodology used for assessing cumulative impacts in this Draft EIS. The information presented includes a description of the resource-specific geographic analysis areas as well as the types of actions that BOEM has identified as potentially contributing to cumulative impacts when combined with impacts from the Proposed Action and other alternatives over the geography and time scale identified. Using the methodology described in Appendix C, each resource-specific Environmental Consequences section in Chapter 3 of this Draft EIS discusses cumulative impacts.

[8] Additional information and guidance related to the PDE concept can be found here: https://www.boem.gov/Draft-Design-Envelope-Guidance/.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1. ALTERNATIVES

This chapter describes five action alternatives (one of which has two sub-alternatives) and the No Action Alternative for the proposed Project (see Table 2.1-1). This chapter provides additional details and assumptions for each of the alternatives for assessing potential impacts. The assumptions and maps for all action alternatives other than the Proposed Action do not represent specific proposals, and are provided only for context and illustration about what these alternatives could look like if implemented. If BOEM selects one or more alternative that are not the Proposed Action, the layouts constructed could vary with diverse considerations such as engineering, presence of cultural or historic resources, or seabed hazards.

Table 2.1-1: Alternatives Considered For Analysis

Alternative	Description
Alternative A—Proposed Action	Under Alternative A, the Proposed Action, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of design parameters outlined in the Vineyard Wind COP (Epsilon 2018a), subject to applicable mitigation measures.
Alternative B—Covell's Beach Cable Landfall Alternative	Under Alternative B, the Covell's Beach Cable Landfall Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, the New Hampshire Avenue landfall location option presented in the COP would not be used, and the cable landfall would be limited to Covell's Beach to potentially reduce impacts on environmental and socioeconomic resources.
Alternative C—No Surface Occupancy in the Northern-Most Portion of the Project Area Alternative	Under Alternative C, the No Surface Occupancy in the Northern-Most Portion of the Project Area Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, no surface occupancy would occur in the northern-most portion of the proposed Project area to potentially reduce the visual impacts of the proposed Project and potential conflicts with existing ocean uses, such as, marine navigation and commercial fishing. This alternative would result in the exclusion of approximately six of the northern-most WTG locations.
Alternative D—Wind Turbine Layout Modification Alternative	Under Alternative D, the Wind Turbine Layout Modification Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the Vineyard Wind lease area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to potentially reduce impacts on existing ocean uses, such as commercial fishing and marine navigation. Each of the below sub-alternatives may be individually selected or combined with any or all of the other alternatives or sub-alternatives.
Alternative D1—One-Nautical Mile Wind Turbine Spacing Alternative	Under Alternative D1, WTGs would have a minimum spacing of 1 nautical mile between them and the lanes between turbines would also be a minimum of 1 nautical mile to potentially reduce conflicts with existing ocean uses, such as commercial fishing and marine navigation.
Alternative D2—East-West and One-Nautical Mile Wind Turbine Layout Alternative	Under Alternative D2, the wind turbine layout would be arranged in an east-west orientation and all WTGs in the east-west direction would have a minimum spacing of 1 nautical mile between them to allow for vessels to travel in an unobstructed path between rows of turbines in an east-west direction. This alternative would potentially reduce conflicts with existing ocean uses, such as commercial fishing, by facilitating the established practice of mobile and fixed gear fishing practices and vessels fishing in an east-west direction.
Alternative E—Reduced Project Size Alternative	Under Alternative E, the Reduced Project Size Alternative, the construction, operation, maintenance, and eventual decommissioning of a large-scale commercial wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures, with the following exception: the proposed Project would consist of no more than 84 WTGs in order to potentially reduce impacts on existing ocean uses and environmental resources.

Alternative	Description
Alternative F—No Action Alternative	Under Alternative F, the No Action Alternative, the proposed Project and associated activities as described in the Vineyard Wind COP would not be approved and the proposed construction, operation, maintenance, and decommissioning activities would not occur. Any potential environmental and socioeconomic costs and benefits associated with the proposed Project as described under Alternative A, the Proposed Action, would not occur.

COP = Construction and Operations Plan; MW = megawatt; OCS = Outer Continental Shelf; WTG = wind turbine generator

These alternatives were developed using screening criteria for determining a range of reasonable alternatives, extensive coordination with state and federal agencies, and input from the public and potentially affected stakeholders through the Draft EIS scoping process (see Section 4.3). The alternatives summarized above and analyzed in this Draft EIS support the purpose and need for the EIS, are within the scope of the Proposed Action, are relevant to BOEM's decision, and are implementable and technically feasible.

The alternatives listed in Table 2.1-1 are not mutually exclusive. If the COP is approved or approved with modifications, BOEM could "mix and match" multiple listed alternatives to result in a preferred alternative so long as crucial design parameters are compatible and otherwise meet the purpose and need of the Proposed Action. For example, BOEM could select a combination of alternatives for the proposed Project with the Northern-most Wind Turbines Removed and only the Covell's Beach Cable Landfall (i.e., Alternatives B and C).

As part of the Proposed Action, Vineyard Wind would self-implement measures to avoid or reduce impacts (summarized in COP Table 4.2-1; Epsilon 2018a); however, BOEM considers only those measures that Vineyard Wind has committed to in its COP to be part of the Proposed Action and action alternatives. The alternatives listed in Table 2.1-1 do not include potential additional mitigation measures that are analyzed separately in this Draft EIS (see Section 2.2.1). BOEM may select any of these mitigation measures in addition to its preferred alternative, and may select other measures arising during review of the COP. Compliance with existing laws and regulations by Vineyard Wind and BOEM may require additional measures or changes to the measures described in this Draft EIS. The completion of consultations—for example under the Marine Mammal Protection Act (MMPA), Section 7 of the Endangered Species Act (ESA), or Magnuson-Stevens Fishery Conservation and Management Act (MSA)—may result in additional measures or changes to the measures described in this Draft EIS.

2.1.1. Proposed Action (Alternative A)

Alternative A, the Proposed Action, would allow Vineyard Wind to construct, operate, maintain, and eventually decommission a wind energy facility approximately 800 MW in scale on the OCS offshore Massachusetts within Vineyard Wind's WDA, along with associated export cables. As discussed in Section 1.1, Vineyard Wind has submitted a COP describing its Proposed Action, which is summarized below. The Proposed Action does not include additional mitigation measures that BOEM is analyzing and could implement as part of its review and potential approval process (see Section 2.2.1 and Appendix D). Vineyard Wind would undertake the Proposed Action within the PDE summarized in Table G-1.[1] Additional details of the Proposed Action are contained in COP Volume I (Epsilon 2018a).

2.1.1.1. Construction and Installation

The Proposed Action would include the construction and installation of both onshore and offshore facilities. Construction and installation would begin late 2019 and be completed in 2022. Vineyard Wind anticipates beginning land-based construction before the offshore components. The majority of land-based construction activities would occur outside of the summer season. A detailed Project schedule is included in COP Chapter 4, Figure 4.1-1 (Volume I; Epsilon 2018a).

Onshore Activities and Facilities

Proposed onshore Project elements include the landfall site, the onshore export cables from the landfall site to the onshore substation, the onshore substation site, and the connection from the proposed substation site to the existing bulk power grid (see Figure 2.1-1). COP Volume I provides detailed construction and installation methods (Epsilon 2018a).

The proposed Project contemplates two Onshore Export Cable Routes (OECRs), with alternative options within each route. The western route would begin at the Covell's Beach landfall site in Barnstable, while the eastern route would begin at the New Hampshire Avenue landfall site in Yarmouth. The majority of the two proposed OECRs would pass

[1] See Section 1.6.1 and Appendix G for additional design envelope information.

through already developed areas, primarily paved roads and existing utility ROWs, and would be entirely underground. Either route would run for 5.4 miles (8.6 km^2) to 6 miles (9.7 km^2) until it reached the proposed substation site discussed below. Figure 2.1-1 shows the two proposed landfall option locations, Covell's Beach and New Hampshire Avenue. The Covell's Beach landfall site is located on Craigville Beach Road near a paved parking lot entrance to a public beach that is owned and managed by the Town of Barnstable. The New Hampshire Avenue landfall site is located inside of Lewis Bay at a dead-end road just west of Englewood Beach at a low concrete bulkhead. The transition of the export cables from offshore to onshore would be accomplished by horizontal directional drilling (HDD), which would bring the proposed cables beneath the nearshore area, the tidal zone, beach, and adjoining coastal areas to one of the two proposed landfall sites. Alternatively, Vineyard Wind could bring the proposed cables ashore at the New Hampshire Avenue landfall through direct bury. Vineyard Wind has requested approval of both landfall locations as part of its PDE, but would only implement one for the Proposed Action. The Draft EIS assesses both proposed landfall locations, as well as the different proposed installation methods.

Vineyard Wind would construct one or more underground concrete transition vaults, also called splice vaults, at the landfall site. These would be accessible after construction via a manhole. Inside the splice vault(s), the 220-kilovolt (kV) alternating current (AC) offshore export cables would be connected to the 220-kV onshore export cables.

Vineyard Wind would run the onshore export cables through a single concrete duct bank buried along the entire OECR. The duct bank may vary in size along its length, and the planned duct bank could be arrayed four conduits wide by two conduits deep (flat layout) measuring up to 5 feet (1.5 meters) wide by 2.5 feet (0.8 meter) deep or vice versa with an upright layout with two conduits wide by four conduits deep. The top of the duct bank would typically have a minimum of 3 feet (0.9 meter) of cover comprised of properly compacted sand topped by pavement.

The proposed onshore export cables would terminate at the proposed substation site. This previously developed site is adjacent to an existing substation within Independence Park, a commercial/industrial area in Barnstable. The new onshore substation site would occupy 7 acres (28,328.1 square meters [m^2]). The buried duct bank would enter the proposed onshore substation site via an access road that provides access to the transmission corridor from Mary Dunn Road. The onshore substation site would connect the proposed Project to the existing bulk power grid via step-down transformers. Vineyard Wind plans to connect the proposed Project to the grid via available positions at the Eversource Barnstable Switching Station, just north of the proposed onshore substation site (see Figure 2.1-1); however, Vineyard Wind's COP also includes an option to connect at the West Barnstable Switching Station.

Onshore construction and installation activities and associated equipment would involve fuel and lubricating and hydraulic oils.

Offshore Activities and Facilities

Proposed offshore Project components include WTGs and their foundations, electrical service platforms (ESPs) and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cables that connects the ESPs, and the export cables to the landfall location (see Figure 2.1-2). The proposed offshore Project elements are located within federal waters, with the exception of a portion of the export cables located within state waters. COP Section 4.2.3 provides a detailed description of proposed construction and installation methods (Volume I; Epsilon 2018a).

Vineyard Wind would erect up to 100 WTGs of 8 to 10 MW capacity extending up to 696 feet (212 meters) above mean lower low water (MLLW) with a spacing between WTGs of approximately 0.75 to 1 nautical mile within the 75,614 acre (306 km^2) WDA. Vineyard Wind would mount the WTGs on either monopile or jacket foundations. A monopile is a long steel tube driven 66 to 148 feet (20 to 45 meters) into the seabed. A jacket foundation is a latticed steel frame with three or four supporting piles driven 98 to 197 feet (30 to 60 meters) into the seabed. Vineyard Wind would likely install jacket foundations in deeper WTG locations. Vineyard Wind's PDE includes up to 12 jacket foundations for the proposed Project (up to 10 jackets for WTG foundations and up to 2 jackets for ESP foundations). Schematic drawings and photos of the proposed foundation types are included in COP Volume I, Section 3.1.2 (Epsilon 2018a). Each WTG would contain approximately 1,585 gallons (6,000 liters) of transformer oil and approximately 2,113.4 gallons (8,000 liters) of general oil (for hydraulics and gearboxes). Use of other chemicals would include diesel fuel, coolants/refrigerants, grease, paints, and sulphur hexafluoride. COP Section 4.2 provides additional details related to proposed chemicals and their anticipated volumes (Volume I; Epsilon 2018a).[2]

[2] Section 3.2.2 provides information related to the potential impacts of chemical spills from wind turbines. Additional specific information related to environmental risks, fate, and effects of chemicals associated with wind turbines on the Atlantic OCS can be found in Bejarano et al. 2013.

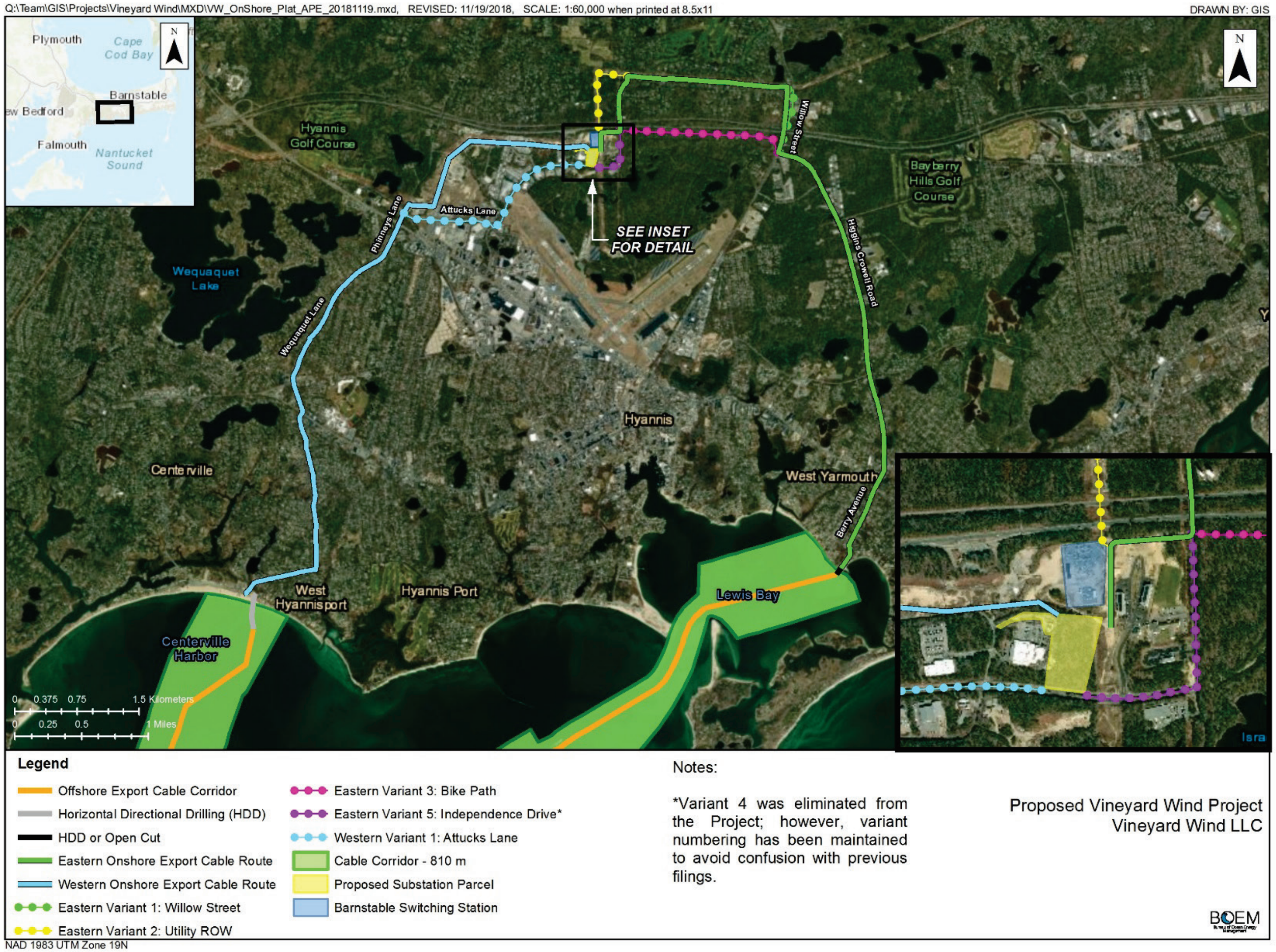
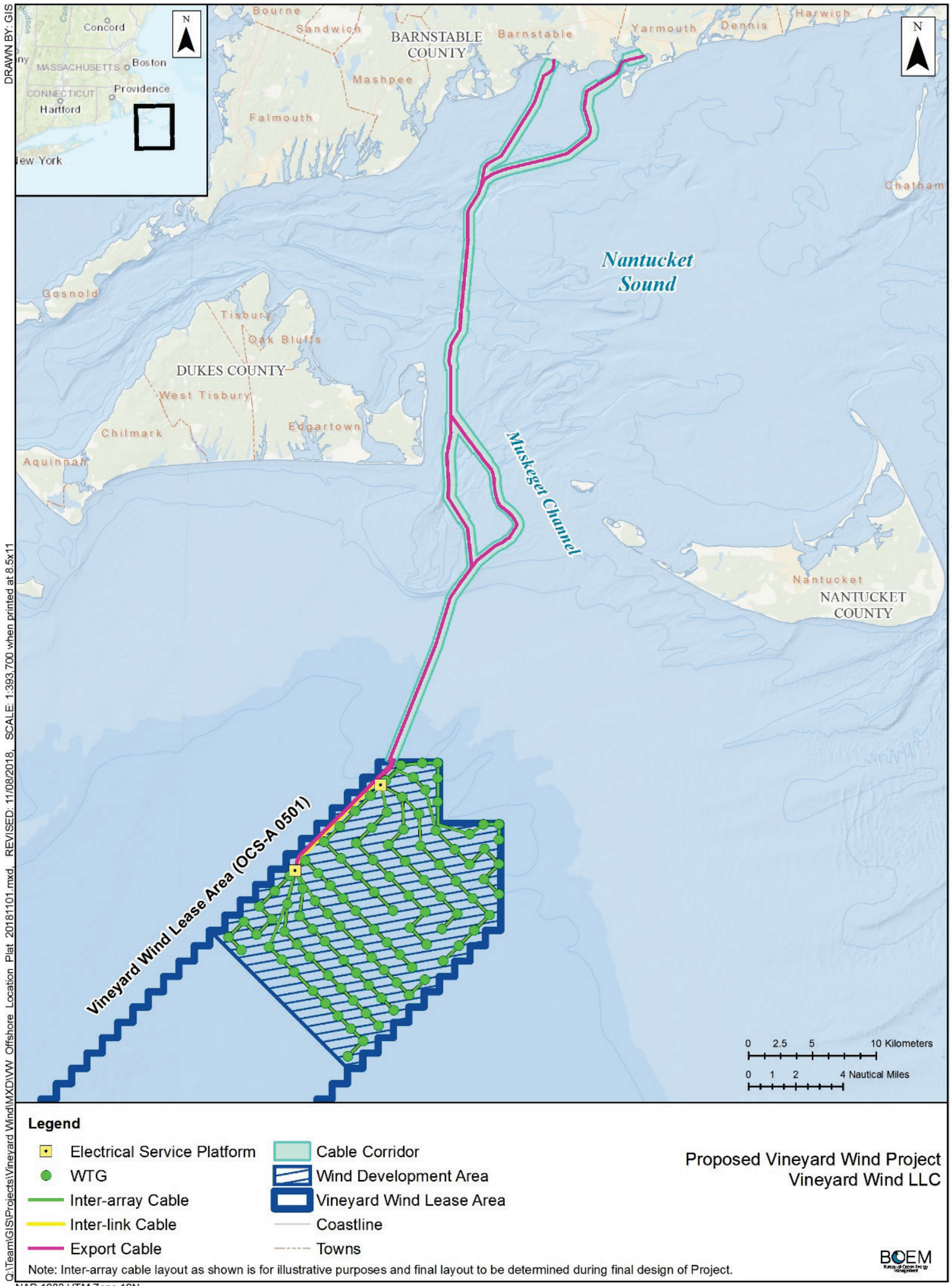


Figure 2.1-1: Proposed Landfall Sites



Note: The inter-array cable layout shown is an example, and the final layout and location of the cables would be located within the approved PDE.

Figure 2.1-2: Proposed Offshore Project Elements

Vineyard Wind would construct one to two ESPs, each installed on a monopile or jacket foundation, in the WDA. The ESPs would serve as the interconnection point between the WTGs and the export cables. The ESPs would be located along the northwest edge of the WDA and would include step-up transformers and other electrical equipment needed to connect the 66-kV inter-array cables to the 220-kV offshore export cables. Between 6 and 10 WTGs would be connected through an inter-array cable that would be buried below the seabed and then connected to the ESPs. If the proposed Project uses more than one ESP, a 200-kV inter-link cable would be required to connect the ESPs together. Each ESP would contain up to approximately 123,209.9 gallons (466,400 liters) of transformer oil and approximately 348.7 gallons (1,320 liters) of general oil. As mentioned above, COP Section 4.2 provides additional details related to chemicals and their anticipated volumes (Volume I; Epsilon 2018a). Vineyard Wind has stated that the Proposed Action would be designed to meet International Electrotechnical Commission standards for WTGs. The WTGs would be designed to endure sustained wind speeds of up to 112 miles per hour (mph) (182.2 kilometers per hour [kph]) and gusts of 157 mph (252.7 kph). WTGs would also automatically shut down when wind speeds exceed 69 mph (111 kph). In addition, the structures would be designed for maximum wave heights greater than 60 feet (18.3 meters) (Vineyard Wind 2018e).

The WTGs and ESPs would include a nighttime obstruction lighting system that complies with Federal Aviation Administration (FAA) and United States Coast Guard (USCG) lighting standards, and is consistent with BOEM best practices. Vineyard Wind's Aids to Navigation Plan would describe the lighting and marking system as part of the final layout plan. As outlined in Section 2.2.1, Vineyard Wind may be required, as a condition of COP approval, to use either an Aircraft Detection Lighting System (ADLS) that would automatically activate lights when aircraft approach, or a system that automatically adjusts lighting intensity based on visibility conditions, either of which would require FAA approval. Vineyard Wind would paint WTGs no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey to help reduce potential visibility against the horizon. Additionally, the lower sections of each structure would be marked with high-visibility yellow paint from the water line to an approximate height of at least 50 feet (15 meters), consistent with International Association of Lighthouse Authorities guidance. To further enhance marine navigation safety, sound signals[3] and automatic identification system (AIS) transponders may be included on some or all of the structures.

Vineyard Wind would install foundations and WTGs using a jack-up vessel and/or a vessel capable of dynamic positioning[4], as well as necessary support vessels and barges. Vessels would be equipped with a crane and a pile-driving hammer. Vineyard Wind would begin pile driving by using a soft start to help enable some marine life to leave the area before driving intensity increases. ESP foundation installations may require specialized crane vessels. It is possible that monopiles would be transported to the WDA by floating them in the water while pulled by tugs. COP Section 4.2.3 provides more details about installation (Volume I; Epsilon 2018a).Vineyard Wind would place scour protection around all foundations to stabilize the seabed near the foundations as well as the foundations themselves. The scour protection would be approximately 3 to 6 feet (1 to 2 meters) in height, would extend away from the foundation as far as 94 feet (28.6 meters), and would consist of rock and stone ranging from 4 to 12 inches (10 to 30 centimeters) on the intermediate axis.

Two offshore export cables in one cable corridor would connect the proposed wind facility to the onshore electrical grid (see Figure 2.1-2). Each offshore export cable would consist of three-core 220-kV AC cables that would deliver power from the ESPs to the onshore facilities. The cable routes currently being considered contain several routing options. The Offshore Export Cable Corridor (OECC) from the WDA could pass through the deepest part of Muskeget Channel proper, or it could pass atop the shoals to the east of the deepest area (see Figure 2.1-2). As the offshore export cables approaches Cape Cod, the final route would be contingent on the choice of landfall site, which would occur either at Covell's Beach in Barnstable or at New Hampshire Avenue in Yarmouth.

As part of the PDE, Vineyard Wind has proposed several cable route installation methods for the inter-array cables, inter-link cables, and offshore export cables. Vineyard Wind would bury the cables using a jet plow, mechanical plow, and/or mechanical trenching, as suited for the bottom type in the immediate area. Prior to installation of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. Following the pre-grapnel run, dredging within the OECC would occur (where necessary) to allow for effective cable laying through the sand waves. The majority of dredging would occur on large sand waves, which are mobile features. See COP Volume II-A, Figure 2.1-13 for an indication of areas prone to large sand waves (Epsilon 2018a). Vineyard Wind anticipates that dredging would occur within a corridor that is 65.6 feet (20 meters) wide and 1.6 feet (0.5 meters) deep, and potentially as deep as 14.7 feet (4.5 meters). Vineyard Wind is proposing to lay most of the inter-array cables and offshore export cables using simultaneous lay and bury via jet embedment. In certain areas, alternative installation methods may be needed. In any case, cable burial would likely use a tool that

[3] In consultation with USCG, sound signals could include audible sound devices, such as horns, on the WTGs and ESPs.
[4] Dynamic positioning allows a vessel to maintain its position by using a computer-controlled system that operates the propellers and thrusters.

slides along the seafloor on skids or tracks (up to 3.3 to 6.6 feet [1 to 2 meters] wide), which would not dig into the seafloor but would still cause temporary disturbance. The installation methodologies are described in detail in COP Volume I, Section 4.2.3 (Volume I; Epsilon 2018a).

For the installation of the two cables, total dredging could impact up to 69 acres (279,400 m^2) and could include up to 214,500 cubic yards (164,000 cubic meters) of dredged material. Vineyard Wind could use several techniques to accomplish the dredging: trailing suction hopper dredge (TSHD) or jetting (also known as mass flow excavation).[5] TSHD would discharge the sand removed from the vessel within the 2,657-foot (810-meter) wide cable corridor.[6] Jetting would use a pressurized stream of water to push sand to the side. The jetting tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. The down pipe is positioned over the cable alignment, enabling the stream of water to fluidize the sands around the cable, which allows the cable to settle into the trench. This process causes the top layer of sand to be side-casted to either side of the trench; therefore, jetting would both remove the top of the sand wave and bury the cable. Typically, a number of passes are required to lower the cable to the minimum target burial depth.

Vineyard Wind would need to use vessels, vehicles, and aircraft during construction. The construction and installation phase of the Project would make use of both construction and support vessels to complete tasks in the WDA and along the OECC. Construction vessels would transit between the WDA and the New Bedford Marine Commerce Terminal (MCT); however, vessels may operate from other port facilities, as needed. During construction and installation, Vineyard Wind anticipates an average of approximately 25 vessels operating during a typical workday in the WDA and along the OECC. Vineyard Wind has noted that many of those vessels would remain in the WDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning, if needed. Therefore, Vineyard Wind expects that proposed-Project construction would generate an average of seven daily trips to or from New Bedford Harbor or a secondary port each day. During the proposed Project's most active construction period, Vineyard Wind estimates that a maximum of approximately 46 vessels could operate simultaneously within the WDA or OECC. In an extreme case, all 46 of these vessels could need to travel to or from New Bedford or a secondary port in the same day; however, Vineyard Wind estimates that activities during the proposed Project's most active period would typically generate 18 vessel trips per day to or from ports. The maximum number of vessels involved in the proposed Project at any one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act (COP Volume III, Section 7.8 and Appendix III-I). Vessel types proposed for the cable installation could be vessels capable of dynamic positioning, anchored vessels, self-propelled vessels, and/or barges.

Protection conduits installed at the approach to each WTG and ESP foundation would protect all offshore export cables and inter-array cables. In the event that cables cannot achieve proper burial depths or where the proposed offshore export cables cross existing infrastructure, Vineyard Wind could use the following protection methods: (1) rock placement, (2) concrete mattresses, or (3) half-shell pipes or similar product made from composite materials (e.g., Subsea Uraduct from Trelleborg Offshore) or cast iron with suitable corrosion protection.[7] Vineyard Wind has conservatively estimated up to 10 percent of the inter-array and OECC would require one of these protective measures. Based on ongoing review of the 2018 survey data for the WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array and inter-link cables due to consistent geology to the cable burial depth with limited coarse material. For the offshore export cables, the geology is more variable closer to shore. Extensive and iterative analyses of the data would take place up until the time of installation in an effort to ensure burial and avoid the use of cable protection. These analyses may allow Vineyard Wind to identify areas with a greater risk of insufficient cable burial; however, final locations for cable protection, if needed, would not be known until completion of proposed Project installation activities.

[5] TSHD can be used in sand waves of most sizes, whereas the jetting technique is most likely to be used in areas where sand waves are less than 6.6 feet (2 meters) high. Therefore, the sand wave dredging could be accomplished entirely by the TSHD on its own, or the dredging could be accomplished by a combination of jetting and TSHD, where jetting would be used in smaller sand waves and the TSHD would be used to remove the larger sand waves.

[6] Vineyard Wind anticipates that the TSHD would dredge along the OECC until the hopper was filled to an appropriate capacity, then the TSHD would sail several hundred meters away (while remaining within the 2,657-foot [810-meter] corridor) and bottom dump the dredged material.

[7] Half-shell pipes come in two halves and are fixed around the cable to provide mechanical protection. Half-shell pipes or similar solutions are generally used for short spans, at crossings or near offshore structures, where there is a high risk from falling objects. The pipes do not provide protection from damage due to fishing trawls or anchor drags (COP Volume I, Section 3.1.5.3; Epsilon 2018a).

Construction Facilities

Port facilities used for construction would include the 26-acre (0.1-km^2) MCT and possibly other nearby ports (Figure 2.1-3). Vineyard Wind would use the MCT to offload shipments of components, prepare them for installation, and load components onto jack-up barges or other suitable vessels for delivery to the WDA (COP Volume I, Section 4.2; Epsilon 2018a). Vineyard Wind may stage certain activities from other Massachusetts or North Atlantic commercial ports (Figure 2.1-3).

Vineyard Wind has indicated that ports may require site-specific modifications, shoreline stabilization, maintenance dredging, installation of various equipment to berth construction and installation vessels, as well as new structures to accommodate workforce and equipment needs; however, Vineyard Wind does not propose to direct or implement any potential port improvements. Rather, Vineyard Wind would consider whether the ports are suitable for Vineyard Wind's needs if and when the owner or lessor makes any necessary upgrades. Therefore, none of these port upgrades would be occurring as a direct result of the Proposed Action (COP Volume I, Section 3.2.5; Epsilon 2018a). Table 2.1-2 lists the ports that Vineyard Wind could use for the proposed Project.

Table 2.1-2: Potential Construction Ports

Stage [a]	Port
Construction Staging/Fabrication	Bridgeport, CT
	New London, CT
	Brayton Point, Somerset, MA
	Montaup, Somerset, MA
	Other New Bedford Ports, MA
	Providence, RI
	Quonset Point, North Kingstown, RI
	Canadian Ports [b]

[a] Vineyard Wind has not identified any ports that could be used during proposed Project operations and maintenance other than the New Bedford Marine Commerce Terminal or Vineyard Haven Harbor.
[b] Vineyard Wind states that it is considering the ports of Saint John, New Brunswick, and Halifax and Sheet Harbour, Nova Scotia.

2.1.1.2. Operations and Maintenance

The proposed Project would have an operating phase of 30 years[8]. Vineyard Wind would monitor operations continuously from the Operations and Maintenance Facilities and possibly other remote locations as well. Specifically, Vineyard Wind would use a new operations and maintenance facility in Vineyard Haven on Martha's Vineyard. The Operations and Maintenance Facilities would include offices, control rooms, warehouses, shop space, and pier space, which may be supplemented by continued use of the MCT on the mainland; however, as mentioned above, Vineyard Wind does not propose to direct or implement any port improvements. Therefore, none of these activities would be occurring as a direct result of the Proposed Action (COP Volume I, Section 3.2.5; Epsilon 2018a).

The proposed Project would include a comprehensive maintenance program, including preventive maintenance based on statutory requirements, original equipment manufacturers' guidelines, and industry best practices. In addition, before construction and installation activities begin, Vineyard Wind would complete an Oil Spill Response Plan, an Emergency Response Plan, and a Safety Management System (see COP Appendices I-A and I-B; Epsilon 2018a) that would be issued to the vessels and construction firms. Vineyard Wind would inspect WTGs, foundations, ESPs, inter-array cables, offshore export cables, landfall locations, onshore export cables, and other parts of the proposed Project using methods appropriate for the location and element characteristics.

Onshore Activities and Facilities

The onshore substation site, onshore export cables, and splice vaults would require minimal maintenance. When needed, Vineyard Wind would conduct inspections and repairs according to industry standards for land-based power transmission facilities.

[8] Vineyard Wind's lease with BOEM (Lease OCS-A 0501) has an operations term of 25 years that commences on the date of COP approval. (See https://www.boem.gov/Lease-OCS-A-0501/ at Addendum B; see also 30 CFR § 585.235(a)(3).) Vineyard Wind would need to request an extension of its operations term from BOEM in order to operate the proposed Project for 30 years. For purposes of the maximum-case scenario and to ensure NEPA coverage if BOEM grants such an extension, however, the Draft EIS analyzes a 30-year operations term.

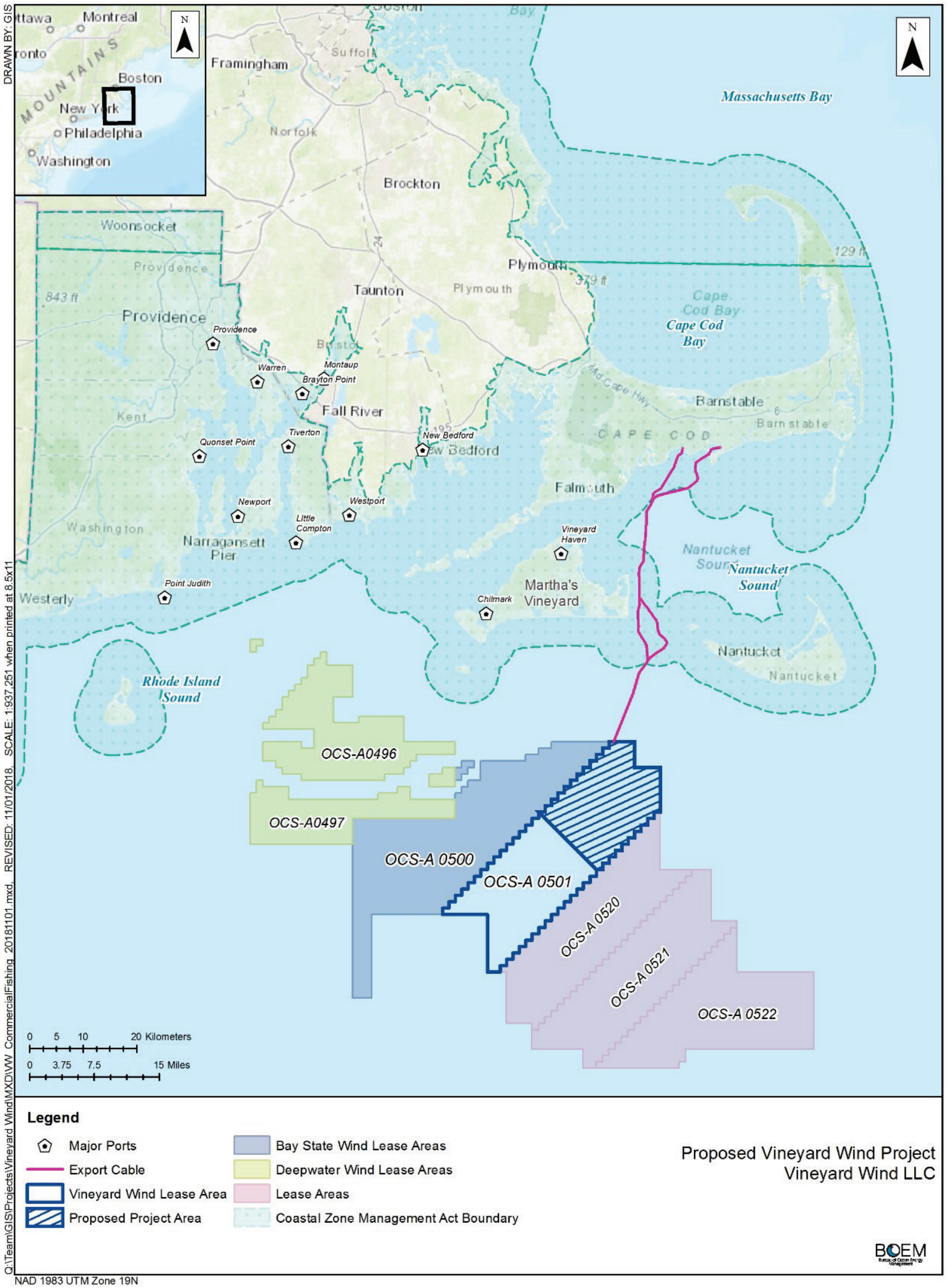


Figure 2.1-3: Proposed Port Facilities for Construction

Offshore Activities and Facilities

Vineyard Wind would design WTGs and ESPs to operate by remote control, so personnel would not be required to be present except to inspect equipment and conduct repairs. Spare parts would be housed at the Operations and Maintenance Facilities, and possibly other facilities for larger parts, and would be available so that Vineyard Wind could initiate repairs expeditiously.

Vineyard Wind would need to use vessels, vehicles, and aircraft during operations and maintenance. The Proposed Action would generate trips by crew transport vessels (about 75 feet [22.3 meters] in length), multipurpose vessels, and service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length), with larger vessels based at the MCT and smaller vessels based at Vineyard Haven. In a typical year, the Proposed Action would generate 256 crew transfer vessel trips, 110 multipurpose vessel trips, and 26 service operation vessel trips (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2018a). Dedicated crew transport vessels specifically designed for offshore wind energy work would provide access. These vessels would be based primarily at the Operations and Maintenance Facilities. Vineyard Wind may also use helicopters for access and/or visual inspections. The helicopters would be based at a general aviation airport near the Operations and Maintenance Facilities.

Vineyard Wind would change WTG gearbox oil after years 5, 13, and 21 of service. See COP Section 4.3 for additional operations and maintenance information (Volume I; Epsilon 2018a).

Vineyard Wind's proposed WTG layout includes demarcated 1-nautical-mile corridors in the northwest/southeast and northeast/southwest direction within the WTG array. In addition, Vineyard Wind intends to adopt a 2-nautical-mile-wide regional transit lane that is being developed through discussion among fishing stakeholders and state agencies (COP Volume I, Section 2.1; Epsilon 2018a). If Vineyard Wind and other stakeholders achieve consensus on this lane, it would be oriented in the northwest to southeast direction and would reside to the south of the WDA (see Figure 2.1-2, COP Volume I, Section 2.1; Epsilon 2018a).

2.1.1.3. Decommissioning

According to 30 CFR Part 585 and other BOEM requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR § 585.910(a)). Absent permission from BOEM, Vineyard Wind would have to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension if it wanted to operate the proposed Project for more than 30 years.

The above decommissioning plans are subject to a separate approval process. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Vineyard Wind would need to obtain separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. As noted above, BOEM regulations require the removal of all Project facilities and complete site clearance.

Onshore Activities and Facilities

Depending on the needs of the host town, Vineyard Wind may leave onshore facilities in place for future use. Cable removal, if required, would probably proceed using truck-mounted winches and handling equipment. There are no plans to disrupt streets or onshore public utility ROWs by excavating or deconstructing buried facilities.

Offshore Activities and Facilities

Offshore cables may be retired in place or removed. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gears), Vineyard Wind is committed to removing scour protection during decommissioning. Vineyard Wind would drain WTG and ESP fluids into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion buried below 15 feet (4.6 meters) would remain, and the depression refilled with the temporarily removed sediment. By maintaining an inventory list of all components of the proposed Project, the decommissioning team would be able to track each piece so that no component would be lost or forgotten.

2.1.2. Alternative B—Covell's Beach Cable Landfall Alternative

As summarized in Table 2.1-1, Alternative B would be identical to Alternative A, the Proposed Action, with one exception: it would eliminate the New Hampshire Avenue cable landfall location and would be limited to the Covell's Beach landfall location. All other proposed Project elements would be the same as described under Alternative A.

2.1.3. Alternative C—No Surface Occupancy in the Northern-Most Portion of the Project Area Alternative

Under Alternative C, no surface occupancy would occur in the northern/northeastern-most portion of the WDA, resulting in the exclusion of some of the northern-most WTG locations as shown on Figure 2.1-4. The impact assessment of this alternative includes the following assumptions:

- The acreage of the WDA would remain unchanged, and all WTGs and ESPs would be sited within the same sized footprint as described under the Proposed Action.
- The six northern-most WTG locations identified in Figure 2.1-4 would be removed and instead placed along the southern portion of the WDA. A new inter-array cable would link these WTGs to the southern ESP(s).
- There would be no changes to ESP locations or the OECC routes.
- Additional survey work may be required to address changes in WTG placements and inter-array cable locations; however, these surveys would be limited in nature and Project delays would not be anticipated.

2.1.4. Alternative D—Wind Turbine Layout Modification Alternative

Alternative D includes two sub-alternatives related to the layout of the WTGs. A description of each sub-alternative and the assumptions made for impact assessment purposes are described below. Prior to COP approval, BOEM would require substantial additional survey work for the two sub-alternatives to resolve data gaps for WTG placements and inter-array cable locations not contemplated in Alternative A (the Proposed Action). These site characterization surveys would be similar to those described in Section 3.1.3 of the EA (BOEM 2012a), with the attendant environmental impacts described in EA Section 4.2 (BOEM 2012a)

2.1.4.1. Alternative D1—One-Nautical Mile Wind Turbine Spacing Alternative

This alternative would ensure all WTGs having a minimum spacing of 1 nautical mile between them (the Proposed Action allows for a minimum of 0.75 nautical miles spacing). Furthermore, the lanes between turbines would also be a minimum of 1 nautical mile wide to potentially reduce conflicts with existing ocean uses such as commercial fishing and marine navigation. The impact assessment of this sub-alternative includes the following assumption:

- There would be no changes to the number of WTGs, ESP locations, or the OECC routes.
- There would be no demarcated transit corridors within the WDA. The total acreage of the WDA would increase by approximately 22 percent from 75,614 acres (306 km^2) to approximately 92,217 acres (373 km^2) as a result of requiring additional space to accommodate WTGs spaced at a greater distance than the Proposed Action (see Figure 2.1-5). To calculate this change in area, BOEM assumes the distance from the southern-most row of WTGs and the southern WDA boundary to be the same as the distance under the Proposed Action[9].
- The amount and length of inter-array cabling would increase but would not exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers).
- The construction schedule and timing would not be the same as under the Proposed Action if significant additional survey work is required, potentially delaying the proposed Project for at least a year.

2.1.4.2. Alternative D2 – East-West Wind Turbine Layout Alternative

This alternative would arrange the WTG layout in an east-west orientation. In addition to the east-west orientation, all WTGs in the east-west direction would have a minimum spacing of 1 nautical mile between them. The impact assessment of this sub-alternative includes the following assumptions:

- There would be no changes to the number of WTGs or the OECC routes.
- There would be no demarcated transit corridors within the WDA.
- The acreage of the WDA throughout which Project components would be distributed would increase[9] (see Figure 2.1-5).
- The amount and length of inter-array cabling would increase but would not exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers).
- The construction schedule and timing would not be the same as under the Proposed Action if significant additional survey work is required, potentially delaying the Project for at least a year.

[9] If the regional transit lane discussed above is established for fishing vessels, WTG placements associated with this alternative would need to be placed south of the transit lane, thus increasing the footprint required for this alternative.

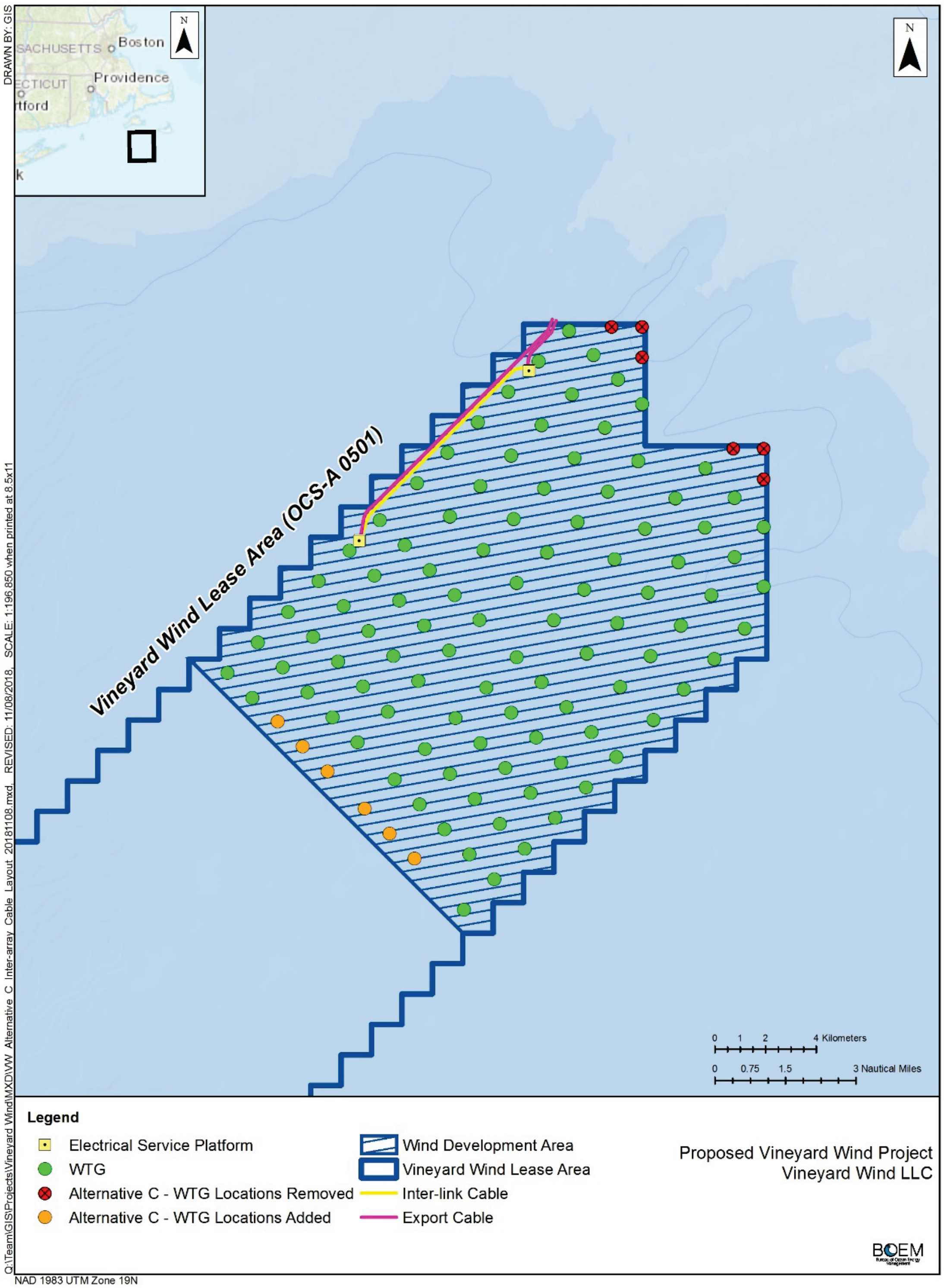
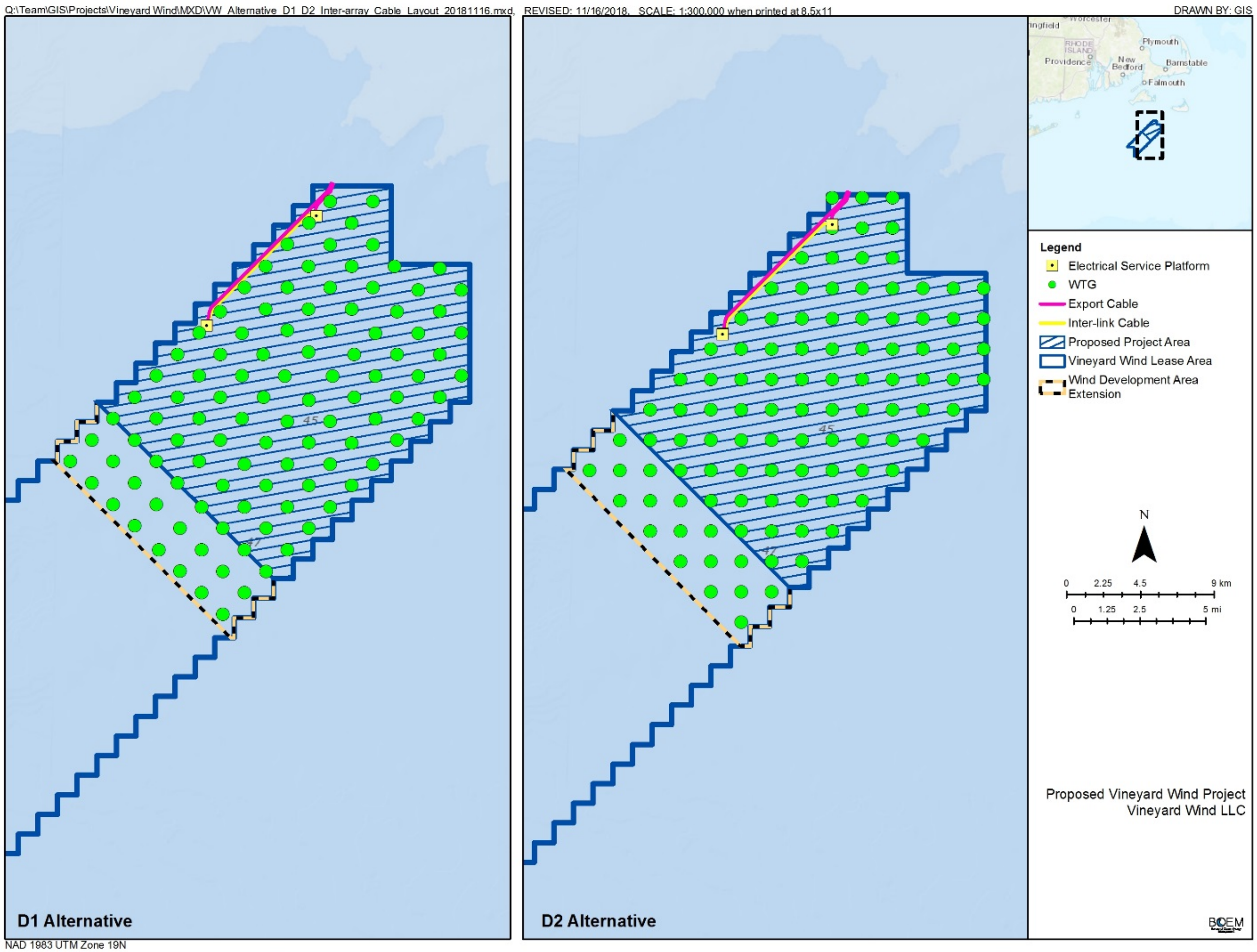


Figure 2.1-4: Alternative C—No Surface Occupancy in the Northern-Most Portion of the Project Area Alternative



Note: The layout shown is for illustrative purposes only.

Figure 2.1-5: Alternative D1—1-Nautical-Mile WTG Spacing and Alternative D2—East-West and 1 Nautical Mile WTG Layout

2.1.5. Alternative E—Reduced Project Size Alternative

Alternative E would limit the proposed Project to 84 WTGs. On November 9, 2018, Vineyard Wind informed Rhode Island's Coastal Resources Management Council that they could use the largest WTG commercially available and would only need 84 WTG locations to achieve an approximately 800 MW capacity project (Vineyard Wind 2018f). In addition, on November 27, 2018, Vineyard Wind announced their preferred WTG supplier and indicated that 84 units of 9.5 MW WTGs would be expected to be utilized (Vineyard Wind 2018g). The impact assessment of this alternative includes the following assumptions:[10]

- The ESP locations and the OECC routes would be the same as the Proposed Action.
- The spacing between each of the transit corridors would be at least the same distance as the Proposed Action, but could be greater. The locations of the transit corridors themselves would remain the same.
- The construction schedule and timing would be the same as the Proposed Action.
- The acreage of the WDA would likely decrease.
- The use of 9.5-MW WTGs would be required for approximately 800 MW total power generation.
- The 84 WTGs would be located within the 106 locations presented as part of the Proposed Action by Vineyard Wind.

2.1.6. Alternative F—No Action Alternative

As described in Table 2.1-1, under the No Action Alternative, BOEM would not approve the proposed Project activities of the Vineyard Wind Offshore Project. No other permits and/or authorizations for this proposed Project would be issued.

2.1.7. Alternatives Considered but not Analyzed in Detail

Several alternatives have been considered but eliminated from detailed study. These alternatives were identified through coordination with state and federal agencies and input from the public and potentially affected stakeholders through the Draft EIS scoping process (see Section 4.3). BOEM evaluated the alternatives described below, and excluded them from further consideration because they did not meet the purpose and need and/or did not meet the screening criteria. These alternatives are presented below with a brief discussion of the reasons for their elimination as prescribed in Council on Environmental Quality (CEQ) regulations at 40 CFR § 1502.14(a) and Department of the Interior regulations at 43 CFR § 46.420(b-c). The screening criteria used included:

- Consistency with law and regulations;
- Operational, technical, and economic feasibility;
- Environmental impact; and
- Geographical considerations.

Alternative Wind Turbine Foundation Types: BOEM received comments suggesting the use of suction bucket, gravity based, or floating wind turbine foundation types to reduce impacts to marine mammals, sea turtles, and fish from pile driving associated with monopile and jacket foundations. These foundation types are not feasible within the Project area due to, among other things, the seafloor substrate and water depths, specifically:

- The dense soils beneath an upper loose surficial layer of sand may prevent the full penetration required for stability of suction bucket foundations.
- The loose upper layer of sandy sediment also presents a settlement risk for gravity-based foundations.
- The water depths are too shallow in portions of the Project area for floating foundations, a technology that is unproven for a project the size of what is proposed by Vineyard Wind.

While these foundation types would not require pile driving, the larger footprint of suction bucket and gravity-based foundations would increase seabed disturbance; additionally, all three foundation types would create less room for fishing activities between turbines when compared to monopile or jacket foundations. Moreover, site preparation and dredging activities for suction bucket and gravity-based foundations could increase environmental impacts when compared to monopile or jacket foundations. The cables associated with floating wind turbines would also increase the risk of entanglement for marine mammals. Overall, these alternative foundation types are not feasible in the Project area and may increase long-term environmental impacts over those from monopile or jacket foundations.

[10] Although Vineyard Wind has indicated that the largest capacity WTG currently available is 9.5 MW, the PDE as well as the impact assessment of the Proposed Action includes use of up to 10 MW WTGs to allow for potential advancements in technology and/or commercial availability.

Alternative Landfall Location: BOEM received comments suggesting a cable landfall at Brayton Point instead of New Hampshire Avenue or Covell's Beach. A landfall at Brayton Point would require the use of a high-voltage direct current transmission line, as opposed to a high-voltage alternating current transmission line, which currently has an accepted length limit of 62 miles (100 km). High-voltage direct current has more technical challenges than high-voltage alternating current, and would require the installation of a midway converter station and associated equipment; this, in turn, would increase the offshore footprint of the proposed Project and introduce additional technical risk. Although this landfall location could require less onshore construction than the Proposed Action, it would likely have greater net environmental impacts due to longer length of the OECC and the construction of an additional converter station. Additional length of cable required for the offshore export cables could also increase impacts on fishing activities due to greater risk of snags for fishing gear. The Brayton Point location is therefore less operationally feasible and increases environmental impacts offshore.

Offshore Regional Transmission Network: Several commenters suggested that BOEM mandate the use of an offshore regional transmission cable system for the proposed Project. This alternative is unfeasible primarily because such a system does not yet exist, BOEM has issued no ROWs for such a system, and there are no pending proposals to construct one. Furthermore, it is unclear what entit(ies) would pay for transmission capacity in excess of what would be required for the Proposed Action. The time needed to properly plan a regional transmission network that would not reduce system resiliency or pose capacity issues for onshore substations would result in substantial delays to the proposed Project timeline. This, in turn, would be inconsistent with EO 13807 and could impact the proposed Project's ability to meet the requirements of its power purchase agreements, potentially foreclosing its economic feasibility. This alternative would effectively be the same as selecting Alternative F (No Action). At the present time, these factors outweigh any potential future decrease in cumulative seabed disturbance that may result from having multiple projects sharing one regional cable network.

Shared Cable Corridor: Some commenters suggested that BOEM mandate the use of a shared cable corridor as the OECC. BOEM believes this alternative is unnecessary at the present time because construction of a cable within the OECC would not foreclose the future installation of cables for other offshore wind facilities along the same route. BOEM can authorize multiple cable easements and ROWs in parallel and in relatively close proximity. For example, 30 CFR § 585.302(b) states that the rights granted under a ROW for a transmission cable would not prevent the granting of other rights by the United States, either before or after the granting of the ROW, provided a subsequent authorization would not unreasonably interfere with the activities or existing operations. Moreover, as discussed above, requiring the construction of cables that accommodate future offshore wind facilities as part of the proposed Project could create capacity issues for onshore substations, and is it is unclear what entit(ies) would pay for transmission capacity in excess of what would be required for the Proposed Action. At this time, these factors outweigh any potential future decrease in cumulative seabed disturbance that may result from having multiple projects sharing one cable corridor.

Alternative Location for the Wind Energy Facility Outside of Lease OCS-A 0501: Locating the wind energy facility outside of lease area OCS-A 0501 would constitute a new proposed action, and would not address BOEM's regulatory need to respond to Vineyard Wind's proposal to build a large-scale commercial wind energy facility on Lease OCS-A 0501. BOEM's regulations require it to analyze Vineyard Wind's proposal to build a commercial wind energy facility on Lease OCS-A 0501. BOEM would consider proposals on other existing leases through a separate regulatory process. Other potential lease areas may be considered at a later date, either through a competitive lease sale process if multiple companies wish to bid; or through a non-competitive process if no competitive interest exists. This alternative would therefore not meet the purpose and need of this Draft EIS, and would effectively be the same as selecting Alternative F (No Action).

Alternative Location for the Wind Energy Facility Further Offshore in Lease OCS-A 0501: Several commenters have suggested that BOEM consider a project that is on Lease OCS-A 0501 but further offshore and/or further southwest, extending outside the WDA. This alternative would decrease the potential for viewshed conflicts as compared to Alternative A, the Proposed Action, but such benefits would likely be outweighed by increased seabed disturbance from a longer export cable, including the potential addition of a converter station, and longer vessel trips to the Project area during construction and operations. The evidence also does not indicate that moving the proposed Project further offshore within the lease area would reduce impacts to biological resources or commercial fishing. Moving the proposed Project further offshore would also severely impact the proposed Project's feasibility for several reasons. Moving the proposed Project further offshore would also create permitting delays and Project risk due to the need for additional surveys for some or all of the Project area, which would be inconsistent with EO 13807 and could impact the proposed Project's ability to meet the requirements of its power purchase agreements, potentially foreclosing its economic feasibility. Depending on how much further out the proposed Project is moved, this alternative could essentially constitute a different proposal. This alternative would therefore not meet the purpose and need of this Draft EIS, and would effectively be the same as selecting Alternative F (No Action).

Alternative Spacing between Wind Energy Turbines: Several commenters have suggested an alternate spacing of 1.5 to 2 nautical miles or greater between WTGs, which would result in turbines outside the lease area. This alternative would create permitting delays and Project risk due to the need for additional surveys for some or all of the Project area, which would be inconsistent with EO 13807 and could impact the proposed Project's ability to meet the requirements of its power purchase agreements, potentially foreclosing its economic feasibility. While this alternative could reduce the potential for limiting fishing opportunities within the Project area, the substantial increase in the footprint of the proposed Project would likely have a net increase in environmental impacts—particularly due to increased seabed disturbance for inter-array cables and increased duration of vessel trips during construction and operations. If turbines were spaced 1.5 or 2 nautical miles, this alternative would involve turbines being outside the lease area (see Figure 2.1-6; see Alternative Location for the Wind Energy Facility Outside of Lease OCS-A 0501 above) and would essentially constitute a different proposal. This alternative would therefore not meet the purpose and need of this Draft EIS, and would effectively be the same as selecting Alternative F (No Action).

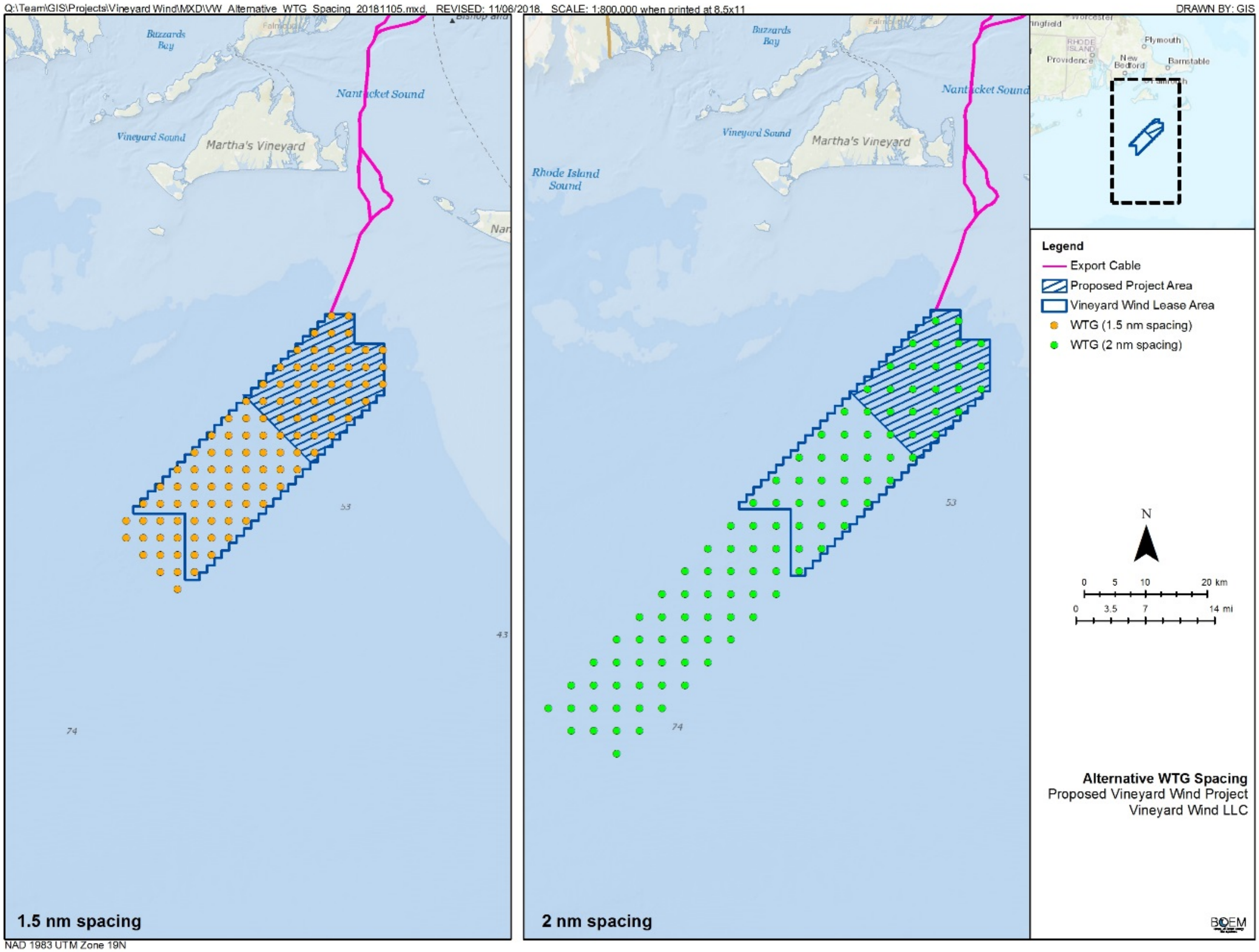
Two Nautical Mile Transit Corridor through WDA: Numerous commercial fisheries stakeholders have asserted that they need a northwest-to-southeast transit corridor to travel from certain ports to fishing grounds on the other side of the WDA, and that such a corridor needs to be at least 2 nautical miles wide for safety purposes. BOEM had initially intended to fully analyze an alternative that removed a row of turbines from Alternative A to create such a corridor. In the interim, however, commercial fisheries stakeholders, state agencies, USCG, and BOEM engaged in discussions to establish transit corridors outside of the WDA that would address fisheries navigation concerns on a regional basis (see Section 2.1.1.2). Therefore, BOEM has concluded that an alternative for a 2 nautical mile transit corridor through the WDA is no longer necessary to address stakeholder concerns and does not provide additional environmental benefits that are not provided by other, fully analyzed alternatives.

Phased Development and Monitoring: Several commenters recommended an alternative under which BOEM would require phased development of the proposed Project. Under this alternative, BOEM would allow initial construction of only a portion of the turbines, require the first phase to be studied for several years, and then only permit the remainder of the turbines to be constructed if deemed environmentally acceptable (or subject to additional terms and conditions) based on the results of those studies. While this alternative might have the eventual effect of reducing some environmental impacts, such reductions in impacts are speculative at this time. This alternative would also, by its nature, create permitting delays and project risk that could impact the proposed Project's ability to meet the requirements of its power purchase agreements, potentially foreclosing its economic feasibility. This alternative would therefore effectively be the same as selecting Alternative F (No Action).

2.2. Resources, Issues, and Mitigation Measures

Based on previous environmental reviews, subject-matter expert input, consultation efforts, and public involvement to date for proposed offshore wind development activities, BOEM considered the following resources to be potentially affected by the proposed Project (directly, indirectly, or both). The baseline conditions of these resources, and the potential impacts of the Proposed Action and other alternatives on them, are evaluated in Chapter 3.

- Air Quality
- Water Quality
- Terrestrial and Coastal Fauna
- Birds
- Bats
- Coastal Habitats
- Benthic Resources
- Finfish, Invertebrates, and Essential Fish Habitat
- Marine Mammals
- Sea Turtles
- Demographics, Employment, and Economics
- Environmental Justice
- Cultural, Historical, and Archaeological Resources
- Recreation and Tourism
- Commercial Fisheries and For-Hire Recreational Fishing
- Land Use and Coastal Infrastructure
- Navigation and Vessel Traffic
- Other Uses (Marine Minerals, Military Use, Aviation, Offshore Energy)



Note: The layout shown is for illustrative purposes only.

Figure 2.1-6: Alternative Spacing Between Wind Energy Turbines

2.2.1. Mitigation Identified for Analysis in the Environmental Impact Statement

As part of the Proposed Action, Vineyard Wind would self-implement measures to avoid or reduce impacts (summarized in COP Table 4.2-1; Epsilon 2018a) on the resources discussed in Chapter 3 of the Draft EIS; however, BOEM considers only those measures that Vineyard Wind has committed to in the COP to be part of the Proposed Action and action alternatives. BOEM may select alternatives and/or require additional mitigation measures to further protect these resources, and other mitigation measures may be required through reviews under several environmental statutes (see Section 2.1). Those additional mitigation measures presented in Appendix D, Table D-1, may not all be within BOEM's statutory and regulatory authority to require; however, other governmental agencies could potentially impose them. Table D-1 provides descriptions of mitigation measures identified by BOEM for analysis in this Draft EIS.

2.3. Non-Routine Activities and Low Probability Events

Non-routine activities and low-probability events associated with the proposed Project could occur during construction, operations, maintenance, or decommissioning. Examples of such activities or events could include corrective maintenance activities; collisions or allisions (a vessel striking a stationary object) between vessels, vessels and WTGs or ESPs, or vessels and marine life; cable displacement or damage by anchors or fishing gear; chemical spills or releases; severe weather and other natural events; and/or terrorist attacks. These activities or events are impossible to predict with certainty. This section provides a brief assessment of each of these potential events or activities.

- *Corrective maintenance activities:* These activities could be required as a result of other low probability events, or as a result of unanticipated equipment wear or malfunctions. Vineyard Wind anticipates stocking spare parts and having ample workforce available for addressing corrective maintenance activities if required.
- *Collisions and allisions:* These could result in spills (described below) or injuries or fatalities to wildlife (addressed in Section 3.3). Collisions and allisions are anticipated to be unlikely based on the following factors that would be considered for the proposed Project:
  - USCG requirement for lighting on vessels;
  - High vessel traffic areas were excluded from the MA WEA;
  - National Oceanic and Atmospheric Administration (NOAA) vessel-strike guidance would be implemented, as practicable;
  - The proposed spacing between WTGs and other facility components;
  - The lighting and marking plan that would be implemented, as described above; and
  - The inclusion of proposed-Project components on nautical charts.
- *Cable displacement or damage by vessel anchors or fishing gear:* This could result in safety concerns and economic damages to vessel operators and may require corrective action by Vineyard Wind. However, such incidents are unlikely to occur because the proposed Project area would be indicated on navigational charts and the cable would be buried at least 5 feet (1.5 meters) deep or protected with hard armor.
- *Chemical spills or releases:* For offshore activities, these include inadvertent releases from refueling vessels, spills from routine maintenance activities, and any more significant spills as a result of a catastrophic event. Vineyard Wind does not expect spills from vessels to occur, but if one did occur, it would likely be small and expected to dissipate rapidly and evaporate within days. Vineyard Wind would be expected to comply with USCG and Bureau of Safety and Environmental Enforcement regulations relating to prevention and control of oil spills. In addition, spill impacts would be minimized by adherence to the Oil Spill Response Plan included in COP Appendix I-A (Volume III; Epsilon 2018a). Additional information related to potential spills can be found in the Navigational Risk Assessment (COP Appendix III-I; Epsilon 2018a), Bejarano et al. 2013, and Section 3.2.2, of this Draft EIS. Onshore, releases could potentially occur from construction equipment and/or HDD activities. Vineyard Wind would conduct refueling and lubrication of stationary equipment in a manner that protects coastal habitats from accidental spills. Additionally, a Construction Spill Prevention, Control, and Countermeasure Plan would be prepared in accordance with applicable requirements, and would outline spill prevention plans and measures to take to contain and clean up spills that may occur.
- *Severe weather and natural events:* As described above, Vineyard Wind designed the proposed Project components to withstand severe weather events.[11] The WTGs would be designed to endure sustained wind speeds of up to 112 mph (182.2 kph) and gusts of 157 mph (252.7 kph). WTGs would also automatically shut down when wind speeds exceed 69 mph (111 kph). In addition, the structures would be designed for maximum wave heights greater than 60 feet (18.3 meters) (Vineyard Wind 2018e). If severe weather caused a spill or release, the actions

[11] Appendix B provides hurricane magnitude and frequency information for severe weather that has occurred in Massachusetts and the WDA.

outlined above would help reduce potential impacts. Severe flooding or coastal erosion could require repairs, with impacts associated with repairs being similar to those outlined in Chapter 3, during construction activities. While highly unlikely, structural failure of a WTG (i.e., loss of a blade or tower collapse) would result in temporary hazards to navigation for all vessels, similar to the construction and installation impacts described in Chapter 3.

- *Terrorist attacks:* BOEM considers these unlikely, but impacts could vary depending on the magnitude and extent of any attacks. The actual impacts of this type of activity would be the same as the outcomes listed above. Therefore, terrorist attacks are not analyzed further.

2.4. SUMMARY AND COMPARISON OF IMPACTS BY ALTERNATIVES

Table 2.4-1 provides a summary and comparison of the impacts under each action alternative assessed in Chapter 3. Under Alternative F (No Action), any potential environmental and socioeconomic impacts, including benefits, associated with the proposed Project would not occur; however, impacts could occur from other activities as described through Chapter 3 under the cumulative analysis. Section 3.1 provides definitions for **negligible**, **minor**, **moderate**, and **major** impacts.

Table 2.4-2 provides a summary and comparison of the impacts under each action alternative assessed in Chapter 3, assuming effective implementation of all potential mitigation measures mentioned in Chapter 3 and Table D-1. Under Alternative F (No Action), any potential environmental and socioeconomic impacts associated with the proposed Project, including benefits, would not occur; however, impacts could occur from other activities as described throughout Chapter 3 under the cumulative analysis. Section 3.1 defines **negligible**, **minor**, **moderate**, and **major** impacts. Many of the potential mitigation measures would partially ameliorate negative impacts of the proposed Project, but would not necessarily reduce the impact level category defined in Section 3.1.

Table 2.4-1: Summary and Comparison of Impacts by Action Alternatives with No Mitigation Measures [a]

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Air Quality	**Minor** temporary impacts from construction vessel and equipment emissions, but a net benefit over the life of the Project [b]	Similar to the Proposed Action	Similar to Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Water Quality	**Minor** temporary impacts from sediment suspension and vessel discharges, but **negligible** impact over the long-term	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Terrestrial and Coastal Fauna	**Minor** short-term impacts from direct mortality, temporary habitat alteration, and risk of affecting wetlands and streams; **minor** to **moderate** impacts due to land clearing (permanent habitat loss)	**Minor** short-term impacts from direct mortality and temporary habitat alteration; **minor** impacts due to land clearing (permanent habitat loss); less risk of affecting wetlands and streams	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Birds	**Negligible** to **minor** short-term impacts from onshore construction; **negligible** to **minor** long-term impacts from offshore operations	Similar to the Proposed Action, potentially to a lesser degree onshore	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Bats	Likely **negligible** but possibly **minor** short-term impacts due to forest clearing; **negligible** long-term impacts on migrating bats during offshore operation	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Coastal Habitats	**Negligible** to **minor** short-term impacts at landfall site; **minor** to **moderate** short-term impacts from vessel anchoring, dredging and cable installation; **minor** to **moderate** long-term cumulative effects of coastal development; **negligible** to **minor beneficial** long-term impact of hard protection atop cables; overall impact likely **negligible**	Less impact at landfall site; **minor** to **moderate** short-term impacts from vessel anchoring, dredging and cable installation; **minor** to **moderate** long-term cumulative effects of coastal development; **negligible** to **minor beneficial** long-term impact of hard protection atop cables; overall impact likely **negligible**	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Benthic Resources	**Minor** short-term impacts from direct mortality and sedimentation; **moderate** short-term impacts from dredging and entrainment; **minor** long-term impact from scouring; possible long-term **moderate beneficial** effect of scour protection and cable protection	Similar to the Proposed Action, but no impact would occur in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree in the WDA
Finfish, Invertebrates, and Essential Fish Habitat	**Minor** short-term impacts from turbidity, sedimentation, direct mortality, and installation noise; **minor** long-term impact from operational noise and electromagnetic frequencies; **moderate** impacts from temporary habitat disturbance and permanent habitat conversion; **moderate beneficial** long-term reef effect from piles and scour protection	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Marine Mammals	**Minor** to **moderate** short-term impacts from survey noise, pile driving noise, vessel noise, and vessel strikes; **negligible** to **minor** short-term impacts from turbidity and decommissioning noise; **negligible** to **minor** long-term impacts from electromagnetic frequencies and avoidance of the WDA; **moderate** long-term impact of increased vessel traffic; possible **minor** beneficial long-term impacts to seal habitat by hard protection.	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Sea Turtles	**Minor** short-term impacts from pile driving noise, vessel noise, and vessel strikes; **minor** long-term impacts from habitat alteration and increased vessel traffic	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Demographics, Employment, and Economics	**Minor beneficial** long-term effects of creating jobs and generating revenue	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Environmental Justice	Likely **moderate**, but potentially **major** short-term impacts on commercial fishing, subsistence fishing, and disruption of marine businesses in Lewis Bay, which could contribute to **moderate** cumulative impacts	**Moderate** short-term impacts related to commercial fishing, subsistence fishing, and cumulative impacts; no disruption in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Cultural, Historical, and Archaeological Resources	**Minor** short-term impacts on onshore and offshore archaeological sites; **minor** long-term visual impacts on historic properties, which could contribute to **minor** cumulative impacts	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Recreation and Tourism	**Minor** to **moderate** short-term impacts from construction and decommissioning activities onshore, offshore, and at public beaches and boating areas adjacent to landfall sites; **minor** long-term impacts on recreational vessel traffic and tourism	Less impact in the Lewis Bay area; **Minor** short-term impacts from construction and decommissioning activities onshore, offshore, and at public beaches and boating areas adjacent to landfall sites; **minor** long-term impacts on recreational vessel traffic and tourism	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Commercial Fisheries and For-Hire Recreational Fishing	**Minor** short-term effects of increased vessel traffic; **minor** long-term effects on fishing trip distances and routes; **moderate** to **major** short-term effects from areas of temporarily restricted access; **moderate** to **major** long-term impacts on target populations or locations, loss or damage of gear, and the cumulative impact of other offshore developments	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree [c]	Similar to the Proposed Action, potentially to a lesser degree [c]	Similar to the Proposed Action, potentially to a lesser degree [c]
Land Use and Coastal Infrastructure	**Minor beneficial** long-term effects at ports due to increased compatible uses of existing facilities and areas; **moderate** short-term adverse impacts due to onshore construction noise, dust, and traffic flow disturbances	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Navigation and Vessel Traffic	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; potential temporary **major** impacts in Lewis Bay	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; no impact in Lewis Bay	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree
Other Uses	**Negligible** long-term impacts on radar signals; **minor** long-term impacts on cables and pipelines, offshore energy and mineral use, aviation and air traffic, and military or national security uses; **minor** long-term adverse and beneficial impacts on scientific research in this area	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

[a] Impact rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. Where impacts are presented as a range, the color representing the highest level of impact has been applied.
[b] The No Action Alternative would likely result in moderate long-term adverse impacts on air quality, as new fossil fuel-fired power plants would be required to meet future power demands.
[c] Although the impact rating levels are equal, the Rhode Island Coastal Resources Management Council and the Rhode Island Department of Environmental Management Marine Fisheries Section have commented that Alternatives D1, D2, and E would be less impactful than the Proposed Action.

Table 2.4-2: Summary and Comparison of Impacts by Action Alternatives Implementing Mitigation Measures Analyzed [a]

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Air Quality	**Minor** temporary impacts from construction vessel and equipment emissions, but a net benefit over the life of the Project [b]	Similar to the Proposed Action	Similar to Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Water Quality	**Minor** temporary impacts from sediment suspension and vessel discharges, but **negligible** impact over the long-term	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Terrestrial and Coastal Fauna	**Minor** short-term impacts from direct mortality, temporary habitat alteration, and risk of affecting wetlands and streams; **minor** to **moderate** impacts due to land clearing (permanent habitat loss)	**Minor** short-term impacts from direct mortality and temporary habitat alteration; **minor** impacts due to land clearing (permanent habitat loss); less risk of affecting wetlands and streams	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Birds	**Negligible** to **minor** short-term impacts from onshore construction; **negligible** to **minor** long-term impacts from offshore operations	Similar to the Proposed Action, potentially to a lesser degree onshore	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Bats	**Negligible** long-term impacts on migrating bats during offshore operation	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Coastal Habitats	**Negligible** short-term impacts at landfall site; **minor** to **moderate** short-term impacts from vessel anchoring, dredging and cable installation; **minor** to **moderate** long-term cumulative effects of coastal development; **negligible** to **minor beneficial** long-term impact of hard protection atop cables; overall impact likely **negligible**	Less impact at landfall site; **minor** to **moderate** short-term impacts from vessel anchoring, dredging and cable installation; **minor** to **moderate** long-term cumulative effects of coastal development; **negligible** to **minor beneficial** long-term impact of hard protection atop cables; overall impact likely **negligible**	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Benthic Resources	**Minor** short-term impacts from direct mortality, dredging, entrainment, and sedimentation; **minor** long-term impact from scouring; possible long-term **moderate beneficial** effect of scour protection and cable protection	Similar to the Proposed Action, but no impact would occur in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree in the WDA
Finfish, Invertebrates, and Essential Fish Habitat	**Minor** short-term impacts from turbidity, sedimentation, direct mortality, and installation noise; **minor** long-term impact from operational noise and electromagnetic frequencies; **moderate** impacts from temporary habitat disturbance and permanent habitat conversion; **moderate beneficial** long-term reef effect from piles and scour protection	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Marine Mammals	**Minor** to **moderate** short-term impacts from survey noise, pile driving noise, vessel noise, and vessel strikes; **negligible** to **minor** short-term impacts from turbidity and decommissioning noise; **negligible** to **minor** long-term impacts from electromagnetic frequencies and avoidance of the WDA; **moderate** long-term impact of increased vessel traffic; possible **minor** beneficial long-term impacts to seal habitat by hard protection.	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Sea Turtles	**Minor** short-term impacts from pile driving noise, vessel noise, and vessel strikes; **minor** long-term impacts from habitat alteration and increased vessel traffic	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Demographics, Employment, and Economics	**Minor beneficial** long-term effects of creating jobs and generating revenue	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Environmental Justice	**Minor** to **moderate** short-term impacts related to commercial fishing, subsistence fishing, and disruption of marine businesses, which could contribute to **moderate** cumulative impacts	**Minor** to **moderate** short-term impacts related to commercial fishing, subsistence fishing, and cumulative impacts; no disruption in Lewis Bay	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Cultural, Historical, and Archaeological Resources	**Negligible** to **minor** short-term impacts on onshore and offshore archaeological sites; **negligible** to **minor** long-term visual impacts on historic properties, which could contribute to **minor** cumulative impacts	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree
Recreation and Tourism	**Minor** short-term impacts from construction and decommissioning activities onshore, offshore, and at public beaches and boating areas adjacent to landfall sites; **minor** long-term impacts on recreational vessel traffic and tourism	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree

Resource affected	Proposed Action	Alternative B	Alternative C	Alternative D1	Alternative D2	Alternative E
Commercial Fisheries and For-Hire Recreational Fishing	**Minor** short-term effects of increased vessel traffic; m**inor** long-term effects on fishing trip distances and routes; **moderate** short-term effects from areas of temporarily restricted access; **moderate** long-term impacts on target populations or locations, loss or damage of gear, and the cumulative impact of other offshore developments	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action, potentially to a lesser degree [c]	Similar to the Proposed Action, potentially to a lesser degree [c]	Similar to the Proposed Action, potentially to a lesser degree [c]
Land Use and Coastal Infrastructure	**Minor beneficial** long-term effects at ports due to increased compatible uses of existing facilities and areas; **moderate** short-term adverse impacts due to onshore construction noise, dust, and traffic flow disturbances	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action
Navigation and Vessel Traffic	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; potential temporary **major** impacts in Lewis Bay	**Minor** to **moderate** short-term impacts from Project vessel traffic; **minor** to **moderate** long-term impacts from changes in navigation routes, delays in ports, and degraded communication and radar signals; no impact in Lewis Bay	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree	Similar to the Proposed Action, potentially to a lesser degree
Other Uses	**Negligible** long-term impacts on radar signals; **minor** long-term impacts on cables and pipelines, offshore energy and mineral use, aviation and air traffic, and military or national security uses; **minor** long-term adverse and beneficial impacts on scientific research in this area	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action	Similar to the Proposed Action

[a] Impact rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. Where impacts are presented as a range, the color representing the highest level of impact has been applied.
[b] The No Action Alternative would likely result in moderate long-term adverse impacts on air quality, as new fossil fuel-fired power plants would be required to meet future power demands.
[c] Although the impact rating levels are equal, the Rhode Island Coastal Resources Management Council and the Rhode Island Department of Environmental Management Marine Fisheries Section have commented that Alternatives D1, D2, and E would be less impactful than the Proposed Action.

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter addresses the affected environment for each resource area and the potential environmental consequences of the alternatives described in Chapter 2, including the Proposed Action and the No Action alternatives. The affected environment sections describe the environment as it exists today and could potentially be impacted by the alternatives. Most information is from the COP (Epsilon 2018a), government sources, and scientific literature. The baseline information in the affected environment sections is used to assess potential direct and indirect impacts. Direct impacts are defined as those occurring at the same time and place as the action. Indirect effects are those that could occur later in time or at a different place, but are still reasonably foreseeable.

BOEM separately assesses environmental consequences in this chapter based on the following phases of proposed Project activities: construction and installation, operations and maintenance, and decommissioning. As proposed Project construction activities progress, however, impacts associated with construction would become increasingly similar to impacts described under operations and maintenance.

This chapter also reviews cumulative impacts that could result from the incremental impact of a specific action, such as the Proposed Action, when combined with other past, present, or reasonably foreseeable future actions or other projects. Cumulative impacts can occur from individually minor, but collectively significant actions that take place over time.

3.1. DEFINITIONS OF IMPACT LEVELS

This Draft EIS uses a four-level classification scheme to characterize the potential impacts of the alternatives, including the Proposed Action. Table 3.1-1 below provides negative (i.e., adverse) impact levels for all biological, physical, and socioeconomic resources that the proposed Project and alternatives could potentially affect.[1] The classification scheme with some revision is based on an approach defined in the *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf* (MMS 2007). Table 3.1-2 provides a similar approach for potential beneficial impacts; BOEM's *Evaluating Benefits of Offshore Wind Energy Projects in NEPA* (AECOM 2017), with some revision, provides the basis for these levels. This Draft EIS does not use all of the impact levels defined in the tables below, the levels are included for reference and comparison.

Table 3.1-1: Definitions of Potential Negative Impact Levels

Impact Level	Biological and Physical Resources	Socioeconomic Resources
Negligible	• No measurable impacts.	• No measurable impacts.
Minor	• Most impacts on the affected resource could be avoided with proper mitigation. • If impacts occur, the affected resource is expected to recover completely without any mitigation once Vineyard Wind eliminates the impacting agent.	• Adverse impacts on the affected activity or community could be avoided with proper mitigation. • Impacts would not disrupt the normal or routine functions of the affected activity or community. • Once Vineyard Wind eliminates the impacting agent, the affected activity or community is expected to return to a condition with no measurable effects without any mitigation.
Moderate	• Impacts on the affected resource are unavoidable. • The viability of the affected resource is not threatened although some impacts may be irreversible, OR • The affected resource would recover completely if Vineyard Wind applies proper mitigation during the life of the proposed Project, including decommissioning, or takes proper remedial action once the impacting agent is gone.	• Impacts on the affected activity or community are unavoidable. • Proper mitigation would reduce impacts substantially during the life of the proposed Project, including decommissioning. • The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project, OR • Once the impacting agent is gone, the affected activity or community is expected to return to a condition with no measurable effects if Vineyard Wind takes proper remedial action.

[1] The resource areas assessed in this Draft EIS are listed in Section 2.2.

Impact Level	Biological and Physical Resources	Socioeconomic Resources
Major	• Impacts on the affected resource are unavoidable. • The viability of the affected resource may be threatened, AND • The affected resource would not fully recover even if Vineyard Wind applies proper mitigation during the life of the proposed Project, including decommissioning, or takes remedial action once the impacting agent is gone.	• Impacts on the affected activity or community are unavoidable. • Proper mitigation would reduce impacts somewhat during the life of the proposed Project, including decommissioning. • The affected activity or community would experience unavoidable disruptions to a degree beyond what is normally acceptable, AND • The affected activity or community may retain measurable effects indefinitely, even after the impacting agent is gone and even if Vineyard Wind takes remedial action.

Table 3.1-2: Definitions of Potential Beneficial Impact Levels

Benefit Level	Biological and Physical Resources	Socioeconomic Resources
Negligible	Either no effect or uncertain slight: • Improvement in the health of local ecosystem; • Increase in the extent and quality of habitat both for special status species and species common to the area; • Increase in species richness or abundance of species common to the area; • Improvement in air or water quality.	Either no effect or uncertain slight: • Improvement in human health for individuals or communities; • Benefits other than health for some individuals or communities (e.g., small number of additional employment opportunities); • Improvements to facilities services in the community; • Benefits the overall economy (e.g., limited local procurement); • Benefits for tourism or regional or local cultural resources.
Minor	A small but reasonably certain: • Improvement in local ecosystem health; • Increase in the extent and quality of habitat for both special-status species and species common to the proposed Project area; • Increase in populations of species common to the proposed Project area; • Improvement in air or water quality.	A small but reasonably certain: • Improvement in human health; • Benefit for local employment; • Improvement to infrastructure and community services; • Benefit to the overall economy (e.g., local suppliers); • Economic improvement; • Benefit for local or regional tourism or cultural resources.
Moderate	A notable but not large: • Improvement in local ecosystem health; • Increase in the extent and quality of habitat for both special-status species and species common to the proposed Project area; • Increase in populations of species common to the proposed Project area; • Improvement in air or water quality.	A notable but not large: • Improvement in human health; • Benefits to employment on a regional scale; • Improvements to facilities and community services; • Local or regional economic improvement; • Benefit for local or regional tourism or cultural resources.
Major	A large: • Improvement in the health of ecosystems regionally; • Increase in the extent and quality of habitat for both special status and commonly occurring species on a regional scale; • Improvement in air or water quality on a regional scale.	A large: • Improvement in human health; • Benefit to employment on a regional scale; • Improvements to facilities and community services; • Improvement in the regional economy; • Economic improvement; • Benefit to local or regional tourism or cultural resources.

3.2. PHYSICAL RESOURCES

3.2.1. Air Quality

The proposed Project's WTGs, ESPs, and OECC do not generate air emissions. However, air emissions from equipment used in the construction, operations and maintenance, and decommissioning phases could impact air quality in the proposed Project area and nearby coastal waters and shore areas. Most emissions would occur temporarily during construction, offshore in the WDA, onshore at the landfall site, along the OECC and OECR, at the onshore substation, and at the construction staging area. Additional emissions related to the proposed Project could also occur at nearby ports used to transport material and personnel to and from the Project site. However, as described below, the proposed Project would provide beneficial impacts to the air quality near the proposed Project location and the surrounding region in comparison to fossil-fuel power generating stations.

3.2.1.1. Description of the Affected Environment for Air Quality

The affected environment for air quality includes the air above the WDA and adjacent OCS, along the OECC and OECR, at the onshore construction and proposed Project-related sites, and at the ports used to support proposed Project activities.

Air quality within a region is measured in comparison to the National Ambient Air Quality Standards (NAAQS), which are standards established by the U.S. Environmental Protection Agency (USEPA) pursuant to the Clean Air Act (CAA) (42 USC § 7409) for criteria pollutants to protect human health and welfare. The criteria pollutants are carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

The USEPA classifies all areas of the country as in attainment, nonattainment, or unclassified for each criteria pollutant. An attainment area complies with all NAAQS. A nonattainment area does not meet NAAQS for one or more pollutants. Unclassified areas are where attainment status cannot be determined based on available information and are treated as attainment areas. Note that an area can be in attainment for some pollutants and nonattainment for others.

The attainment status of an area can be found at 40 CFR § 81 and in the USEPA Green Book, which the agency revises from time to time (USEPA 2017). Attainment status is determined through evaluation of air quality data from a network of monitors.

The CAA amendments directed USEPA to establish requirements to control air pollution from OCS oil- and gas-related activities along the Pacific, Arctic, and Atlantic coasts, and along the U.S. Gulf Coast off of Florida, eastward of 87^{o} 30' West longitude. The OCS Air Regulations (40 CFR § 55) establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement for facilities subject to the CAA. These regulations apply to OCS sources that are located beyond state seaward boundaries. Applicants locating within 25 nautical miles of a state seaward boundary are required to comply with the air quality requirements of the nearest or corresponding onshore area, including applicable permitting requirements.

Project Area

The proposed Project area is shown in Figure 1.1-1, and encompasses the WDA, adjacent OCS, and nearby coastal areas of Massachusetts, Rhode Island, Connecticut, and New York. The WDA is located approximately 14 miles (23 kilometers) southeast of Martha's Vineyard. The proposed Project may generate air emissions within Massachusetts in Barnstable County, Bristol County, Dukes County, and Nantucket County (offshore Nantucket only). The proposed Project intends to use the MCT as the primary construction staging area. However, Vineyard Wind may need to stage certain activities from other commercial seaports. If a port besides MCT is used during construction, proposed Project-related air emissions could potentially occur in one or more of the following counties: New London, Middlesex, New Haven, and Fairfield (Connecticut); Suffolk County (New York); or Washington, Newport, Kent, Providence, and Bristol (Rhode Island). Vineyard Wind is considering operations and maintenance facilities at Vineyard Haven Harbor in Tisbury. Please see Section 3.4.6 for additional information on land use and proposed ports.

Aspects of Resource Potentially Affected

Air quality in the proposed Project area may be impacted due to the emission of criteria pollutants from sources involved in the construction or maintenance of the proposed Project as well as potentially during operations. These impacts, while generally localized to the emission source in question, may occur at any location associated with the proposed Project, be it offshore in the WDA or at any of the onshore construction or support sites. Additionally, ozone levels in the region could potentially be impacted.

Condition and Trend

At its nearest point, the WDA is just over 14 miles (23 kilometers) from the southeast corner of Martha's Vineyard, located in Dukes County. Dukes County, like all counties in Massachusetts, is presently designated as unclassifiable or attainment for all criteria pollutants with the exception of ozone, for which Dukes County is designated marginally nonattainment for the 2008 ozone NAAQS. This designation was based on data collected at the Herring Creek Road Aquinnah monitor (Monitor #25-007-0001) from 2009–2011, which showed a monitored concentration of 76 parts per billion (ppb) versus the 2008 NAAQS of 75 ppb. While the 2008 NAAQS is still technically in effect, Dukes County was recently (August 2018) designated attainment against the more stringent 2015 ozone NAAQS of 70 ppb, based on 2014–2016 monitored concentration of 64.3 ppb. Thus, while the 2008 designation has not yet been changed, monitored values in Dukes County have significantly improved since 2011 and are now the ozone NAAQS.

The entire State of Rhode Island is currently in attainment for all criteria pollutants.

The New York-Northern New Jersey-Long Island Area, also known as the New York Metro Area, is comprised of the region surrounding New York City, Long Island, the southwestern portion of Connecticut, and the northern half of New Jersey. Proposed Project emissions could occur within the New York Metro area in Fairfield County, Middlesex County, and New Haven County in Connecticut and Suffolk County in New York. The USEPA currently classifies the New York Metro Area as being in moderate nonattainment with the 2015 8-hour ozone standard. Depending on the ports used for the proposed Project, air emissions could also occur in New London, which is within the Greater Connecticut area. The USEPA currently designates the Greater Connecticut area as marginal nonattainment for the 2015 O_3 NAAQS.

COP Figure 5.1-1 (Volume I; Epsilon 2018a) shows air quality trends for $PM_{2.5}$, SO_2, NO_2, and O_3 at regional ambient monitors. The graphs show that for each of these pollutants and periods, ambient concentrations have either decreased or at worst remained constant over the last decade.

3.2.1.2. Environmental Consequence

Relevant Design Parameters

The proposed-Project design parameters that would influence the magnitude of impacts on air quality include the following:

- Air emission ratings of construction equipment engines;
- Location of construction laydown areas;
- Choice of cable-laying locations and pathways;
- Choice of marine traffic routes to and from the proposed Project area;
- Soil characteristics at excavation areas for fugitive emissions determination; and
- Emission control strategy for fugitive emissions due to excavation and hauling operations.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the number of WTGs and their spacing within the proposed Project area, spatial coverage of the overall proposed Project area, and the construction schedule. Additionally, variations in the planned cable layout and landfall locations would impact the magnitude and spatial extent of emissions.

3.2.1.3. Impacts of Alternative A (Proposed Action) on Air Quality

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

The sections below summarize the potential direct and indirect impacts of the Proposed Action on air quality during the various phases of the Proposed Action.

<u>Construction and Installation</u>

The majority of air emissions from the Proposed Action would come from the main engines, auxiliary engines, and auxiliary equipment on marine vessels used during construction activities. Fugitive emissions would occur as a result of excavation and hauling of soil.

Fuel combustion and some incidental solvent use would cause construction-related air emissions. The air pollutants would include nitrogen oxides (NO_X), SO_2, CO, PM_{10}, $PM_{2.5}$, volatile organic compounds, carbon dioxide equivalent (CO_{2e}) or greenhouse gas emissions, and total hazardous air pollutants. COP Appendix III-B provides a complete description of all emission points associated with the construction phase of the Proposed Action, including engine sizes, hours of operation, load factors, emission factors, and fuel consumption rates, along with a description of the air emission calculation methodology (Volume III; Epsilon 2018a). Combustion emissions would use appropriate fuel-efficient engines and would comply with all applicable air emission standards in an effort to keep combustion emissions and associated air quality impacts at a minimum.

During the construction phase, the activities of additional workers, increased traffic congestion, additional commuting miles for construction personnel, and increased air-polluting activities of supporting businesses could have indirect impacts on air quality.

A more detailed description of offshore and onshore construction activities can be found in COP Sections 3.1, 3.2, 4.1, and 4.2 (Volume I; Epsilon 2018a).

Construction and Installation of Offshore Components

Emissions from offshore activities occur during pile and scour protection installation, offshore cable laying, turbine installation, and ESP installation. Offshore activities would have more significant power requirements, resulting in more need for diesel-generating equipment to supply temporary power to WTGs or ESPs and other construction equipment. Offshore construction-related emissions would come from diesel generators used to temporarily supply power to the WTGs and ESPs so that workers could power up lights, controls, and other equipment before cabling is in place. There would also be emissions from engines used to power pile-driving hammers and air compressors used to supply compressed air to noise mitigation devices during pile driving. Emissions from vessels used to transport workers, supplies, and equipment to and from the construction areas would result in additional air quality impacts. Vineyard Wind may need emergency generators at times, resulting in increased emissions for limited time periods.

The overall air quality impacts of offshore activities would continue for a longer period than those of onshore activities, potentially as long as two years. Specific emissions from potential sources or construction activities would vary throughout the construction/installation of offshore components. For pollutants such as NO_2, SO_2, and $PM_{2.5,}$ USEPA bases NAAQS standards on 3-year and 5-year averages. Because the construction and installation phase of the offshore components would likely not extend past 2 years and because the emissions would vary throughout the phase, BOEM does not expect projected air quality impacts to exceed the NAAQS for these pollutants. Overall, BOEM anticipates **minor** air quality impacts due to the construction and installation of offshore components. The potential impacts from sea vessels and diesel generating equipment would be further reduced if the potential mitigation measure related to fuel-efficient engines outlined in Appendix D became a condition of COP approval.

Construction and Installation of Onshore Project Components

The onshore activities would consist of HDD, duct bank construction, and cable pulling operations. Emissions from HDD would be due to the operation of diesel-powered equipment (e.g., drilling rigs or other machinery). Because such activities would occur for short periods of time and be limited to combustion emissions, they would only have a **negligible** overall impact on air quality. Other activities involving excavation, such as duct bank construction and hauling operations during cable pulling and splicing activities, would result in combustion emissions from vehicle activity such as bulldozers, excavators, and diesel trucks, and fugitive particulate emissions from excavation and hauling of soil. These emissions would be highly variable and limited in spatial extent at any given period and would result in **minor** impacts, as they are temporary in nature. Fugitive particulate emissions would vary depending on the spatial extent of the excavated areas, soil type, and soil moisture content and the magnitude and direction of ground level winds. Fugitive emissions could be partially mitigated by imposing limits on the surface area of exposed soils in a specific area and by spraying water for dust control when possible, thereby resulting in **minor** impacts.

Overall, the onshore activities would occur for a shorter time-period than the offshore operations. The HDD would take several weeks to complete. Duct back construction and cable pulling operations could take up to six months. It is anticipated that emissions and the corresponding air quality impacts of onshore construction activities would be limited to approximately one-year. Overall, BOEM expects **minor** impacts from onshore construction and installation. In addition, the potential impacts from construction and diesel generating equipment would be further reduced through mitigation measures related to fuel-efficient engines and dust control plans, as outlined in Appendix D.

Operations and Maintenance

During the Proposed Action's operational phase (up to 30 years), air emissions from the operations and maintenance phase of the Proposed Action would be significantly less than emissions from the construction phase. COP Section 4.3 provides a more detailed description of offshore and onshore operations and maintenance activities (Volume I; Epsilon 2018a).

Operations and Maintenance of Offshore Components

Operations and maintenance activities would consist of WTG operations, planned maintenance, and unplanned emergency maintenance. The WTGs operating in the Proposed Action would have no pollutant emissions. Emergency generators located on the WTGs and the ESPs would only operate during emergencies or testing, so emissions from these sources would be transient and therefore **negligible**. Pollutant emissions from operations and maintenance would be mostly the result of operations of ocean vessels and helicopters used for maintenance activities. Crew transfer vessels and helicopters would transport crews to the proposed offshore Project area for inspections, routine maintenance, and repairs. Jack-up vessels, multipurpose offshore support vessels, and rock-dumping vessels would infrequently travel to the proposed offshore Project area for significant maintenance and repairs. Emissions during these would be **minor** and confined to the Proposed Action. Therefore, BOEM anticipates that air quality impacts of operations and maintenance of offshore components would be **minor**, occurring for short blocks of time, several times per year. In addition, the potential impacts from sea vessels and diesel generating equipment would be further reduced if the potential mitigation measure related to fuel-efficient engines outlined in Appendix D became a condition of COP approval.

Operations and Maintenance of Onshore Project Components

Emissions from onshore operations and maintenance activities would be limited to periodic use of construction vehicles and equipment. Onshore operations and maintenance activities would include occasional inspections and repairs to the onshore substation and splice vaults, which would require minimal use of worker vehicles and construction equipment. Vineyard Wind intends to use port facilities at both Vineyard Haven on Martha's Vineyard and the MCT to support operations and maintenance activities. Smaller vessels used for operations and maintenance activities would likely be based out of Vineyard Haven while larger vessels used for major repairs during operations and maintenance would likely use the MCT. BOEM anticipates that air quality impacts due to onshore operations and maintenance would be **minor**, occurring for short periods of time and temporary. In addition, Vineyard Wind could further reduce the potential impacts from sea vessels if the potential mitigation measure related to fuel-efficient engines outlined in Appendix D became a condition of COP approval.

Decommissioning

As described in COP Section 4.4 (Volume I; Epsilon 2018a), the decommissioning process would be largely the reverse of the installation process. As a result, the impacts of decommissioning on air quality would resemble the impacts of the construction phase. During decommissioning, Vineyard Wind would use commercial marine vessels to remove the offshore cable system, WTGs, foundations, and scour protection. It is anticipated that equipment and vessels used for decommissioning would be similar to those used during construction, but would likely have lower polluting engines (historically, emission standards for marine vessels have become increasingly stringent over time).

For onshore decommissioning activities, Vineyard Wind would remove onshore export cables from the duct bank using truck-mounted winches, cable reels, and cable reel transport trucks. Vineyard Wind could leave the concrete-encased duct bank and splice vaults in place for future reuse, as well as elements of the onshore substation and grid connections. Consequently, onshore decommissioning emissions would be significantly less than onshore construction emissions. Overall, BOEM anticipates **minor** and temporary air quality impacts due to decommissioning.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action Activities that can result in air emissions consist of non-routine corrective action and maintenance activities, collisions and possible chemical spills. Accidental air emissions due to collisions or spills and occasional corrective action activities are likely to be rare and short-lived events. Corrective actions are likely to consist of short-lived combustion emissions due to vessels or construction equipment. BOEM anticipates that these activities would have a **negligible** air quality impact on the proposed Project area and the surrounding region.

Conclusion

The Proposed Action would result in a net decrease in overall emissions over the region compared to the installation of a traditional fossil-fuel power generating station. In addition to the reduction of emissions, the proposed Project would likely result in slowing of the climate change process.

Although there would be some air quality impacts due to various activities associated with construction, maintenance, and eventual decommissioning, these emissions would be relatively small and limited in duration. BOEM could reduce potential impacts by requiring the use of fuel-efficient engines and by requiring dust control plans for onshore construction areas as a condition of COP approval (see Section 2.2.1). As a result, while it is anticipated that there would be **minor** air quality impacts for a limited time during these phases, there would be a net **minor beneficial** impact to the air quality near the Proposed Action site and the surrounding region overall when compared to fossil-fuel power generating stations. Although overall emissions would not be insignificant, appropriate mitigation measures would be implemented to ensure compliance with NAAQS in accordance with the CAA permit. In addition, the potential impacts from construction activities and the operation of the various vehicles, sea vessels, and temporary power-generating and maintenance equipment would be further reduced if the potential mitigation measures related to fuel-efficient engines and dust control plans outlined in Appendix D became a condition of COP approval. While the significance level of impacts would remain the same, BOEM could further reduce the temporary impacts on air quality impacts with mitigation measures.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.2.1.4. Impacts of Alternative B on Air Quality

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

The majority of air emissions from Alternative B would come from the main engines, auxiliary engines, and auxiliary equipment on marine vessels used during construction activities and from construction activities such as excavation and hauling of soil and materials. Emission sources from onshore construction activities would include non-road equipment and vehicles used during the unloading and loading of equipment at the construction staging areas, HDD, installation of the onshore export cable, and construction of the onshore substation. Combustion emissions from construction equipment, vehicles, and vessels would use appropriate fuel-efficient engines that comply with all applicable air emission standards to minimize combustion emissions and associated air quality impacts.

For Alternative B, BOEM anticipates no significant change in overall emissions and as a result, expects air quality impacts to be similar to those of the Proposed Action. BOEM anticipates that construction during Alternative B would cause temporary **minor** air quality impacts.

Operations and Maintenance

Operations and maintenance activities of Alternative B would be identical to those of the Proposed Action. Therefore, BOEM expects **minor** air quality impacts for Alternative B.

Decommissioning

Emissions during the decommissioning of Alternative B would be similar to those of the decommissioning of the Proposed Action; BOEM expects **minor** air quality impacts for the decommissioning phase of Alternative B.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action that could result in air emissions. These consist of non-routine corrective action activities, collisions, and possible chemical spills. Accidental air emissions due to collisions or spills and occasional corrective action activities are likely to be rare and short-lived events. Corrective actions are likely to consist of short-lived combustion emissions due to vessels or construction equipment. BOEM anticipates that these activities would have a **negligible** air quality impact on the proposed Project area and surrounding region.

Conclusion

As with the Proposed Action, the implementation of Alternative B would result in a net decrease in overall emissions over the region compared to installation of a traditional fossil-fuel power generating station. Some emissions relative to the Proposed Action might change in Alternative B due to modifications in some construction activities, but BOEM does not expect significant differences in air quality impacts for Alternative B compared with Proposed Action. As a result, BOEM anticipates that Alternative B would have **minor** air quality impacts for limited time periods and a net **minor beneficial** impact on the air quality of the proposed Project area and the surrounding region when compared to fossil-fuel power generating stations. Although overall emissions would not be insignificant, appropriate mitigation measures would be implemented to ensure compliance with NAAQS in accordance with the CAA permit. In addition, the potential impacts from construction activities and the operation of the various vehicles, sea vessels, and temporary power-generating and maintenance equipment would be further reduced if the potential mitigation measures related to fuel-efficient engines and dust control plans, outlined in Appendix D became a condition of COP approval.

3.2.1.5. Impacts of Alternative C on Air Quality

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction and Installation

The majority of air emissions from Alternative C would come from the main engines, auxiliary engines, and auxiliary equipment on marine vessels used during construction activities and from construction activities such as excavation and hauling of soil and materials. Emission sources from onshore construction activities would include non-road equipment and vehicles used during the unloading and loading of equipment at the construction staging areas, HDD, installation of the onshore export cable, and construction of the onshore substation. For Alternative C, BOEM does not expect a significant change in overall emissions and as a result. Some changes in locations of emissions may occur due to shifting some turbines further offshore. This could reduce some onshore air quality impacts while slightly increasing the overall emissions due to the slightly longer travel times for construction related vessels to the proposed-Project site. Overall, BOEM anticipates Alternative C to have temporary **minor** air quality impacts similar to the Proposed Action.

Operations and Maintenance

Operations and maintenance activities of Alternative C would be similar to those of the Proposed Action, with similar impacts in the immediate Project area, slightly increased emissions from maintenance vessels due to the longer travel distance to the site and additional required use of survey vessels, and smaller impacts on shore due to the longer distance.

Decommissioning

Emissions during the decommissioning of Alternative C would be similar to those of the decommissioning of the Proposed Action. BOEM expects **minor** air quality impacts for the decommissioning phase of Alternative C.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action activities that can result in air emissions, such as non-routine corrective action and maintenance activities, collisions, and possible chemical spills. Accidental air emissions due to collisions or spills and occasional corrective action activities are likely to be rare and short-lived events. Corrective actions are likely to consist of short-lived combustion emissions due to vessels or construction equipment. BOEM anticipates that these activities would have a **negligible** air quality impact on the proposed Project area and the surrounding region.

Conclusion

As with the Proposed Action, the implementation of Alternative C would result in a net decrease in overall emissions over the region compared to the installation of a traditional fossil-fuel power generating station. While some emissions might change due to modifications in planned construction activity, BOEM does not expect significant differences in air quality impacts for this alternative compared to the Proposed Action. As a result, BOEM anticipates that Alternative C would have **minor** air quality impacts for a limited time period and a net **minor beneficial** impact on the air quality of the proposed Project area and the surrounding region. Although overall emissions would not be insignificant, appropriate mitigation measures would be implemented to ensure compliance with NAAQS in accordance with the

CAA permit. In addition, the potential impacts from construction activities and from the operation of the various vehicles, sea vessels, and temporary power-generating and maintenance equipment would be further reduced if the potential mitigation measures related to fuel efficient engines and dust control plans, outlined in Appendix D became a condition of COP approval.

3.2.1.6. Impacts of Alternative D on Air Quality

Incremental Contribution of Alternatives D1 and D2

Direct and Indirect Effects of Routine Activities

Construction and Installation

The majority of air emissions from Alternatives D1 and D2 would come from the main engines, auxiliary engines, and auxiliary equipment on marine vessels used during construction activities and from construction activities such as excavation and hauling of soil and materials. Emission sources from onshore construction activities would include non-road equipment and vehicles used during the unloading and loading of equipment at the construction staging areas, HDD, installation of the onshore export cable, and construction of the onshore substation. For Alternatives D1 and D2, BOEM does not anticipate significant changes in overall emissions; as a result, air quality impacts would be similar to those of the Proposed Action. BOEM anticipates that Alternatives D1 and D2 would have temporary **minor** air quality impacts during construction and installation.

Operations and Maintenance

Operations and maintenance activities of Alternatives D1 and D2 would be the same as those of the Proposed Action. BOEM expects **minor** air quality impacts for Alternatives D1 and D2.

Decommissioning

Emissions during the decommissioning phase of Alternatives D1 and D2 would be similar to those during the decommissioning of the Proposed Action. BOEM expects **minor** air quality impacts for the decommissioning phase of Alternatives D1 and D2.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities that can result in air emissions. These consist of non-routine corrective action and maintenance activities, collisions and allisions, and possible chemical spills. Accidental air emissions due to collisions or spills and occasional corrective action activities are likely to be rare and short-lived events. Corrective actions and maintenance activities are likely to consist of short-lived combustion emissions due to vessels or construction equipment. BOEM anticipates for Alternatives D1 and D2 that these activities would have a **negligible** air quality impact on the proposed Project area and the surrounding region similar to the Proposed Action.

Conclusion

Alternatives D1 and D2 would result in a modification to the wind turbine layout used in the Proposed Action. As with the Proposed Action, the implementation of Alternatives D1 and D2 would result in a net decrease in overall emissions over the region compared to the installation of a traditional fossil-fuel power generating station. Although there would be some air quality impacts due to various activities associated with construction, maintenance, and eventual decommissioning, these emissions would be relatively small and limited in duration. While some emissions might change due to modifications in planned construction activity, compared to the Proposed Action, BOEM does not expect a significant difference in air quality impacts for Alternatives D1 and D2. As a result, BOEM anticipates that there would be **minor** air quality impacts for limited time periods and a net **minor beneficial** impact on the air quality of the proposed Project area and the surrounding region for Alternatives D1 and D2. Although overall emissions would not be insignificant, appropriate mitigation measures would be implemented to ensure compliance with NAAQS in accordance with the CAA permit. In addition, the potential impacts from construction activities and the operation of the various vehicles, sea vessels, and temporary power-generating and maintenance equipment would be further reduced if the potential mitigation measures related to fuel-efficient engines and dust control plans, outlined in Appendix D became a condition of COP approval.

3.2.1.7. Impacts of Alternative E on Air Quality

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Indirect impacts during construction and decommissioning would be associated with additional workers, increased traffic, construction commuting, and increased air-polluting activities of supporting businesses. BOEM anticipates **minor** air quality impacts on the proposed Project area and the surrounding region from these activities.

Construction and Installation

Alternative E involves a reduction in the overall size of the project. As a result, the overall emissions due to construction and installation would be less than the Proposed Action due to use of smaller amounts of construction equipment reducing combustion emissions and smaller amounts of vessel traffic and material handling, including potential reductions in excavation. A smaller number of WTGs would also translate to a reduced number of emergency generation equipment.

The majority of air emissions from Alternative E would come from the main engines, auxiliary engines, and auxiliary equipment on marine vessels used during construction activities and from construction activities such as excavation and hauling of soil and materials. Emission sources from onshore construction activities would include non-road equipment and vehicles used during the unloading and loading of equipment at the construction staging areas, HDD, installation of the onshore export cable, and construction of the onshore substation. For Alternative E, BOEM expects fewer air quality impacts compared to those of the Proposed Action and other alternatives due to the reduced project size and reduced emissions. Therefore, BOEM anticipates temporary **minor** air quality impacts during construction and installation of Alternative E.

Operations and Maintenance

Operations and maintenance activities of Alternative E would be the same as those of the Proposed Action except that activities may occur on a smaller scale, resulting in reduced air quality impacts. Although less than the Proposed Action, BOEM expects **minor** air quality impacts for Alternative E.

Decommissioning

Emissions during the decommissioning phase of Alternative E would be less than emissions during the decommissioning phase of the Proposed Action due to the reduced scale of Alternative E. BOEM expects **minor** air quality impacts for the decommissioning phase of Alternative E.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities that can result in air emissions consist of non-routine corrective action and maintenance activities, collisions, and possible chemical spills. Accidental air emissions due to collisions or spills and occasional corrective action activities are likely to be rare and short-lived events. Corrective actions are likely to consist of short-lived combustion emissions due to vessels or construction equipment. Therefore, BOEM anticipates that these activities would have a **negligible** air quality impact on the proposed Project area and the surrounding region.

Conclusion

Alternative E would result in an overall reduced project size relative to the Proposed Action. The implementation of Alternative E would result in a net decrease in overall emissions over the region compared to the installation of a traditional fossil-fuel power generating station, and reduced emissions compared to the Proposed Action. Although there would be some air quality impacts due to various activities associated with construction, maintenance, and eventual decommissioning, these emissions would be relatively small and limited in duration. Some emissions might change due to modifications in planned construction activity, but BOEM does not expect significant differences in air quality impacts for Alternative E. As a result, BOEM anticipates **minor** air quality impacts for limited time periods and a net **minor beneficial** impact on the air quality of the proposed Project area and the surrounding region for Alternative E. Although overall emissions would not be insignificant, appropriate mitigation measures would be implemented to ensure compliance with NAAQS in accordance with the CAA permit. In addition, the potential impacts from construction activities and the operation of the various vehicles, sea vessels, and temporary power-generating and maintenance equipment would be further reduced if the potential mitigation measures related to fuel-efficient engines and dust control plans, outlined in Chapter 2 became a condition of COP approval.

3.2.1.8. Impacts of Alternative F (No Action Alternative) on Air Quality

The no action alternative (Alternative F) would likely result in increased air quality impacts regionally due to the need to construct and operate new energy generation facilities to meet future power demands. These facilities may consist of new natural gas-fired power plants, coal-fired, oil-fired, or clean coal-fired plants. These types of facilities would likely have larger and continuous emissions and result in greater impacts on air quality in the region in comparison to the alternatives assessed above.

3.2.1.9. Comparison of Alternatives for Air Quality

Alternatives B, C, D1, and D2 would have similar air quality impacts to that of the Proposed Action (Alternative A), with **minor** air quality impacts for a limited time during construction, operation, and decommissioning phases. Alternatives C and D may have slightly higher emissions due to increased travel distance for vessels and some shift in the locations of turbines. As a result, some additional air quality impacts may occur for Alternatives C and D when compared with Alternatives A and B. For Alternative E, BOEM expects lower air quality impacts than those of the Proposed Action. Although there would be no air quality impacts from Alternative F (No Action Alternative), this alternative would likely result in increased air quality impacts regionally since other types of facilities (power plants) required to meet future power demands have larger and continuous emissions. For all other alternatives, BOEM expects transient, **minor** air quality impacts. BOEM anticipates a net **minor beneficial** cumulative air quality impact resulting from a reduction in the need to install additional fossil fuel generating stations or modify existing fossil fuel generating stations.

3.2.1.10. Cumulative Impacts

The Proposed Action, when combined with past, present, and future projects, could result in cumulative impacts that differ from the impacts predicted by proposed Project activities alone. The analysis area for air quality is the airshed within 15.5 miles (25 kilometers) of the potentially impacted area (Appendix C, Table C-1). This includes the lease area, the on-land construction areas, and the mustering port(s) (see Appendix C, Figure C.1-1). Given the generally low emissions of the sea vessels and equipment used during proposed construction activities, any potential air quality impacts would likely be very close (within a few miles/kilometers) to the source. Appendix C describes projects that could generate cumulative impacts on air quality.

The primary processes and activities that can affect the cumulative air quality impacts are expansions and modifications to existing fossil fuel power plants, both onshore and offshore activities involving renewable energy facilities, and various construction activities. The largest direct contribution to cumulative air quality impacts would be expansions of fossil fuel power plants and expansions of various industrial facilities and large construction projects. Such things as vessel traffic, operation of diesel-powered equipment, air traffic emissions, commercial and public vehicular emissions, onshore power development operations and renewable energy activities, cable and pipeline installation, excavation and soil-hauling operations, and sand and gravel mining operations would generally have lower, variable and/or temporary emissions. Additionally, routine vessel traffic emissions that occur in the surrounding region of the Proposed Action would also contribute to the cumulative air quality impacts. Other activities such as onshore construction or excavation activities or cable-laying operations, as well as modifications to vessel traffic, will likely yield **negligible** cumulative air quality impacts.

A review of the ongoing and proposed projects in the general vicinity of the Proposed Action found one reasonably foreseeable offshore wind energy project adjacent to the Proposed Action that could contribute to cumulative air quality impacts, the Tier 2 South Fork Wind Farm. Although not considered reasonably foreseeable, of the four Tier 3 projects discussed in Appendix C, two of them (the Bay State Wind Farm [BSW] and Revolution Wind) could contribute to cumulative effects if they came to fruition.[2] In addition, there are several wind energy leases that could result in future development of other wind energy projects. Additionally, there are a number of coastal development activities and building construction projects planned. However, BOEM anticipates that these emissions would result in **minor** cumulative air quality impacts that would be largely confined to the local area around each specific project. Additionally, construction activities and operations of diesel equipment from these projects would result in air quality impacts over limited areas for limited time periods.

Because the emissions related to onshore and offshore activities would be widely dispersed and transient, BOEM expects all air quality impacts to occur close to the emitting sources. Thus, BOEM expects **minor** cumulative impacts on air quality from the interaction of emissions at various locations within the analysis area. Since the Proposed Action would provide additional power generation to the area, development of additional fossil fuel facilities would not occur or be limited in size, resulting in a net air quality benefit. BOEM expects that the Proposed Action when combined with

[2] The two Tier 1 projects and the other two Tier 3 projects are not within the geographic analysis area described in Appendix C.

past, present, and future projects, would result in **minor** impacts. However, there would still be net **minor beneficial** cumulative air quality impacts.

As was the case with the Proposed Action, because the air emissions related to onshore and offshore activities would be widely dispersed and transient, BOEM expects all air quality impacts to occur close to the emitting sources. Thus, BOEM expects **minor** cumulative impacts on air quality from the interaction of emissions at various project locations. Since Alternatives B, C, D1, D2, and E would provide additional power generation to the area, development of additional fossil fuel facilities would not occur or be limited in size, also resulting in a net air quality benefit. BOEM expects that Alternatives B, C, D1, D2, and E would result in an overall net **minor beneficial** cumulative air quality impact.

3.2.1.11. Incomplete or Unavailable Information for Air Quality

A detailed emissions inventory is needed to develop a comprehensive assessment of sources and activities that have the potential to contribute to air quality impacts at the location of the Proposed Action and in the surrounding region. Although this was not available at the time of the preparation of this document, sufficient information exists to support the findings presented herein.

3.2.2. Water Quality

3.2.2.1. Description of the Affected Environment for Water Quality

The affected environment for water quality includes waters within the OCS in the WDA, the OECC, the navigation routes between these areas, and the primary ports that Vineyard Wind would likely use to support proposed Project activities.

Water temperature, salinity, dissolved oxygen (DO), chlorophyll *a*, turbidity, and nutrient levels are the key parameters characterizing ocean water quality, and contribute to the latter's ability to support and maintain a healthy ecosystem. Some of these parameters are accepted proxies for ecosystem health (e.g., DO, nutrient levels), while others delineate coastal habitats from marine habitats (e.g., temperature, salinity):

- *Water temperature*: Water temperature heavily affects species distribution in the ocean. Large-scale changes to water temperature may impact seasonal phytoplankton blooms, an important part of New England marine ecosystems (Oviatt 2004).
- *Salinity*: Salinity, or salt concentration, also affects species distribution. In general, seasonal variation in the region is smaller than year-to-year variation and less predictable than temperature changes (Kaplan 2011).
- *Dissolved oxygen*: The amount of DO in water determines the amount of oxygen that is available for marine life to use. Temperature strongly influences DO content, which is further influenced by local biological processes. For a marine system to maintain a healthy environment, DO concentrations should be above 5 milligrams per liter (mg/L); lower levels may affect sensitive organisms (USEPA 2000).
- *Chlorophyll a*: Chlorophyll *a* is a measure of how much photosynthetic life is present. Chlorophyll *a* levels are sensitive to changes in other water parameters, making it a good indicator of ecosystem health. The USEPA considers estuarine and marine levels of chlorophyll *a* under 5 micrograms per liter (µg/L) to be good, 5 to 20 µg/L to be fair, and over 20 µg/L to be poor (USEPA 2015; Leibman 2005).
- *Turbidity:* Turbidity is a measure of water clarity. Turbid water lets less light reach the seafloor, which may be detrimental to photosynthetic marine life (CCS 2017). In estuaries, a turbidity level of 0 to 10 nephelometric turbidity units (NTU) is healthy while a turbidity level over 15 NTU is detrimental (NOAA 2018b). Marine waters generally have less turbidity than estuaries.
- *Nutrients*: Key ocean nutrients include nitrogen and phosphorous. Photosynthetic marine organisms need nutrients to thrive (with nitrogen being the primary limiting nutrient), but excess nutrients can cause problematic algal blooms. Algal blooms can significantly lower DO concentration, and toxic algal blooms can contaminate human food sources. Both natural and human-derived sources of pollutants contribute to nutrient excess.

Regional Setting

Large-scale regional water circulation is strongest in late spring and summer. The clockwise movement around Georges Bank and flow towards the equator dominates the regional water circulation (Gulf of Maine Census 2018). The edge of the continental shelf creates a shelf-break front that encourages upwelling. Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011). Appendix B includes additional regional setting information.

Project Area

The proposed Project area is a typical subset of the regional setting described above and includes coastal waters in nearshore areas where bottom depth is less than 98.4 feet (30 meters), and marine waters in deeper offshore areas; the 98.4-foot (30-meter) isobath delineates between these ecologically distinct nearshore and offshore systems (FGDC 2012). The OECC is located entirely within coastal waters, and the WDA is located within marine waters.

Coastal waters include the OECC, parts of navigation routes to access the proposed Project area from shore, and ports that Vineyard Wind may use during construction, operations, maintenance, and decommissioning.

The export cable would pass through Nantucket Sound to link the WDA to the coast (see Figure 2.1-2). Water depth generally decreases with proximity to shore (COP Volume I, Section 2.1; Epsilon 2018a). Lewis Bay and waters adjacent to Nantucket Island are both Class SA water bodies, which are designated as "an excellent source of habitat for fish, other aquatic life and wildlife" (USDOI MMS 2009). Table 3.2.2-1 shows ranges of water quality parameters taken from three locations in Nantucket Sound from 2010 to 2016.

Table 3.2.2-1: Ranges Observed in Nantucket Sound for Selected Water Quality Parameters (2010-2016)

Parameter	South	Central	North	Mean [a]
Temperature (°C)	8.7–22.8	8.2–24.2	9.9–26.3	19.2
Salinity (psu)	30.7–32.7	30.7–32.5	30.6–32.5	31.7
Dissolved Oxygen (mg/L)	6.9–9.6	6.4–11.4	5.4–11.8	7.6
Chlorophyll *a* (µg/L) [b]	0.5–4.7	0.2–4.8	0.6–4.3	1.8
Turbidity (NTU)	0.1–3.2	0.1–2.3	0.1–2.2	0.7
Nitrogen (µM)	4.4–18.1	3.3–20.4	3.1–75.8	11.6
Phosphorous (µM)	0.3–1.6	0.2–1.9	0.3–2.6	0.8

Source: Modified from COP Table 5.2-1 (Volume III; Epsilon 2018a); originally obtained from buoy data from the Center for Coastal Studies from 2010-2016. The specific Stations sampled are South = Station NTKS_1; Central = NTKS_6; North = Station NTKS_1. COP Figure 5.2-1 shows locations for each buoy (Volume III.; Epsilon 2018a)

°C = degrees Celsius; µg/L = microgram per liter; µM = micromolar; mg/L = milligrams per liter; NTU = nephelometric turbidity units; psu = practical salinity units

[a] "Mean" is an unweighted mean combining the calculated means for all three stations.

[b] Chlorophyll *a* values in the COP are incorrectly described as being in mg/L but are actually given in µg/L.

The large temperature range is due to the strong seasonality of New England waters; within-year data from 2016 at the same three stations demonstrate these seasonal patterns (CCS 2016a; 2016b; 2016c). Salinity levels have low variability. DO levels in Nantucket Sound show a small decrease in oxygenation from south to north but are within healthy range. Local chlorophyll *a* levels are also highly seasonal; the chlorophyll *a* concentrations in Table 3.2.2-1 likely reflect seasonal variation and difference in location. The north station has a significantly higher maximum nitrogen level: this station is the closest to mainland Cape Cod and potentially subject to more sources of nitrogen influx, such as discharge from estuaries and groundwater.

The MCT is the primary port identified to support proposed Project activities; four additional ports in Narragansett Bay and several other commercial seaports in the region may also be used (see COP Tables 3.2-1 and 3.2-2 [Volume I; Epsilon 2018a]). These ports are located within protected embayments and urban estuaries that typically have worse water quality conditions than waters further offshore (e.g., in Buzzards Bay or Nantucket Sound) due to groundwater discharge, which results in nutrient pollution and other water quality issues. The MCT is located in the estuarine section of the Acushnet River, in lower New Bedford Harbor. New Bedford Harbor is the most urbanized and contaminated area in Buzzards Bay (Pesch et al. 2011). Inner New Bedford Harbor was given a score of 44.9 (Fair) out of 100 in the Buzzards Bay Coalition's Bay Health Index score, which combines water turbidity, nitrogen levels, DO concentration, and algae content. Outer New Bedford Harbor had a score of 67 (Good), while the Acushnet River had a score of 17.4 (Poor) (Buzzards Bay Coalition 2011).

Average DO concentration in Narragansett Bay from 2005 through 2015 ranged from an average of 3.4 (in the Seekonk and Providence Rivers) to 4.8 (in the Lower Bay); hypoxic events, which typically occur at the bottom, reduce these averages. Average summer surface temperature during the same study ranged from 21.1 to 24.2 degrees Celsius (°C); salinity ranged from 23.7 to 28.4 (NBEP 2017). Narragansett Bay's history of good water clarity has fluctuated in recent years. Chlorophyll concentrations are seasonal and decrease from north to south; it can be greater than 60 µg/L in the Seekonk River (nearest nutrient sources) during the growing season, but sampling in the lower Bay has found concentrations of approximately 5 to 20 µg/L and below (NBEP 2017).

The WDA is 75,614 acres (306 km^2) and located in marine waters, approximately 14 miles (22.5 kilometers) south of Nantucket and Martha's Vineyard at its nearest point. Water depths in the WDA range from approximately 115 to 161 feet deep (approximately 35 to 49 meters) (COP Volume I; Epsilon 2018a). Offshore temperatures also vary with depth and season due to seasonal thermoclines (Ullman and Codiga 2010), shown in Table 3.2.2-2. DO concentration in temperate climates generally decreases with depth and changes seasonally with temperature: it is highest in winter and lowest in the summer and fall (Ullman and Codiga 2010). DO concentration in 2016 (the most recent available year) fell during May through late summer as waters warmed, and rose in late September as waters cooled (CCS 2016a; 2016b; 2016c). Ullman and Codiga (2010) found turbidity near the proposed Project area ranged from 0.25 to 0.5 NTU in September, March, and June, but in December increased to a range of 0.75 to 1.25 NTU. Nutrient concentrations in the Project area are not well sampled.

Table 3.2.2-2: Seasonal Ranges Observed near the WDA for Selected Water Quality Parameters

Season	Surface Temp (°C)	Bottom Temp (°C)	Surface Salinity (psu)	Bottom Salinity (psu)	Chlorophyll *a* (µg/L)
Spring	6.3	7.2	32.9	33.5	0.7-1.6
Summer	na	na	na	na	0.4-1.0
Fall	17.5	12.7	32.9	33.4	0.9-1.9
Winter	5.4	7.5	32.9	33.8	0.9-2.4

Source: Modified from COP Table 5.2-2 (Volume III; Epsilon 2018a) for temperature and salinity and from Figure 4-3 in BOEM 2014a for chlorophyll *a*. Collection dates and locations are described by their respective sources. Chlorophyll *a* data solely represent the range at the surface. The study that collected the temperature and salinity data did not sample during the summer.
°C = degrees Celsius; µg/L = microgram per liter; na = not available; psu = practical salinity units

Vineyard Wind would choose one of two potential landfall sites: Covell's Beach in Barnstable or New Hampshire Avenue in Yarmouth. An onshore export cable would connect the landfall site to a new onshore substation in Barnstable, which would connect to the existing power grid at the Barnstable Switching Station (COP Figure 2.2-1, Volume I; Epsilon 2018a). The onshore substation site is located in a Wellhead Protection District (Town of Barnstable 2017). Vineyard Wind proposes two potential OECRs, the western (in Barnstable) and eastern (beginning in Yarmouth, ending in Barnstable). Onshore cables would be underground, mostly beneath public roads.

The Massachusetts Department of Environmental Protection considers the Lewis Bay Watershed, which includes the New Hampshire Avenue landfall site and areas of Barnstable and Yarmouth, impaired due to excessive nitrogen (from septic systems, stormwater, and fertilizers). This impairment has resulted in loss of eelgrass beds, periodic algae blooms and drops in DO concentration, and reduction in benthic diversity (Cape Cod Commission 2017a). Parts of the proposed western OECR may cross into the Centerville River Watershed (the Covell's Beach landfall site is near the border of this watershed), which is also designated as impaired due to nitrogen excess (Cape Cod Commission 2017b). Cape Cod Commission's Watershed Reports (2017a, 2017b) and the Total Maximum Daily Load reports (MassDEP 2007, 2015) provide detailed information on sources and levels of contamination within each watershed.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect water quality in coastal waters. Disturbance to the sediment bed affects turbidity, and installation and maintenance of transmission cables between the WDA and shore would have short-term, local effects on turbidity. If materials such as dead organic matter or contaminants are present in the sediment, they could be released into the water column. Decomposition can reduce DO concentration and pollutants can have adverse effects (both lethal and nonlethal) when taken up by marine organisms. Heat generated by power transmission has the potential to affect water temperatures (Meißner et al. 2006). The Proposed Action could expose coastal waters to contaminants (such as fuel, sewage, solid waste or chemicals, solvents, oils, or grease from equipment) in the event of a spill during routine vessel use. Allowed vessel discharges, such as bilge and ballast water, are restricted to uncontaminated or properly treated liquids, as described in Section 5.2.2.1.5 of the COP Volume III (Epsilon 2018a).

The Proposed Action would also affect water quality in marine waters. Installation and decommissioning of the WTGs, ESPs, inter-array cables, and that portion of the export cable in the WDA are likely to impact local turbidity. The OECCs within the WDA could influence water temperatures. Routine vessel use during proposed Project activities has the same potential spill risk and restricted discharge as described above.

Vineyard Wind may use HDD to make the ocean-to-land transition or use other methods such as a direct lay approach (considered for Lewis Bay/New Hampshire Avenue); the latter could have effects similar to the cable-laying methods described above. Impact on the intertidal zone would depend on the method chosen.

Chemical releases such as spilled oil or dielectric fluid during onshore construction, cable laying, or operations could potentially enter the town's groundwater, and could ultimately end up in drinking water or migrate to nearby surface waters.

Current Condition and Trend

Northeastern coastal waters are experiencing a long-term warming trend; average temperatures from 1980 to 2005 are 0.5 to 1.3°C warmer than average temperatures from 1890 to 1905. The warming trend in surface temperature is greater than warming in local air temperature over the same period, suggesting that changes in water temperature in the Gulf of Maine are not caused by local air temperature but by movement of warmer water from other water bodies that have shown warming trends in both sea-surface temperature and air temperature (Shearman and Lentz 2010).

Increased coastal development on Cape Cod is causing increased nutrient pollution in communities, approximately 80 percent of which is due to groundwater contamination by septic systems. Nutrient overloading in estuaries and coastal waters goes back several decades (Cape Cod Commission 2013a). Both development and increased boat traffic contribute to other contaminant levels.

3.2.2.2. Environmental Consequence

Relevant Design Parameters

Appendix G discusses the PDE and maximum-case scenario for the Proposed Action in detail. The primary design parameters that would influence the magnitude of impacts on water quality due to proposed-Project activities include:

- The amount of vessel use during installation, operations, and decommissioning.
- The number of WTGs and ESPs and the amount of cable laid determines the area of seafloor and volume of sediment disturbed by installation. Representing the maximum-case scenario, a maximum of 100 WTGs installed, one large 800 MW ESP or two 400 MW ESPs, 171 miles (275 kilometers) of inter-array cable, and 98 miles (158 kilometers) of export and inter-link cable would be installed in the WDA (see Appendix G).
- Installation methods chosen and the duration of installation.
- Proximity to sensitive groundwater or surface water sources and mitigation measures used for onshore proposed-Project activities.
- The landfall site and associated OECR chosen, as well as routing variants within the selected OECR.
- In the event of a non-routine event such as a spill, the quantity and type of oil, lubricants, or other chemicals contained in the WTGs, vessels, and other proposed-Project equipment.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the exact number of WTGs and ESPs (determining the total area of foundation footprints); the number of monopile foundations and jacket foundations; the total length of inter-array cable; the total area of scour protection needed; and the number, type, and frequency of vessels used in each phase of the proposed Project.

3.2.2.3. Impacts of Alternative A (Proposed Action) on Water Quality

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with Proposed Action construction, operations, maintenance, and decommissioning.

Direct and Indirect Effects of Routine Activities

Routine activities that would directly impact offshore water quality include Proposed Action-related vessel activity (and associated vessel discharges, such as bilge, ballast water, trash, and sanitary waste) and, to a lesser extent, activities that disturb the seafloor. Vessel discharges can introduce contaminants to the water column, while activities that disturb the seafloor cause temporary sediment suspension and turbidity.

<u>Construction and Installation of Offshore Components</u>

During construction, an average of 25 and a maximum of 46 vessels may be present in the WDA or OECC (COP Volume I, Section 4.2.4; Epsilon 2018a). COP Table 4.2-2 lists types of waste potentially produced by the Proposed Action, and COP Table 4.2-3 lists potential chemical products to be used and describes planned treatment, discharge, and disposal options for each (COP Volume I, Sections 4.2.5 and 4.2.6; Epsilon 2018a). Vineyard Wind would only be allowed to discharge untreated wastes overboard; this includes uncontaminated ballast water and uncontaminated water used for vessel air conditioning. Vineyard Wind would treat all other wastes before discharge, or would retain and dispose of the wastes on land. Vineyard Wind has submitted chemical waste and management plans to BOEM for approval, described in COP Section 4.2 (Volume I; Epsilon 2018a) and COP Appendices I-A and I-B (Volume III). With appropriate mitigations and measures in place (COP Volume III, Section 5.2.2.1.6; Epsilon 2018a), the impact of routine vessel discharge is expected to be **minor**.

Other projects using similar installation methods (e.g., jet plowing, pile driving) have been characterized as having **minor** impacts on water quality due to the short-term and localized nature of the disturbance (Latham et al. 2017). The Hydrodynamic and Sediment Dispersion Modeling Study done for the proposed Project predicted a similar short-term and localized disturbance, as described in the Vineyard Wind Connector Supplemental Draft Environmental Impact Report (Epsilon 2018c). The model predicted that disturbed sediments would typically settle within 4 to 6 hours. Vineyard Wind would use pile driving to install both monopile and jacket foundations, which should only cause sediment resuspension local to the pile outer diameter (COP Volume III, Sections 5.2.2.1.1 and 5.3.2.1.1; Epsilon 2018a). Vineyard Wind would install the submarine cable mostly by jet plow or mechanical plow, and Vineyard Wind has modeled that the resultant plume is predicted to stay in the lower portion of the water column (bottom 9.8 feet [3 meters]). The portion of the cable installation plume that exceeds a concentration of 10 mg/L[3] should typically extend 656 feet (200 meters) from the route centerline but could extend to a maximum of approximately 1.2 miles (2 kilometers) (Attachment F in Epsilon 2018c). Suspended sediment concentrations between 45 and 71 mg/L can occur in Nantucket Sound under natural tidal conditions, and increases in suspended sediment concentrations due to jet plow are within the range of variability already caused by tidal currents, storms, trawling, and vessel propulsion (USDOI MMS 2009). As a result, BOEM expects **minor** impacts on water quality due to sediment dispersion and increased turbidity during installation and cable laying because of the brief duration and small area of impact.

The greatest potential impact from cable laying would occur if Vineyard Wind uses pre-cable installation dredging during the cable-laying process. Modeling showed sediment concentrations greater than 10 mg/L from dredging could extend up to 10 miles (16 kilometers) from the route centerline and spread through the entire water column. These plumes typically settled within 3 hours but could persist in small areas (15 acres [60,702.8 m^2] or less) for up to 6 to 12 hours (Epsilon 2018c). Dredged material disposal could cause concentrations greater than 1,000 mg/L for a duration of less than 2 hours and a distance of approximately 3 miles (5 kilometers). For this reason, Vineyard Wind expects to use dredging only when necessary in sand wave areas, and not at all within Lewis Bay. A predicted maximum of 3.8 miles (6.1 kilometers) of dredging may occur in the OECC (see Table 1-5 in Epsilon 2018c). Attachment C of Epsilon 2018c depicts potential areas of discontinuous dredging. Although turbidity is likely to be high in the affected areas, the sediment no longer impacts water quality once it has settled. Because the period of sediment suspension is very short-term and localized and the use of dredging is restricted, BOEM expects **minor** impact on water quality.

Contamination is more typically present in sediments near harbors and industrial sites than offshore waters because coastal development is the primary source of contaminants (USDOI MMS 2009). Sediment core samples from within Nantucket Sound found sediment contaminant levels below the Effects Range-Low marine sediment quality guidelines, the lowest likelihood (10 percent or below) of toxic effects on fauna (USDOI MMS 2009). Vibracore samples taken near the New Hampshire Avenue landfall site were classified as Category 1, Type A material (i.e., contains the least amount of contaminants) based on Massachusetts Department of Environmental Protection criteria (USDOI MMS 2009). Given the low levels observed in the area and the brief duration of sediment resuspension, the likelihood of impacts on water quality due to sediment contamination during sediment resuspension is **negligible** to **minor**.

Vineyard Wind prefers direct bury as the installation method for the transition to onshore at the New Hampshire Avenue landfall site, partly because the area is already altered/disturbed, the site provides direct access to the water, and there are no sensitive environmental resources that would be impacted (Epsilon 2018c). If the alternative (i.e., HDD) were used, it would avoid temporary disturbance to approximately 200 feet by 30 feet (approximately 61 meters to 9.1 meters) of seafloor offshore from a small, previously altered coastal beach, but there would be greater potential for an extended schedule and a greater construction footprint onshore (Vineyard Wind 2018a). BOEM expects direct bury or the alternative (i.e., HDD) to have **negligible** impacts on water quality in the area due to methods described in Sections 1.4.2.3 and 1.4.2.4 of Epsilon 2018c.

Construction and Installation of Onshore Project Components

As described in Section 2.1.1, construction and installation of onshore components would include installation of one or more concrete transition vaults at the selected landfall site, installation of a single buried concrete duct bank through which the onshore export cables would run, and substation construction. Ground disturbance associated with these

[3] A suspended sediment concentration of 10 mg/L is a typical value for coastal waters; therefore, modeling is designed to predict concentrations above this ambient level (Bejarano et al. 2013).

activities could lead to unvegetated or otherwise unstable soils. Precipitation events could potentially mobilize the soils into nearby surface waters, leading to potential erosion and sedimentation effects and subsequent increased turbidity. For example, the eastern OECR would cross an existing culverted road-stream crossing at Thornton Brook, which may be susceptible to such potential impacts. However, Vineyard Wind would implement erosion and sedimentation controls during the construction period, making these potential effects **negligible**.

The OECR and the route variants associated with the New Hampshire Avenue landfall site would cross through 3.01 to 3.6 miles (4.8 to 5.8 kilometers) of Zone I or Zone II protection areas depending on the variant route selected).[4] The Covell's Beach landfall site would not pass through a Zone I area, but would pass through 4 miles (6.4 kilometers) of Zone II protection areas. If the variant route associated with the Covell's Beach landfall site were selected (see Figure 2.1-1), a total of 4.2 miles (6.8 kilometers) of Zone II protection areas would be crossed (Epsilon 2018b). In addition, much of the OECR associated with the Covell's Beach landfall would be located within the Barnstable Groundwater Protection Overlay District, and it would also cross a Freshwater Resource Area (Section 8.1.2 in Epsilon 2018b). The proposed substation site is located within a Zone II Wellhead Protection Area and the Barnstable Groundwater Protection Overlay District.

Vineyard Wind would use a new operations and maintenance facility in Vineyard Haven on Martha's Vineyard. At the time of preparation of this Draft EIS, information was lacking to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port.

The aforementioned construction activities would require heavy equipment use, and potential spills could occur as a result of an inadvertent release from the machinery or during refueling activities. Vineyard Wind would perform the majority of fueling and equipment maintenance activities at service stations or a contractor's yard (Section 9.8.1 in Epsilon 2018b). Less mobile equipment such as excavators or paving equipment would be refueled on site, but Vineyard Wind has stated that this would not be done within 100 feet (30.5 meters) of wetlands, waterbodies, or known private or community potable wells, or within any Zone I area (Section 9.8.1 in Epsilon 2018b). Additionally, a Construction Spill Prevention, Control, and Countermeasure Plan would be prepared in accordance with applicable requirements, and would outline spill prevention plans and measures to contain and cleanup spills if they were to occur. Lastly, Vineyard Wind would use solid cables that do not contain fluids for the Proposed Action export cables. Therefore, BOEM anticipates **negligible** potential impacts on surface and groundwater quality as a result of releases from heavy equipment and other cable installation activities.

Operations and Maintenance of Offshore Components

Vineyard Wind expects substantially less vessel use during routine operations/maintenance than during construction. Vessel use would consist of scheduled inspection and maintenance activities (an example schedule is provided in COP Volume I, Figure 4.3-1; Epsilon 2018a), with corrective maintenance as needed. Vineyard Wind would maintain each wind facility component annually, resulting in 401 to 887 round trips per year, or an average of 1 to 3 vessel trips per day (COP Volume I, Table 4.3-2; Epsilon 2018a). Vessels would still comply with the discharge measures described above, resulting in **negligible** to **minor** impacts on water quality.

The WTGs and ESPs are self-contained and do not generate discharges under normal operations. Except in the event of a spill related to a vessel allision or other unexpected or low-probability event (see Section 2.3), the impacts during operations should be **negligible**.

In offshore wind facilities in Europe, scour processes have been a concern in some instances due to the potential impacts on water quality through the formation of sediment plumes. However, European offshore wind facilities are generally located at shallower depths with tidally dominated currents, and Vineyard Wind predicts the scour potential for the Proposed Action to be significantly less due to the difference in local hydrodynamic forces (COP Volume III, Section 2.1, Appendix III-K; Epsilon 2018a). The WTG and ESP foundations would result in some alteration of local water currents, but Vineyard Wind would not expect significant scour even without scour protection due to the low current speeds and minimal seabed motility in the WDA (Section 3.2.2, COP Volume II; Epsilon 2018a). The addition of scour protection would further minimize effects on local sediment transport. Scouring processes are more prevalent in portions of the proposed OECC in shallower water where tidal current flow can have a greater effect, but the buried depth of cables are planned to be below the mobile sand layer in hard and soft-bottomed areas. Where burial is not possible in hard-bottom areas, the addition of cable armoring and the coarseness of the local sediment are anticipated to prevent scour (COP Volume III, Section 3.2.1 and 3.2.2, Appendix III-K; Epsilon 2018a). With measures in place to mitigate scour potential, BOEM anticipates **negligible** to **minor** sediment plumes and water quality impacts.

[4] A Zone I protection area is a protective radius required around a public water supply well or wellfield. A Zone II protection area is the area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated. Zone I areas reside within Zone II areas. See Section 8.1 in Epsilon 2018a for more information.

Operations and Maintenance of Onshore Project Components

As described above, onshore export cables would not contain fluids and would not be susceptible to leaks that could affect water quality. The transformers at the proposed substation would each contain between 15,000 and 20,000 gallons (56,781.2 to 75,708.2 liters) of dielectric fluid; each iron core reactor could contain 10,000 gallons (37,854.1 liters), and the capacitor banks would contain up to 1,500 gallons (5,678.1 liters) (Epsilon 2018b).[5] The proposed substation site is located within a Zone II Wellhead Protection Area and the Barnstable Groundwater Protection Overlay District; according to the Town of Barnstable (2018), the site would reside above the aquifer that is the sole source of drinking water for the village of Hyannis. As stated in the Draft Environmental Impact Report, the proposed substation would be equipped with full volume impervious containment sumps capable of capturing 110 percent of stored fluids for any components containing dielectric fluid, including all transformers and capacitor banks (Sections 2.3.2 and 8.1, Epsilon 2018b). In response to a request made by the Town of Barnstable, Vineyard Wind stated in the Supplemental Draft Environmental Impact Report that it is "willing to adjust the 110% containment volume upwards to account for simultaneous 100-year, 24-hour rainfall events, which on Cape Cod is conservatively established at 9 inches of rain" (Epsilon 2018c). The Supplemental Draft Environmental Impact Report also included the following additional information related to substation components and measures to minimize or avoid potential impacts on water quality in the event of a potential spill (Section 1.4.4.1, Epsilon 2018c):

- The substation design includes routing each individual containment area through an oil-absorbing device and to an oil/water separator before draining into an infiltration basin.
- Spill response would be included in the emergency response plans as part of the safety management system.
- Spill containment kits and control accessories would be strategically located at the substation.
- Vineyard Wind would train substation operators to use spill prevention equipment.
- Per the Oil Spill Response Plan, a third-party licensed spill response contractor would be on call.
- Vineyard Wind has and is investigating the possible use of biodegradable dielectric fluid for the main transformers.

Vineyard Wind will develop Project-specific operations and maintenance plans (described in COP Volume I, Section 4.3; Epsilon 2018a) including scheduled inspections and maintenance over the life of the project and continuous review and improvement. Based on the information provided above, BOEM anticipates **negligible** impacts on water quality in the event of a potential release at the substation.

Decommissioning

Decommissioning reverses the installation process and has similar environmental impacts, with some exceptions. Vineyard Wind would drain all fluid chemicals from the WTGs and ESPs, and dismantle and remove them. Vineyard Wind would also remove monopile and/or jacket foundations. Vineyard Wind would remove scour protection and cable protection. Vineyard Wind could remove the offshore cable system, or, with BOEM approval, retire the cable system in place (COP Volume I, Section 4.4.4; Epsilon 2018a). The latter option would require both less vessel activity and less sediment resuspension since there would be no cause for disturbance along the OECC. BOEM anticipates decommissioning to have **minor** impacts on water quality.

Decommissioning onshore components is subject to consultation with the host towns, which may choose to retire the onshore cables, encasements, and other structures in place for future reuse or to lessen environmental impact. The maximum-case scenario would be to remove all onshore cables and structures, which would have no more impact than installation (COP Volume I, Section 4.4; Epsilon 2018a).

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. If cable laying in Lewis Bay prevented future dredging in the bay, it would indirectly impact water quality by impairing future tidal flushing. However, Section 4 of the Vineyard Wind Connector Draft Environmental Impact Report (Epsilon 2018b) determined that the cable route would not cause bathymetric changes to the bay and avoids existing dredge channels. BOEM anticipates **negligible** impacts on water quality via this indirect mechanism.

In the non-routine event of a spill, the severity of impact would depend on the quantity of oil or other contaminant released. Small-volume spills could conceivably occur during maintenance or transfer of fluids (including maintenance failures resulting in equipment or structural issues), while low-probability small- or large-volume spills could occur due to vessel collision or an allision with the WTGs/ESPs, or incidents such as toppling during a storm or earthquake. COP Appendix I-A includes a draft Oil Spill Response Plan (Volume III; Epsilon 2018a).

[5] Fluids used in substation components would not contain polychlorinated biphenyls.

BOEM has done extensive modeling to determine the likelihood and effects of a chemical spill within an offshore wind facility, including modeling situated near the proposed Project area (Bejarano et al. 2013). COP Table 4.2-1 lists the vessels used for construction and the approximate fuel capacity of each in (COP Volume I; Epsilon 2018a). Trenching vessels used for cable installation/removal have the largest fuel capacities. COP Table 4.2-3 lists the volume and types of chemicals found in the WTGs and ESPs. The ESPs would contain the greatest volumes of oils, with a maximum of approximately 123,210 gallons (466,400.6 liters) of transformer oil, 15 gallons (56.8 liters) of lubrication oil, and 348.7 gallons (1,320 liters) of general oil. This is close to the volume (128,000 gallons [484,532.7 liters] of oil mixture) Bejarano et al. (2013) models in Scenario All-Mix2-129K, which represents a catastrophic release. Bejarano et al. (2013) calculates the probability of such a spill as "Very Low," or one time in 1,000 or more years. The only incidents calculated to potentially occur within the life of the Proposed Action are spills of up to 90 to 440 gallons (340.7 to 1,665.6 liters) of WTG fluid (one time in 1 to 5 years) or a diesel fuel spill of up to 2,000 gallons (7,570.8) (one time in 20 years). The likelihood of a given spill resulting in a release of the total container volume is low. Table 3.2.2-3 presents a selection of potential spill-causing events and their calculated probabilities. BOEM anticipates small vessel allisions to be unable to cause significant damage to ESPs or WTGs. Vessels would likely have their own onboard containment measures that would further reduce the impact of an allision. The model calculates the likelihood of allision with a WTG by assuming 30 miles of exposed WTGs that could potentially be struck by an off-course vessel; however, the likelihood of a vessel crossing into the row of WTGs and actually hitting a WTG is much lower because a vessel is more likely to pass between the WTGs than allide with them. The likelihood of a vessel crossing into the WTG line and alliding with a WTG is only 14.5 percent (Section 3.2.6 in Bejarano et al. 2013).

Table 3.2.2-3: Selected Estimated Annual Incident Rates Modeled for the Deepwater Wind Lease Area

Incident Type	Estimated Annual Incident Rate	Estimated Years Between Incidents
Small vessel allision	0.29	3.45
Large vessel allision	0.22	4.55
Large vessel multiple WTG (5) allision	0.04	25.00
Seismic event over 5.0	0.0014	714.29
Seismic event over 7.0 and tsunami	0.00006	16,666.67
Storm exceeding Category 3	0.04545	22.00
Transfer error	0.01	100.00

Source: Modified from Tables 3.14, 3.16, 3.17, and 3.19 in Bejarano et al. 2013, which models incident rates in the Deepwater WLA. The Deepwater WLA is situated slightly west of the Vineyard WLA and is delineated in Figure 1.1-1 (Section 1.1).
Note: Bejarano et al. (2013) and the COP refer to the Deepwater WLA as the Rhode Island-Massachusetts WEA.

Section 5 of Bejarano et al. (2013) characterizes the properties of oils and chemicals commonly used in offshore wind facilities in detail. Different chemicals possess different viscosity, propensity for floating, and other characteristics that affect their dispersal and ability to adversely affect water quality. Calculating the ultimate effects of a potential oil spill involves combining the probability of a spill, the probability of a given spill exceeding the threshold concentration expected to have an adverse effect, and the volume or area exposed to concentrations exceeding the threshold. Across multiple impact risk analysis models, the impact risk was generally low for the realistic-case simulations of all spill scenarios, except for the aforementioned 2,000-gallon (7,570.8-liter) diesel spill and 128,600-gallon (486,804-liters) oil-mixture spill, which had the greatest probability of having **moderate** water column impacts. In one model, a 10,000-gallon (37,854.1-liter) spill of napthenic mineral oil also had **moderate** impact. The overall impact risk was generally low for the maximum-case simulations, except for the same two spill scenarios and for 500- to 40,000-gallon (1,892.7- to 151,416.5-liter) napthenic oil spills, which would have **moderate** impacts. Even **moderate** impacts may be of very short duration. For example, diesel is acutely toxic and can disperse throughout the water column via droplets, but it is also a non-persistent oil that both diffuses rapidly and evaporates readily, usually within days (Bejarano et al. 2013). The spill scenarios most likely to occur (90 to 440 gallons [340.7 to 1,665.6 liters]) had a zero percent probability of exceeding the risk threshold in the water column or at the water surface in any model (Section 7.4.4 in Bejarano et al. 2013). Therefore, they would have **negligible** impacts, while a larger spill, although unlikely to occur, could have potentially **moderate** impacts.

The models used in this analysis incorporated extensive information from the Deepwater WLA (situated slightly west of the Vineyard WLA) and the project parameters utilized in the Cape Wind Project Final EIS (USDOI MMS 2009). Differences between the Proposed Action and the Cape Wind Project parameters could lead to increased or decreased likelihood of spill events compared to the Bejarano et al. (2013) model. There are several features of the Proposed Action compared to Cape Wind that are likely to decrease the probability of a spill event. These include (1) fewer WTGs (100 instead of 130); (2) wider spacing of WTGs (0.88 by 1.2 miles [1.4 by 1.9 kilometers] apart instead of 0.39 by 0.62 mile [0.63 by 1 kilometer] apart); and (3) greater distance from typical vessel routes (COP Volume III, Section 8; Epsilon 2018a; USDOI MMS 2009). Overall, the probability of a large enough oil or chemical spill to impact water quality is extremely low; but if it were to occur, such a spill could have potentially **moderate** or greater impacts on water quality depending on spill volumes.

Conclusion

Minor, localized short-term impacts and **negligible** long-term impacts on water quality could occur due to routine activities of the Proposed Action:

- Sediment resuspension during construction and decommissioning, both from regular cable laying and from pre-laying dredging, is anticipated have short-term, **minor** localized impacts on water quality.
- Vessel discharge for the duration of the Proposed Action (construction, operations, maintenance, and decommissioning) would be restricted to uncontaminated or treated liquids; therefore, BOEM expects **minor** to **negligible** impacts on water quality from vessel discharge.
- The risk of adverse effects from sediment contamination is **negligible** to **minor** due to the low contaminant levels of the sediment.
- Making the landfall transition at the New Hampshire Avenue landfall site should have **negligible** impacts for either direct bury or HDD, as these methods would be short-term in nature.
- WTGs and ESPs do not produce discharges and BOEM anticipates **negligible** impacts during operations.
- Sediment plumes due to scour should be **negligible** due to local hydrodynamic forces, and scour protection should have **negligible** to **minor** impact.
- Potential impacts on onshore water quality (surface and groundwater) should be **negligible** due to the implementation of BMPs during construction and operations.

Modeling near the proposed Project area indicates that the most likely type of spill (i.e., non-routine event) to occur during the life of the Proposed Action is 90 to 440 gallons (151.4 to 1,665.6 liters), which would have brief, localized impacts on water quality and overall **negligible** impacts. The likelihood of a larger spill is extremely low, but could have **moderate** impacts on water quality if one were to occur. It must be noted that the potential impacts to other resources, such as on finfish or shellfish (described in Section 3.3.6.2), is likely to be greater than the direct impact on water quality.

These conclusions describe the maximum-case scenario for the Proposed Action: if a less impactful scenario within the PDE were implemented by Vineyard Wind then the impacts would be less but would not result in different impact ratings than those described above.

3.2.2.4. Impacts of Alternative B on Water Quality

Alternative B narrows the PDE to use the Covell's Beach landfall site in Barnstable, and does not allow the flexibility to use the New Hampshire Avenue landfall site in Yarmouth.

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

All offshore installation activities would be the same as in the Proposed Action and the impact risks of vessel discharge, sediment suspension, and sediment contamination would also be the same. The offshore cable length would not exceed the maximum length described for the Proposed Action, and would consist of the Covell's Beach landfall site instead of New Hampshire Avenue (Lewis Bay). Vineyard Wind would only use HDD for the landfall transition in Alternative B, which is less impactful than the direct bury method. Alternative B would connect the landfall site to the onshore substation using existing road ROWs, thereby avoiding wetlands (see Section 3.3.4, Coastal Habitats). As described in Section 3.2.2.3, Alternative B would also avoid crossing a Zone I protection area, but would pass through more Zone II protection areas than the Proposed Action and would also be located within the Barnstable Groundwater Protection Overlay District and cross a Freshwater Resource Area. The level of impact is expected to be the same as or less than in the Proposed Action, i.e., **minor**.

Operations and Maintenance

Operations of Alternative B would be identical to the Proposed Action and have **negligible** to **minor** impacts on water quality.

Decommissioning

Decommissioning of Alternative B would be identical to the Proposed Action and have **minor** impacts on water quality.

Direct and Indirect Effects of Non-Routine Activities

The risk of spills would be the same as in the Proposed Action, and the impact of a spill, should it occur, would be the same: **negligible** for small-scale spills and **moderate** for larger spills. Although BOEM considers the indirect risk posed to future dredging of Lewis Bay to be **negligible** for the Proposed Action, it would be nonexistent in Alternative B because the cable would no longer pass through Lewis Bay since the New Hampshire Avenue landfall site would not be used.

Conclusion

The impacts on offshore water quality from Alternative B would be the same as, or less than, the predicted impacts from the Proposed Action, **minor**. Offshore impacts would be identical to the Proposed Action, and nearshore impacts would differ in that there would be no risk of an indirect impact on Lewis Bay because Vineyard Wind would not use the New Hampshire Avenue landfall site. Thus, Alternative B would have a **negligible** impact on nearshore areas. The risk posed by spills would be identical to the Proposed Action: **negligible** for small-scale spills and **moderate** for low-probability large-scale spills.

3.2.2.5. Impacts of Alternative C on Water Quality

Alternative C relocates the six northern-most WTGs and associated inter-array cables to the southern portion of the WDA, which may require additional survey work prior to construction to determine the new WTG and inter-array cable locations. Except in the event of a spill, the impact of vessel use for the additional surveys should be **negligible** due to the short duration and mitigation measures in place. The footprint of the WDA would be the same under Alternative C, and onshore components and associated impacts would remain the same as the Proposed Action.

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction and Installation

Once the WTG and inter-array cable locations are determined, construction and installation should be identical to that described in the Proposed Action and have **minor** impacts on water quality.

Operations and Maintenance

Operations of Alternative C would be identical to the Proposed Action and have **negligible** to **minor** impacts on Water Quality.

Decommissioning

Decommissioning of Alternative C would be identical to the Proposed Action and have **minor** impacts on water quality.

Direct and Indirect Effects of Non-Routine Activities

The risk of spills and the impact of a spill, should it occur, would be the same as with the Proposed Action: **negligible** water quality impacts from small-scale spills and **moderate** impacts from larger spills. There would be **negligible**, indirect impacts on future dredging of Lewis Bay.

Conclusion

The impacts on offshore water quality from Alternative C would be the same as the predicted impacts from the Proposed Action for both routine and non-routine activities. BOEM does not expect any additional impacts on water quality due to the relocation of the WTGs and anticipates **negligible** water quality impacts from any additional surveys that may occur.

3.2.2.6. Impacts of Alternatives D1 and D2 on Water Quality

Alternative D1 would increase the total acreage of the WDA by 22 percent (16,603 acres [67 km^2]) to achieve wider spacing between WTGs.[6] Under Alternative D2, the WTG layout would be arranged in an east-west orientation with a 1 nautical mile spacing in all directions to allow for greater spacing between most rows of WTGs in comparison to the Proposed Action. The amount and length of inter-array cabling would increase but not exceed the maximum design parameter of 171 miles (275 kilometers). Alternatives D1 and D2 alters the arrangement of the WTGs, and BOEM would require substantial additional survey work to resolve data gaps for WTG placements and inter-array cable locations not contemplated in Alternative A (Proposed Action). However, there would be no changes to the number of WTGs or the OECC routes. Onshore components and associated impacts would remain the same as the Proposed Action.

Incremental Contribution of Alternative D1 and D2

Direct and Indirect Effects of Routine Activities

Prior to construction, additional surveys may result in a small, temporary increase in vessel use unaccounted for in the Proposed Action. Upon completion of the surveys, construction and installation would be the same as for the Proposed Action, with **minor** impacts. Operations of Alternatives D1 and D2 would be identical to the Proposed Action (the wider spacing of WTGs may result in a small increase in vessel transit, but not above the maximum-case scenario delineated by the PDE) and have **negligible** to **minor** effects on water quality. Decommissioning of Alternatives D1 and D2 would be identical to the Proposed Action and have **minor** effects on water quality.

Direct and Indirect Effects of Non-Routine Activities

Adjusting the spacing between WTGs for Alternatives D1 and D2 would reduce the likelihood of collisions and allisions within the WDA, preventing resultant spills. The risk of spills would be lower than in the Proposed Action and the impacts of a spill, should it occur, would be the same: **negligible** impacts from small-scale spills and **moderate** impacts from larger spills. There would be **negligible** indirect impacts on future dredging of Lewis Bay.

Conclusion

The impacts on offshore water quality by Alternatives D1 and D2 would be less than the predicted impacts from the Proposed Action for both routine and non-routine activities. BOEM does not expect any additional impacts on water quality due to the relocation of the WTGs and anticipates **negligible** water quality impacts from any additional surveys that may occur.

3.2.2.7. Impacts of Alternative E on Water Quality

Alternative E proposes a maximum of 84 WTGs, each of which would likely have a generation capacity of approximately 9.5 MW. Onshore components and associated impacts would remain the same as the Proposed Action.

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

<u>Construction and Installation</u>

Alternative E would reduce construction and installation impacts from that described for the Proposed Action due to fewer WTGs and less inter-array cable connecting them. The impacts on water quality would be the same as or less than the Proposed Action: **minor** impacts from routine vessel discharge, sediment dispersion, and increased turbidity; **negligible** to **minor** impacts due to sediment contamination; and **negligible** impacts from the onshore transition.

<u>Operations and Maintenance</u>

Operations and maintenance would be the same as or reduced from the Proposed Action. There is no indication that larger WTGs require more maintenance (and therefore greater vessel use) than the smaller WTGs, so the primary variable is that there are fewer WTGs and less cable to maintain. There would also be reduced potential for sediment plume formation due to scour. Therefore, there should be **negligible** to **minor** impacts on water quality.

[6] As noted in Chapter 2, if stakeholders achieve consensus on implementing the regional transit lane to the south of the WDA, WTG placements for Alternative D1 would need to be placed south of the lane, thus increasing the footprint required for this alternative.

Decommissioning

Alternative E would reduce decommissioning impacts from the Proposed Action because Vineyard Wind would have fewer WTGs to remove, but would otherwise be the same as the Proposed Action. Therefore, the overall impacts would be **minor**.

Direct and Indirect Effects of Non-Routine Activities

Using fewer WTGs reduces the total volume of fluid chemicals present in the proposed Project area. The types and quantities of chemical products used in the WTGs were assessed for the Proposed Action using the maximum volumes (COP Volume I, Table 4.2-3; Epsilon 2018a). Therefore, Alternative E would not result in a greater impact than the Proposed Action. The reduction in WTGs also reduces the likelihood of a vessel allision and a resulting chemical spill. Additionally, fewer WTGs would result in fewer annual maintenance transfers, and less opportunity for a maintenance-related spill. The risk of spills would likely be lower than in the Proposed Action and the impacts of a spill, should one occur, would be the same: **negligible** impacts from small-scale spills and **moderate** impacts from larger spills. There would be **negligible** indirect impacts on future dredging of Lewis Bay.

Conclusion

Alternative E would reduce the minor impacts on offshore water quality for routine activities as compared to the Proposed Action. The impacts of non-routine events such as spills would be the same, but the likelihood of a spill would be reduced.

3.2.2.8. Impacts of Alternative F (No Action Alternative) on Water Quality

Under Alternative F, none of the described impacts on water quality would occur. In the absence of the Proposed Action or an alternate accepted project, changes to water quality will be primarily subject to current water quality trends in the area (see Section 3.2.2.1).

3.2.2.9. Comparison of Alternatives for Water Quality

Most alternatives are effectively identical in terms of the impact of routine activities to water quality: **negligible** to **minor** impacts due to vessel discharges; **minor**, short-term and localized impacts due to sediment suspension; **negligible** to **minor** impacts from sediment contamination due to the apparent lack of sediment contaminants in the area; **negligible** impacts from the presence of WTGs and ESPs because they are self-contained; **negligible** to **minor** impacts of scour; and **negligible** impacts from the methods used to make the landfall transition. The parameters altered between the Proposed Action and Alternatives B through D2 have little impact on water quality other than potentially requiring additional vessel surveys to determine new WTG and cable positions and the extra vessel use is expected to be of **negligible** impact. Differences in the length of inter-array cable laid and the distances vessels would traverse (due to wider WTG spacing) would not exceed the maximum-case scenario. Alternatives D1 and D2 may have a reduced likelihood of oil and chemical spills if the altered arrangement of WTGs successfully improves navigation through the area, though the impact on water quality of a spill if it occurred would be the same: **negligible** for small-scale spills and **moderate** for larger spills. There is a **negligible** risk of indirect impacts on Lewis Bay from potential effects on future dredging, which applies to the Proposed Action and all alternatives except Alternative B.

Alternative E substantially changes relevant design parameters by considerably reducing the number of WTGs and the amount of inter-array cable laid. It is likely there would also be reduced vessel use during construction, operations, maintenance, and decommissioning. This would decrease the amount of vessel discharge, sediment disturbance, and the potential risk of offshore chemical spills. This reduction is not likely to change the impact level of any impact-producing factors; for example, there would likely be less sediment suspension that occurs, but where sediment suspension does occur, it would still have a **minor** impact. Overall, however, Alternative E would potentially have the least impact on water quality.

3.2.2.10. Cumulative Impacts

The Proposed Action, when combined with past, present, and future projects, could result in cumulative impacts that differ from the impacts predicted by proposed Project activities alone. The cumulative geographic analysis area for water quality, which would account for some transport of water masses, includes a 10-mile (16.1-kilometer) radius around the WDA, the OECC, and vessel approach routes to port facilities that may be used by the proposed Project (see Appendix C, Figure C.1-2). Appendix C describes projects that could generate cumulative impacts on water quality. Cumulative impacts to turbidity are only likely in the immediate area of the WDA and OECC, and only during Project activities that generate sediment disturbance:

- Offshore Wind Energy Development: Tier 1 (the Atlantic City Wind Farm and Coastal Virginia Offshore Wind [CVOW]) and Tier 2 (South Fork Wind Farm) projects, although reasonably foreseeable, are outside of the geographic analysis area defined above. The BSW project, a Tier 3 project (see Table C-4 in Appendix C), would be adjacent the WDA and reside within the geographic analysis area. BSW plans to begin construction in 2022 while Vineyard Wind anticipates completing offshore construction in early 2022 (COP Volume I; Epsilon 2018a). Based on the criteria presented in Appendix C, BOEM does not consider this project or three other Tier 3 projects to be reasonably foreseeable.[7] If the project comes to fruition, potential water quality impacts associated with installation of BSW's 110 WTGs and two export cables could be similar to the Proposed Action; however, the extent of these effects would depend on project-specific information that is unknown at this time. Additionally, even if the BSW project comes to fruition in the timeframe specified above, there would be minimal temporal overlap (if any at all) with the Proposed Action during construction and only temporary, **minor** cumulative impacts to turbidity. Temporary, **minor** cumulative impacts on turbidity could also occur during cable maintenance and decommissioning.
- Tidal Energy: The proposed Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project is adjacent to the OECC. The project has not moved forward into permitting, and Vineyard Wind may complete cable laying before this other project begins, resulting in no temporal overlap. Depending on the timing of activities, temporary, **minor** cumulative impacts on turbidity could occur during cable laying, cable maintenance, and decommissioning.
- Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables: The only existing undersea transmission line near the OECC is the Falmouth-Tisbury Electric Cable. Cable maintenance is unlikely to have cumulative impacts unless it occurs simultaneously with Project activities that disturb sediment, and such activities would be temporary.
- Marine Minerals Use and Ocean Dredged Material Disposal: The nearest ocean dredged material disposal site (the Rhode Island Sound Disposal Site) is well outside the range of sediment disturbance from proposed Project activities, so there would be no cumulative impacts to turbidity.

Cumulative impacts due to vessel discharge and increased risk of spills could result from increased vessel activity. Marine transportation (such as from fisheries use, recreational use, and military use) in the region overlaps with vessel routes and port cities used in proposed Project activities and with the waters of the WDA and OECC. The activities of other reasonably foreseeable projects could increase local vessel usage; in addition to the projects described above, there are several other offshore wind projects, undersea transmission lines, sand removal and disposal sites, and ongoing surveys of other lease areas that are near enough to Project waters that they would likely overlap in vessel routes and port usage. Port upgrades may occur to support the development of the offshore wind energy industry (Appendix C) and could increase vessel traffic and have temporary impacts due to construction activities, though the impacts of construction are not likely to contribute to cumulative impacts based on information currently available.

BOEM anticipates cumulative impacts from vessel discharges to be **minor**, as all vessels are expected to comply with local regulations on effluent discharge. Major vessel routes are predicted to be relatively stable in the area (see Appendix C), and the Navigational Risk Assessment (NRA) (COP Appendix III-I; Epsilon 2018a) found no significant disruption of normal traffic patterns is anticipated in the WDA; therefore, even if vessel traffic in the region increases, a cumulative increase in the risk of vessel allisions or collisions is not anticipated. Vessel use during routine Project operations is also not anticipated to impact local vessel movement (COP Appendix III-I; Epsilon 2018a) so there would not be a cumulative impact on the risk of a spill during operations.

Climate change impacts water quality primarily via changes in temperature, stronger storms (increasing bottom disturbance), and ocean acidification (see Appendix C, Section C.1.9). BOEM has not identified these as areas of impact based on proposed Project activities, so there are no cumulative impacts. BOEM anticipates **negligible** water quality impacts from all onshore activities and components, so there would be no cumulative impacts with any of the identified onshore developments (see Appendix C, Section C.1.11).

As mentioned above, port upgrades, including the MCT, to support the development of the offshore wind energy industry are likely to occur. However, potential cumulative impacts on water quality associated with this and other ports are expected to be minimal if current regulations regarding construction and vessel discharges are followed. Appendix C provides further information on potential port upgrades.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, and D2 to be the same as under the Proposed Action: **minor** to **negligible**. The reduction in Project footprint under Alternative E would potentially result in an overall reduction in cumulative impacts, but the impact level would likely still be **minor** to **negligible**.

[7] The other three Tier 3 projects are outside of the geographic analysis area described in Appendix C.

3.2.2.11. Incomplete or Unavailable Information for Water Quality

Aside from the potential variances described above, which are accounted for in the maximum-case scenario delineated in the PDE, there is sufficient information to assess water quality.

3.3. BIOLOGICAL RESOURCES

3.3.1. Terrestrial and Coastal Fauna

3.3.1.1. Description of the Affected Environment for Terrestrial and Coastal Fauna

This section describes the terrestrial and coastal fauna of the proposed Project's onshore facilities, which includes the landfall locations, the proposed export cable, and the proposed substation site. See Section 3.3.2 for a discussion on inland birds, Section 3.3.3 for bats, and Section 3.3.4 for coastal areas and habitat within the proposed Project area.

Regional Setting

The terrestrial portion of the proposed Project is located within the Long Island-Cape Cod Coastal Lowland Major Land Resource Area. Much of this area exhibits sandy soils, mixed hardwood-softwood forests, and scrublands subject to periodic fires (USDA 2006).

Project Area

The Proposed Action includes two potential landfall sites and associated OECRs connecting the underground vault at the selected landfall site to the new proposed substation site (see Figure 2.1-1). Both OECRs are co-located with existing, previously disturbed linear corridors (public road, rail, and electric ROW), allowing the export cable to be buried below grade (COP Volume I; Epsilon 2018a).

The majority of the two proposed routes would be located under existing paved roadways in residential and commercial areas with sufficiently wide shoulders, which has limited to no terrestrial wildlife habitat. The remaining segments of the two proposed OECRs would be in previously disturbed corridors, such as railroad and electric transmission ROW, until they reach the proposed substation site. The proposed Project's substation site would be located on the eastern portion of a previously developed site within the Independence Park commercial/industrial area in the Town of Barnstable. Construction of the substation site would require the removal of approximately 7 acres (28,328.1 m^2) of forested habitat that is potentially suitable for use by terrestrial wildlife species.

The proposed western OECR, which runs from the Covell's Beach landfall site to the Barnstable Switching Station, is approximately 5.4 miles (9 kilometers). This route would be located along an existing maintained utility ROW, cross several commercial areas, a sand and gravel mining and processing facility, and an area managed by the Town of Barnstable that bears a conservation restriction. The habitat along this proposed route is mostly grass and scrubland due to the nature of the existing maintained ROW and the removal of incompatible vegetation during ROW maintenance, including most trees and all tall-growing plant species (COP Volume III; Epsilon 2018a).

The proposed eastern OECR, which runs from the New Hampshire Avenue landfall site to the Barnstable Switching Station, is approximately 6 miles (10 kilometers). Approximately 0.5 mile (0.8 kilometer) of this cable route would be located along an existing railroad ROW owned and operated by the Massachusetts Department of Transportation. The proposed Project would install the duct bank under the existing rail bed, which would require temporary removal of the rails and ties. The eastern OECR would then continue approximately 1.2 miles (1.9 kilometers) along an existing maintained utility ROW consisting of grass and scrubland that the utility actively maintains to exclude incompatible vegetation, including most trees and all tall-growing plant species. One potential variant of this section of the proposed eastern OECR (see Figure 2.1-1) would locate the route along the same alignment as the planned extension of the Cape Cod Rail Trail, from Willow Street in Yarmouth to Mary Dunn Way in Barnstable (Cape Cod Commission 2013). The proposed bike path, approximately 1.3 miles (2.1 kilometers), would pass through the Hyannis Ponds Wildlife Management Area (WMA). The Massachusetts Division of Fisheries and Wildlife (MassDFW) manages the area for hunting and passive recreational purposes. The final segment of the eastern OECR would proceed for approximately 0.4 mile (0.6 kilometer) along an existing dirt road that varies in width from 12 to 20 feet (3.7 to 6.1 meters) to the proposed substation site (COP Volume III; Epsilon 2018a).

The proposed 7-acre (28,328.1 m^2) substation site would be located in a mostly developed a commercial/industrial area. In addition to existing parking areas, the site includes pine-oak forest habitat that is locally common.

COP Tables 6.1-1, 6.1-3, and 6.1-4 (Volume III; Epsilon 2018a) list terrestrial and coastal faunal resources that are known to occur near the proposed Project area. Common species known to inhabit pine-oak forests that can be found along the proposed OECR or at the proposed substation site are discussed in Appendix B, Section B.5.2.

The two OECRs and the proposed substation site would not contain and/or cross any wetland resources; however, the eastern OECR would cross a culvert that carries Thornton Brook beneath Higgins Crowell Road in Yarmouth (see COP Figure 6.1-1 [Volume III; Epsilon 2018a]). Several wetland areas have been identified adjacent to the existing utility ROW associated with the eastern OECR, mostly along Higgins Crowell Road in Yarmouth (see Figure 2.1-1 and COP Figure 6.1-2 [Volume III; Epsilon 2018a]). The proposed eastern OECR would approach within 100 feet (30 meters) of five of these wetlands. The closest wetland lies approximately 50 feet (15 meters) east of the centerline of Higgins Crowell Road at a point approximately 750 feet (228 meters) north of its intersection with Lavender Lane in Yarmouth.

Aspects of Resource Potentially Affected

Adverse impacts on terrestrial and coastal faunal resources that could occur during construction, operations and maintenance, and/or decommissioning of the proposed Project include:

- Direct loss of physical habitat and/or conversion of habitat type;
- Direct mortality by equipment during construction and maintenance;
- Temporary alteration of habitat; and
- Temporary disturbance and/or displacement due to noise- and vibration-producing activities (e.g., from construction activities/equipment).

There could also be impacts on the land-sea interface, including beaches that provide habitat for several species. Because the offshore components of the Proposed Action have no potential impacts on terrestrial and coastal fauna other than certain avian species, this section does not discuss offshore components. Sections 3.3.4, 3.3.7, and 3.3.8 of this document discuss potential impacts on coastal habitats, marine mammals, and sea turtles, respectively.

Condition and Trend

Pine-oak forest is one of the most common habitat types on Cape Cod. This habitat also predominates in the 365-acre (1.5 km^2) Hyannis Ponds WMA, which is near the proposed Project area and is managed for wildlife habitat and other non-consumptive uses. Therefore, terrestrial fauna have access to high quality, unfragmented habitat near the proposed Project area. Much of the other habitat along the proposed Project corridor is already fragmented and/or developed for human uses, including roads, utility ROW, an airport, and commercial and light industrial operations.

Of the approximately 48,000 acres (194.2 km^2) of wetlands in Massachusetts, approximately 1,250 acres (5.1 km^2) were changed to other land cover types between 1991 and 2005 (Commonwealth of Massachusetts 2018). The proposed Project area is located in a densely developed part of the state, but several wetlands exist nearby. In the area within approximately 2 miles from the Project area, the Massachusetts Department of Environmental Protection has identified 1.4 acres (5,665.6 m^2) of wetland loss from 2001 to 2009, the most recent year for which wetland maps are available (MassDEP 2016).

Threatened and Endangered Species

The proposed Project would not encounter any known populations or habitats of terrestrial wildlife that are listed as threatened or endangered by the Commonwealth of Massachusetts or the U.S. Fish and Wildlife Service (USFWS).

The northern red-bellied cooter (*Pseudemys rubriventris*) is listed as a federal and state endangered species. This population is more than 13 miles (21 kilometers) from the proposed Project area, and is unlikely to be present in the proposed Project area (MNHESP 2016a). Partially due to extensive management efforts by the MassDFW and its partners, the population appears likely to be slowly growing (MNHESP 2016a).

3.3.1.2. Environmental Consequences

Relevant Project Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on terrestrial and coastal fauna are shown in Appendix G and include the following:

- The landfall site and associated OECR chosen;
- The routing variants within the selected OECR; and
- The time of year during which construction occurs.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the final OECRs and the construction schedule. Below is a summary of potential variances in impacts:

- OECRs: The route chosen (including variants within the general route) would determine the amount of habitat impacted. The western OECR from the Covell's Beach landfall site to the proposed new substation site includes two options, and the eastern OECR from the New Hampshire Avenue landfall site to the proposed new substation includes five options. The following section describes pertinent differences among the options with respect to terrestrial fauna.
- Season of construction: The activity and/or distribution of terrestrial and coastal fauna have distinct seasonal changes. For instance, summer and fall months (May through October) constitute the most active season for terrestrial fauna in this area, especially for reptiles and amphibians. Therefore, construction during months in which terrestrial and coastal fauna are not present, not breeding, or less active would have a lesser impact on terrestrial and coastal fauna than construction during more active times.

3.3.1.3. Impacts of Alternative A (Proposed Action) on Terrestrial and Coastal Fauna

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with construction, operations, maintenance, and decommissioning of the Proposed Action.

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations, maintenance, and decommissioning of the Proposed Action (see Chapter 2). Direct impacts would include the mortality or displacement of individuals; indirect impacts would include temporary or permanent alteration, or loss, of habitat (see Section 3.1).

Construction and Installation

The Proposed Action is mostly within existing roadways and public utility ROW, thus minimizing disruption of quality habitat. It does not pass through any known protected or rare habitats. Vineyard Wind would restore any previously undeveloped areas that were disturbed by construction.

The Proposed Action would require temporary habitat alteration within existing public utility ROW. Clearing, grading, and excavations would temporarily alter existing habitat, which is primarily grassland and small shrubs; such work would remain within a 40-foot-wide (13-meter) corridor. For the species that frequent this forest edge/managed grassland ecosystem, including the mammals mentioned above in 3.3.1.1, BOEM expects **minor** impacts because this ecosystem depends on periodic disturbance. Based on the maximum-case scenario (the eastern OECR shown in Figure 2.1-1), this could potentially affect up to approximately 10 acres (40,468.6 m^2) along a 2.1-mile (3.4-kilometer) route. Other route options could affect less land area. It is possible that individuals could experience repeated stress events if they returned to the site at night, when construction has paused, only for construction to drive them away again each morning. BOEM expects these impacts to be limited and temporary in nature, and therefore **minor**.

Collisions between animals and vehicles or construction equipment might cause direct mortality. BOEM expects this to be rare, as most individuals should avoid the noise and vibration of the construction areas. However, animals with limited mobility, especially the reptiles and amphibians mentioned above in 3.3.1.1, may be vulnerable to this type of impact, and BOEM anticipates **minor** potential impacts given the limited footprint of construction.

If Vineyard Wind were to select the western OECR as part of the Proposed Action, the route would encounter a property that bears a conservation restriction. Information is limited regarding the location and nature of the restriction and, therefore, the construction methods and mitigation measures that Vineyard Wind would need to use and the potential impacts.

Long-term habitat loss or alteration may also result from the Proposed Action. Widening part of an existing public utility ROW by clearing trees and shrubs would convert forest and scrubland habitat into managed grassland. BOEM expects this to affect approximately 0.2 acre (740 m^2) under the maximum-case scenario of the eastern OECR; the effects could be less if another route variant were chosen by Vineyard Wind as part of the Proposed Action. The proposed new substation site would require the clearing of 7 acres (28,328.1 m^2) of pitch pine-oak forest. (See Section 3.3.2. for potential impacts on birds and Section 3.3.3 for potential impacts on bats.) These changes would be expected to have a minimal effect on terrestrial fauna, because this type of forest habitat is common across Cape Cod and is available as a high quality, contiguous block in the nearby Hyannis Ponds WMA, which lies as near as 0.25 miles (0.4 kilometers) from the proposed substation area. As a result, BOEM anticipates **negligible** potential impacts.

A larger amount of habitat loss may result if the proposed eastern OECR were to follow a proposed bike path that the MassDFW is considering constructing through the Hyannis Ponds WMA. This option would involve the clearing of a corridor through a pine-oak forest community that MassDFW currently manages for the benefit of wildlife. This corridor would likely be 40 feet wide (13 meters) by approximately 1.3 miles long (2.1 kilometers), and would lead to the conversion of a 7-acre (28,328.1 m^2) corridor from forested habitat to forest edge habitat. (See Section 3.3.2. for potential impacts on birds and Section 3.3.3 for potential impacts on bats.) Such a path cut through the forest could pose a barrier to some amphibians, especially the northern redback salamander and the red-spotted newt. As stated in the Host Community Agreement (HCA) with the Town of Barnstable, Vineyard Wind would coordinate construction with trail proponents, and would conduct preparatory work to facilitate subsequent bike path installation (Town of Barnstable 2018b). Potential impacts on terrestrial fauna would be **moderate** if this route were selected by Vineyard Wind as part of the Proposed Action before the potential bike path was cleared by MassDFW; if this route were selected after the potential bike path was cleared and committed to that new use, BOEM would expect the Proposed Action to have **minor** incremental impacts in this area. If MassDFW were to create the bike path in the absence of the Project, such action would lead to many of the impacts mentioned above.

Sedimentation of nearby wetlands and streams would be another risk posed by the Proposed Action. No portion of either proposed OECR would cross wetlands or areas of rare species habitats mapped by the MassDFW; however, the eastern OECR would cross an existing culverted road-stream crossing at Thornton Brook, and approach within 100 feet (30 meters) of five wetlands (see Figure 2.1-1). Two of these wetlands are listed as Priority Habitat by MassDFW, one approximately 200 feet (61 meters) west of the railroad tracks at 203 Willow Street in Yarmouth Port, and the other approximately 60 feet (18 meters) west of the centerline of Higgins Crowell Road at the intersection with Mid-Tech Drive in West Yarmouth (MassGIS 2017). Improper installation and maintenance of sediment control measures, or the failure of such measures due to extreme weather or other unexpected events, could deliver sediment into the wetlands or stream and thus alter those habitats and potentially impact populations of amphibians, fishes, and other fauna that rely on those wetlands and streams. Although Vineyard Wind did not detail specific avoidance, minimization, and mitigation measures in the COP other than the use of siltation fencing (Epsilon 2018a), with proper BMP implementation along the eastern OECR, BOEM expects **minor** potential impacts. Selection of the western OECR within the Proposed Action PDE would be even less likely to have adverse impacts on this resource, as it does not cross nor approach as close to wetlands and streams as the New Hampshire Avenue landfall site, thus leading to **negligible** impact.

Overall, considering the avoidance, minimization, and mitigation measures proposed, construction of the Proposed Action would likely have **minor** impacts on terrestrial and coastal fauna.

Operations and Maintenance

BOEM would not expect normal operations and maintenance activities to involve further habitat alteration or otherwise impact terrestrial fauna. Normal operation of the substation would generate continuous noise, but BOEM expects **negligible** associated impacts in the context of existing commercial and industrial noises near the proposed substation. Vineyard Wind would typically accomplish maintenance and any necessary repairs through manholes at the splice vaults for the transmission line, within the fenced area of the substation site, or well within the existing public utility ROW. Management of the existing utility ROW would continue to involve periodic removal of tree saplings, possibly through mowing and/or prescribed fire.

Overall, BOEM expects **negligible** impacts on terrestrial fauna from operations and maintenance.

Decommissioning

Vineyard Wind would likely leave onshore facilities in place for future use (see Chapter 2). There are no plans to disturb the land surface or terrestrial habitat during the course of Proposed Action decommissioning. Therefore, impacts of decommissioning would be **negligible**.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. The foreseen activities and events that could affect this resource include corrective maintenance onshore, chemical spills onshore, severe weather and natural events, and terrorist attacks. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. The presence of onshore construction equipment could temporarily prevent or deter animals from approaching or crossing the site of a given non-routine event. Impacts on terrestrial and coastal fauna would be temporary, lasting only as long as repair or remediation activities necessary to address these non-routine events, and BOEM expects them to be **negligible**.

Conclusion

Temporary habitat alteration along existing ROW could affect up to approximately 10 acres (40,468.6 m^2) along a 2.1-mile (3.4-kilometer) route and lead to **minor** impacts. Direct mortality should be rare and therefore **minor**. BOEM could reduce potential impacts of this type by requiring that trees (greater than 5 inches [15.2 centimeters] diameter at breast height) not be cut from April 15 through October 31 as a condition of COP approval (see Section 2.2.1); with this mitigation measure, the impacts would be less, but would still be classified as **minor**. Tree clearing could lead to long-term habitat loss of up to 13.5 acres (54,633 m^2), resulting in **negligible** to **moderate** impacts, depending on the route chosen. The risk of affecting nearby wetland and stream habitats is **minor**.

Based on the analysis above, and under routine circumstances, the Proposed Action would have **minor** impacts on terrestrial and coastal fauna other than birds (see Section 3.3.2 for information regarding birds). The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.3.1.4. Impacts of Alternative B on Terrestrial and Coastal Fauna

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

The only difference between Alternative B and the Proposed Action is that Alternative B does not permit the use of the New Hampshire Avenue landfall site. This Alternative would use the Covell's Beach landfall site and the western OECR. This route would extend approximately 1.6 miles (2.6 kilometers) along existing utility ROW and more developed areas. The proposed route would encounter a property that bears a conservation restriction; information is incomplete regarding the location and nature of the restriction, the construction methods and BMPs that Vineyard Wind would need to use, and, therefore, the potential impacts. Overall, the nature and extent of impacts of the construction of Alternative B would be highly similar to those of the Proposed Action, with the following exceptions.

Temporary habitat alteration within existing utility corridors could potentially affect approximately 7.8 acres (31,565 m^2) along a 1.6-mile-long (2.6-kilometer) corridor, depending on the routing option chosen. This is a smaller maximum impact than that which could occur as a result of the Proposed Action. No construction would occur within the Hyannis Ponds WMA. In addition, this route does not pass near wetlands and streams, so there is no risk of sedimentation or other impacts on these types of resources.

Overall, considering the avoidance, minimization, and mitigation measures proposed, construction of Alternative B would likely have **minor** impacts on terrestrial and coastal fauna.

Operations and Maintenance

The impacts due to operations and maintenance under this alternative are likely to be practically identical to those of the Proposed Action: **negligible**.

Decommissioning

As described in Chapter 2, Vineyard Wind would likely leave onshore facilities in place for future use. There are no plans to disturb the land surface or terrestrial habitat during the course of proposed Project decommissioning. Therefore, impacts would likely be **negligible**.

Direct and Indirect Effects of Non-Routine Activities

The impacts due to non-routine activities under this alternative are likely to be practically identical to those of the Proposed Action: **negligible**.

Conclusion

The impact-producing factors are similar to those of the Proposed Action, but temporary habitat alteration would affect no more than 7.8 acres (31,565 m^2) along a 1.6-mile-long (2.6-kilometer) corridor. Based on the analysis above, and under routine circumstances, Alternative B would have **minor** impacts on terrestrial and coastal fauna other than birds (see Section 3.3.2 for information regarding birds).

3.3.1.5. Impacts of Alternatives C, D, and E on Terrestrial and Coastal Fauna

The onshore aspects of Alternative C, D (including sub-alternatives D1 and D2) and E are identical to those of the Proposed Action; therefore, the impacts on terrestrial and coastal fauna would also be identical: **negligible** to **moderate**.

3.3.1.6. Impacts of Alternative F (No Action Alternative) on Terrestrial and Coastal Fauna

As described in Section 3.3.1.1, terrestrial and coastal fauna other than birds are and will continue to be present in the study area under the No Action Alternative. MassDFW might construct a proposed bike path through approximately 1.3 miles (2.1 kilometers) of the Hyannis Ponds WMA. Maintenance of existing roads and public utilities will continue indefinitely. Outside of currently protected areas, the conversion of natural areas to developed residential, commercial, and industrial uses is likely to continue.

If BOEM does not approve the proposed Project (either the Proposed Action or another action alternative), the above present and foreseeable actions are likely to continue. The conditions of terrestrial and coastal faunal resources would likely continue along their current trends. The region would miss an opportunity to reduce emissions of carbon dioxide, nitrogen oxides, and SO_2 by 1,630,000; 1,050; and 860 tons per year respectively; such reductions in emissions would have had a beneficial effect on terrestrial and coastal fauna.

3.3.1.7. Comparison of Alternatives for Terrestrial and Coastal Fauna

Compared to the Proposed Action, Alternative B would limit the flexibility of the PDE and would use an OECR that is shorter by approximately 0.5 mile (0.8 kilometer) and would disturb approximately 2.2 acres (8,903 m^2) less of land surface compared to the maximum-case scenario within the Proposed Action. Alternative B would avoid approaching the wetlands, the stream, and the high-quality habitat within the Hyannis Ponds WMA, which the eastern OECR could potentially affect. Other aspects of the potential impacts of Alternative B would be practically identical to those of the Proposed Action.

With respect to terrestrial and coastal fauna other than birds, Alternatives C, D, and E are identical to the Proposed Action.

The No Action Alternative would completely avoid the negative impacts of the Proposed Action, but it would forgo the possible beneficial impacts of reductions in air pollution.

3.3.1.8. Cumulative Impacts

The Proposed Action, when combined with past, present, and future projects, could result in cumulative impacts that differ from the impacts predicted by proposed Project activities alone. The analysis area for terrestrial and coastal fauna includes all land areas that would be disturbed, including a 0.5-mile (0.8-kilometer) buffer (see Appendix C, Figure C.1-3). BOEM expects the faunal resources in this area to have small home ranges and impacts outside their home ranges to be unlikely to affect them. As described in Appendix C, past activities that have impacted terrestrial and coastal fauna in the area were primarily onshore developments, including residential, commercial, and industrial developments. Because the Project area has been heavily developed for decades, the cumulative impacts of the Proposed Action on top of past projects would be **minor**.

Other offshore wind energy development projects (including all Tier 1 and Tier 2 projects) and associated port upgrades described in Appendix C, including the MCT, are outside of the geographic analysis area.

Present and reasonably foreseeable projects and factors that could contribute to cumulative impacts on terrestrial and coastal fauna include:

- Periodic clearing of shrubs and tree saplings along existing utility ROW;
- Climate change, which is altering the seasonal timing and patterns of species distributions and ecological relationships;
- Creation of a proposed new 1.3-mile (2.1-kilometer) bike path extension through the Hyannis Ponds WMA;
- Development of the Villages at Barnstable, a proposed senior apartment complex that is currently under construction on a 13.3-acre (53,823-m^2) site near the proposed onshore substation;
- Development of the Cape Cod Training Center, an approved athletic center sited on 8.3 acres (33,585 m^2) of undeveloped land approximately 240 feet (73 meters) from the proposed eastern OECR;
- Redevelopment and expansion of the Cape Cod Potato Chips Factory on a 5.6-acre (22,662-m^2) site adjacent to the proposed eastern OECR; and
- Continual development of residential, commercial, industrial, solar, transmission, gas pipeline, onshore wind turbine, and cell tower projects spurred by population growth in the region.

The above projects and factors could contribute to the following types of impacts:

- Displacement, increased energy expenditure, injury, and mortality to individual animals;
- Land use change and resulting habitat loss; and
- Soil erosion and sedimentation (which BMPs could minimize).

The first two factors listed above, i.e., periodic clearing and climate change, could be considered more or less continuous, unavoidable, and broad in scale. These present and future projects would likely contribute to **minor** cumulative impacts when combined with the Proposed Action. Continual development of present and future projects within the area is likely to contribute to **minor** cumulative impacts when combined with the Proposed Action. The remaining projects listed above are discrete construction projects, which together are likely to contribute to **minor** to **moderate** cumulative impacts when combined with the Proposed Action.

BOEM expects the cumulative impacts under Alternatives B, C, D1, D2, and E to be the same as those under the Proposed Action, ranging from **minor** to **moderate**, with the following exception. Because Alternative B would not include the New Hampshire Avenue landfall site and associated OECR, the 13.9 acres (56,251 m^2) of disturbance associated with the Cape Cod Training Center and the Cape Cod Potato Chips Factory expansion would occur well outside of the proposed cumulative geographic analysis area.

3.3.1.9. Incomplete or Unavailable information for Terrestrial and Coastal Fauna

Although the differences would appear to be small, the exact lengths, routes, and the nature of the surrounding environment are incompletely described for the various options within each proposed OECR (specifically, Eastern Variants 1, 2, 5, and Western Variant 1 on Figure 2.1-1).

As previously noted, the western OECR would encounter a property that bears a conservation restriction (Epsilon 2018a). Information is incomplete regarding the location and nature of the restriction, the construction methods and BMPs that Vineyard Wind would need to use, and, therefore, the potential impacts.

Although the above information was not available at the time of the preparation of this document, sufficient information exists to support the findings presented herein.

3.3.2. Birds

This section addresses potential impacts on bird species that use inland, coastal, and offshore habitats, including both resident bird species that use the proposed Project area during all (or portions of) the year and migrating bird species with the potential to pass through the proposed Project area during fall and/or spring migration. Detailed information can be found in the COP Volume III, Sections 6.1, 6.2, and Appendix III-C (Epsilon 2018a). Given the differences in life history characteristics and habitat use between offshore and inland/coastal bird species, the sections below provide a separate discussion of each group. This section also discusses Bald and Golden Eagles. The Vineyard Wind Offshore Wind Energy Project Biological Assessment (BA) prepared for the USFWS discussed federally listed threatened and endangered species (BOEM 2018a).

3.3.2.1. Description of the Affected Environment for Birds

Regional Setting

Generally, bird species abundance and species diversity decrease as distance from shore increases (Petersen et al. 2006; Paton et al. 2010; Watts 2010). The Proposed Action is located in an area that has been part of a detailed resource assessment, including a review of bird resources (BOEM 2012a, 2012b, 2015); the MA WEA excludes areas of important offshore sea duck habitat (BOEM 2012a). As such, avian use of offshore habitats in the region is well documented and has been further refined with site-specific surveys (see NOAA 2016a; Veit et al. 2015; Veit et al. 2016; Winship et al. 2018).

The most likely species to occur within the offshore portions of the Proposed Action include 22 species of gulls and terns, 17 species of sea ducks, 9 species of shearwaters and petrels, 4 species of loons and grebes, and 3 species of gannets and cormorants. Additional species may also occur in lower numbers (BOEM 2012a). COP Table 6.2-6 describes each bird species likely to occur offshore of Massachusetts (Volume III; Epsilon 2018a).

Inland and coastal bird species in this region have been catalogued in detail at the Massasoit National Wildlife Refuge, 23 miles (37 kilometers) northeast of the proposed Project area. At least 74 bird species are known or suspected to occur here (COP Volume III, Table 6.1-2; Epsilon 2018a). Many of these species rely on undisturbed native habitats, including pitch pine-oak forest, white pine-oak forest, as well as open water and shallow emergent marsh, while others use forest edges, grasslands, or even urban habitats (USFWS 2017). Many bird species do not normally reside in this region, but pass through during spring and fall migrations. The Atlantic Flyway, which follows the Atlantic coast of North America, is an important migratory route for many bird species moving from breeding grounds in New England and eastern Canada to winter habitats in North, Central, and South America. Bays, beaches, coastal forests, marshes, and wetlands provide important stopover and foraging habitat for migrating birds (MMS 2007). Both the onshore and offshore facilities associated with the Proposed Action are located within the Atlantic Flyway. Bird species using the flyway during spring and fall migration have the potential to encounter proposed Project facilities.

The proposed Project's substation site would be located on the eastern portion of a previously developed site within the Independence Park commercial/industrial area in the Town of Barnstable. Construction of the substation site would require the removal of approximately 7 acres (28,328.1 m^2) of forested habitat that is potentially suitable for use by nesting and/or foraging birds. Site vegetation is comprised primarily of pitch pine (*Pinus rigida*) and scarlet oak (*Quercus coccinea*) in the tree layer with black huckleberry (*Gaylussacia baccata*) and lowbush blueberry (*Vaccinium angustifolium*) dominant in the understory. Bracken fern (*Pteridium aquilinum*) and teaberry (*Gaultheria procumbens*) are present as ground covers (COP Volume I; Epsilon 2018a). This type of Pitch Pine-Oak forest is very common and widespread throughout southeastern Massachusetts (Commonwealth of Massachusetts 2016). Common bird species such as Rufous-sided Towhee (*Pipilo erythrophthalmus*), Pine Warbler (*Dendroica pinus*), and Ruffed Grouse (*Bonasa ubellus*) are typically associated with this habitat (MDFW 2016). The proposed substation site footprint lacks any available water source, but some small ponds are located within 1,400 feet (427 meters) of the site.

The proposed substation site is also located adjacent to the Hyannis Ponds WMA. This WMA contains an important concentration of biodiversity in Massachusetts, and several of the ponds protected by the WMA are among the least disturbed Coastal Plain pond natural communities in Massachusetts (MDFW 1994).

Aspects of Resource Potentially Affected

Birds using nearshore and offshore habitats near the proposed Project are currently exposed to a variety of ongoing human-caused stressors such as boating and fishing (both commercial and recreational) and disturbance, displacement, pollution, and habitat loss related to other human activities (BOEM 2012a; NABCI 2011). Additional impacts on offshore bird species could result from the construction, operations and maintenance, and decommissioning of the proposed Project.

The proposed Project could potentially affect the following offshore bird resources:

- Temporary loss of habitat resulting from vessel traffic and equipment noise during construction, maintenance, and decommissioning;
- Permanent habitat loss as a result of behavioral avoidance of the WDA;
- Attraction to lights on vessels, ESPs, buoys, and towers;
- Discharge of waste materials and accidental fuel leaks;
- Injury or mortality resulting from collisions with vessels, ESPs, or towers; and
- Mortality resulting from collisions with rotating WTG blades during operations.

Inland and coastal bird species could be affected during construction and decommissioning of the proposed Project. Impacts on birds could be indirect (displacement due to noise and habitat loss/modification) or direct (mortality due to contact with construction equipment). Bird mobility is a mitigating factor reducing the risks of negative impacts. Because Vineyard Wind would bury all of the coastal and onshore facilities except the substation, operations and maintenance would present little risk.

Section 3.3.2.2 includes a detailed discussion of these impacts.

Bald and Golden Eagles

Bald Eagles (*Haliaeetus leucocephalus*), which are listed as threatened in Massachusetts, are federally protected by the Bald and Golden Eagle Protection Act, 16 USC § 668 et seq., as are Golden Eagles (*Aquila chrysaetos*). Bald Eagles are year-round residents in Massachusetts and occur in a variety of terrestrial environments, typically near water such as coastlines, rivers, and large lakes (BOEM 2012a; USFWS 2011). Golden Eagles are rarely seen in the Cape Cod area, but small numbers of individuals migrate through on occasion (eBird 2018). Both Bald and Golden Eagles typically migrate over land, well inland of all proposed Project facilities (BOEM 2012a). More information is available in the COP Section 6.2.1.5.4 (Volume III; Epsilon 2018a).

Bald and Golden Eagles are not expected to occur within the offshore Project area, but some potential exists for indirect effects (displacement due to noise and habitat loss/modification) or direct effects (mortality due to contact with construction equipment) resulting from the construction, operations and maintenance, and decommissioning of the onshore facilities.

Threatened and Endangered Bird Species

Three species of birds are listed as threatened or endangered under the ESA and may occur within the proposed Project area: the Roseate Tern (*Sterna dougallii*), the Piping Plover (*Charadrius melodus*), and the Rufa subspecies of Red Knot (*Calidris canutus rufa*) (BOEM 2012a; USFWS 1998; USFWS 2014). A fourth species, the Black-capped Petrel (*Pterodroma hasitata*), was proposed for listing as threatened by the USFWS on October 9, 2018 (Threatened Species Status for the Black-capped Petrel with a Section 4(d) Rule, 83 Fed. Reg. 195 [October 9, 2018]). The Vineyard Wind Offshore Wind Energy Project BA discusses these species (BOEM 2018a).

Condition and Trend

More than one-third of bird species that occur in North America (37 percent, 432 species) are at risk of extinction unless significant conservation actions are taken (NABCI 2016). The Northeastern United States is also home to more than one-third of the human population of the nation. As a result, species that live or migrate through the Atlantic Flyway have historically been, and will continue to be, subject to a variety of human-caused stressors that have the potential to have adverse impacts on bird species.

According to the North American Bird Conservation Initiative (NABCI), more than half of the offshore bird species (57 percent, 31 species) have been placed on the NABCI watch list as a result of small ranges, small and declining populations, and threats to required habitats. This watch list identified species of high conservation concern based upon high vulnerability to a variety of factors, including population size, breeding distribution, non-breeding distribution, threats to breeding, threats to non-breeding, and population trend (NABCI 2016). Globally, monitored offshore bird populations have declined by nearly 70 percent from 1950 to 2010, which may be representative of the overall population trend of seabirds (Paleczny et al. 2015). Overall, offshore bird populations are decreasing; however, considerable differences in population trajectories of offshore bird families have been documented.

According to NABCI, nearly 40 percent of the more than 100 bird species that rely on coastal habitats for breeding or for migration are on the NABCI watch list. Many of these coastal species have small population size and/or restricted distributions, making them especially vulnerable to habitat loss/degradation and other stressors (NABCI 2016).

Between 1966 and 2011, 48 percent of breeding bird species surveyed in Massachusetts declined in abundance, whereas 31 percent have increased and 21 percent have remained stable (Mass Audubon 2011). The list of rare birds in Massachusetts includes 28 state threatened and endangered species, plus 34 more species of conservation concern; many of these species are in greater decline than the other birds in the state. Birds that depend on grasslands, shrublands, and marshes are particularly imperiled. Within these habitats alone, 39 species are "Conservation Action Urgent[8]" species (Mass Audubon 2011). Some of the main drivers of bird population declines include habitat loss, habitat fragmentation, collisions with glass windows and power lines, invasive species, predators, toxic chemicals, and climate change (Mass Audubon 2011, 2013, 2017).

Coastal birds, especially those that nest in coastal marshes and other low-elevation habitats, are additionally vulnerable to sea-level rise and the increasing frequency of strong storms. Models of vulnerability to climate change have estimated that, throughout Massachusetts, 61 species (43 percent of the 143 species modeled) are highly vulnerable, and 22 species (15 percent) are likely vulnerable (Mass Audubon 2017).

3.3.2.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on birds are provided in Appendix G and include the following:

- The new onshore substation, which would require the removal of forested habitat;
- The number, size, and location of WTGs;
- The routing variants within the selected OECR; and
- The time of year during which construction occurs.

Potential Variances in Impacts

Variability of the proposed-Project design exists as outlined in the PDE (see Appendix G). Below is a summary of potential variances in impacts:

- WTG number, size, and location: The level of hazard related to WTGs is proportional to the number of WTGs installed; where fewer WTGs would present less hazard to birds. Depending on how Vineyard Wind implements the PDE, fewer WTGs could allow for greater distances between WTGs, providing more opportunities for birds to avoid them. Use of larger turbines instead of smaller turbines would also present less of a hazard to birds as the distance from sea level to the rotor swept area (RSA) is greater, reducing the number of birds exposed to operating WTGs. Johnston et al. 2014a has documented that the use of fewer WTGs with higher hub heights is an effective method to reduce avian collision risk.

[8] "Conservation Action Urgent" category is a combination of currently listed species and species that have seen drastic declines in their numbers for reasons such as loss of grassland and shrubland habitat.

- OECRs: The route chosen (including variants within the general route) would determine the amount of habitat affected. The western OECR from the Covell's Beach landfall site to the proposed new substation site includes two options, and the eastern OECR from the New Hampshire Avenue landfall site to the proposed new substation includes five options. The sections below detail the pertinent differences among the options with respect to birds.
- The activity and distribution of birds exhibit distinct seasonal changes. For instance, summer and fall months (May through October) constitute the most active season for birds in this area, and the months on either side coincide with major migration events. Therefore, construction during months in which birds are not present, not breeding, or less active would have a lesser impact on birds than construction during more active times.

3.3.2.3. Impacts of Alternative A (Proposed Action) on Birds

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with the construction, operations maintenance, and decommissioning of the Proposed Action.

Direct and Indirect Effects of Routine Activities

The sections below summarize the potential direct and indirect impacts of the Proposed Action on birds during the various phases of the Proposed Action. Routine activities would include construction, operations, maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct impacts would include direct mortality as a result of collision with WTGs. Indirect impacts would include temporary or permanent alteration or loss of habitat, including due to avoidance behavior. BOEM prepared a BA for the potential effects to USFWS federally listed species (BOEM 2018a).

Construction and Installation of Offshore Components

Vineyard Wind performed an exposure assessment to estimate the risk of various offshore bird species encountering the WDA (COP Appendix III-C; Epsilon 2018a). The species with the highest estimated risks were the Herring Gull (*Larus argentatus*), Great Black-backed Gull (*Larus marinus*), Razorbill (*Alca torda*), Cory's Shearwater (*Calonectris borealis*), and Black-legged Kittiwake (*Rissa tridactyla*). The risk for each species may change with the seasons, but at least one species would be at risk during any particular season. Averaged over the year, each species' estimated risk of exposure was insignificant to low/unlikely, except for the Herring Gull and Great Black-backed Gull, for which the risk was medium/likely. This is due to the attraction of gulls to vessels and offshore structures, upon which they may perch.

Effects on offshore bird species could occur during the construction phase of the Proposed Action because of increased vessel traffic and equipment noise (including pile-driving noise). The pile-driving noise impacts would be short-term (3 hours per pile with a maximum of two piles per day and not concurrent). Vessel and construction noise could disturb offshore bird species, but they would likely acclimate to the noise or move away, potentially resulting in a temporary loss of habitat (BOEM 2012a). While birds could encounter construction equipment and vessels during the construction and decommissioning phases, mortality from collisions is unlikely. Substantial lighting could increase risk, but Vineyard Wind's self-imposed measures to reduce lighting would minimize these risks (COP Volume III, Epsilon 2018a; Huppop et al. 2006). Therefore, BOEM anticipates impacts to be **negligible** from the construction and installation of the offshore components.

Federally listed birds could occur within the offshore portions of the Project area. Given the geographic scope of the Proposed Action, BOEM expects some birds could come into contact with a WTG or associated activities. Given that the activities would occur on the OCS, there would be **negligible** impacts on Piping Plover critical habitat. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts by implementing the mitigation measure of not allowing export cable conduit installation from April 1 to August 31 to avoid disturbing nesting shore birds (see Appendix D). Based on the analyses in Section 5 of the BA, the Proposed Action would have **negligible** effects on migrating Roseate Terns, Piping Plovers, and Rufa Red Knots due to pile-driving noise, cable laying, tower collisions, tower lighting, and tower operations and maintenance and decommissioning. Impacts could include escape responses, alteration of flight paths, and injury or death from tower collisions. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on terns by implementing the mitigation measure of avoiding nearshore cable laying during low tide between mid-July and mid-September (see Appendix D). This would avoid impacts on nearshore food resources during the period when terns are preparing for fall migration, and it would also benefit shorebirds and other intertidal feeders that use similar resources.

Construction and Installation of Onshore Project Components

The Proposed Action includes two potential landfall sites and associated OECRs connecting the underground vault at the selected landfall site to the new substation site (see Figure 2.1-1). Both OECRs are co-located with existing, previously disturbed, linear corridors (public road, rail, and electric ROW), allowing the export cable to be buried below grade (COP Volume I; Epsilon 2018a).

The Proposed Action would require temporary habitat alteration within existing public utility ROW. Clearing, grading, and excavations would temporarily alter existing habitat, which is primarily grassland and small shrubs. The noise generated by construction activities, as well as the physical changes to the space, could render an area temporarily unsuitable for birds. Given the nature of the existing habitat, its abundance on the landscape, and the temporary nature of construction, the impacts on bird species that frequent this forest edge/managed grassland ecosystem are expected to be **negligible**.

Collisions between birds and vehicles or construction equipment might cause direct mortality. However, this would be **negligible**, as most individuals would avoid the noisy construction areas.

Long-term habitat loss or alteration may also result from the Proposed Action. Widening part of an existing public utility ROW by clearing trees and shrubs would convert forest and scrubland habitat into managed grassland. The proposed Project expects to affect approximately 0.2 acre (740 m^2) under the maximum-case scenario of the eastern OECR; the effects could be less if another route variant were chosen by Vineyard Wind under the Proposed Action. The proposed new substation site would require the clearing of 7 acres (28,328.1 m^2) of pitch pine-oak forest habitat that is potentially suitable for use by nesting and/or foraging birds. Common bird species such as Rufous-sided Towhee (*Pipilo erythrophthalmus*), Pine Warbler (*Dendroica pinus*), and Ruffed Grouse (*Bonasa ubellus*) are typically associated with this habitat (MDFW 2016). This type of forest is very common throughout southeastern Massachusetts (Commonwealth of Massachusetts 2016). In addition, the proposed substation site would be located on the edge of a previously developed site within the Independence Park commercial/industrial area in the Town of Barnstable. These changes would be expected to have a minimal effect on birds because this type of forest habitat is common across Cape Cod and is available as a high-quality, contiguous block in the nearby Hyannis Ponds WMA, which lies as near as 0.25 miles (0.4 kilometers) from the proposed substation area. As a result, BOEM anticipates **negligible** impacts. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on birds by implementing the mitigation measure of no tree clearing (greater than 5 inches [15.2 centimeters] diameter at breast height) from April 15 through October 31 to minimize effects to species and/or their habitat (see Section 2.2.1 and Appendix D).

Additional habitat loss and fragmentation may result if the proposed eastern OECR were to follow a proposed bike path that the MassDFW is considering constructing through the Hyannis Ponds WMA. This option would involve the clearing of a corridor through a pine-oak forest community that is currently managed by MassDFW for the benefit of wildlife. This corridor would likely be 40 feet wide (13 meters) by approximately 1.3 miles long (2.1 kilometers), and would lead to the conversion of 7 acres (28,328.1 m^2) of forested habitat to forest edge habitat. As stated in the HCA with the Town of Barnstable, Vineyard Wind would coordinate construction with trail proponents, and would conduct preparatory work to facilitate subsequent bike path installation (Town of Barnstable 2018b). Potential impacts on birds would be **minor** if this route were selected by Vineyard Wind as part of the Proposed Action before the potential bike path was cleared by MassDFW; if this route were selected after the potential bike path was cleared and committed to that new use, BOEM would expect the Proposed Action to have **negligible** incremental impacts in this area.

Operations and Maintenance of Offshore Components

Operation of the Proposed Action would result in impacts on offshore bird species, and possibly to coastal and inland bird species during spring and fall migration. These impacts could arise through direct mortality from collisions with WTGs and/or through behavioral avoidance and habitat loss (Drewitt and Langston 2006; Fox et al. 2006; Goodale and Millman 2016). Lesser impacts could also result from increased vessel traffic within the offshore facilities during routine maintenance activities, potential attraction to FAA-required lighting on WTGs, and increased interactions with offshore structures.

The Proposed Action includes the use of red flashing aviation obstruction lights on WTGs and ESPs in accordance with FAA and BOEM requirements (COP Volume III; Epsilon 2018a). Red flashing aviation obstruction lights are commonly used at land-based wind facilities without any observed increase in avian mortality compared with unlit turbine towers (Kerlinger et al. 2010; Orr et al. 2013). Vineyard Wind would use red flashing lights as a measure to decrease the likelihood of attracting migrating birds to the operating WTGs and to minimize the risk of bird collisions. Although birds might encounter vessels, ESPs, or WTG towers, their agility makes it unlikely that any of these objects would pose a collision risk. Therefore, BOEM anticipates the impacts from red flashing lights to be **negligible**. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on birds by implementing the mitigation measure of using an ADLS, which could further reduce the amount of light emitted into the environment and therefore may further reduce risk of bird collisions (see Section 2.2.1 and Appendix D).

The rotating blades of WTGs could injure or kill birds that pass too near. The magnitude of this impact is difficult to estimate, and it differs across species. Generally, abundance of bird species with high collision sensitivity is low within the offshore portion of the proposed Project area during all seasons of the year (see Figure 3.3.2-1). Based on the results of the exposure assessment mentioned above, only cormorants, jaegers, and gulls would exhibit a significant chance of encountering the WDA. While cormorants' typical low flight altitudes make them less vulnerable to collision, this is not the case with jaegers and gulls (COP Volume III; Epsilon 2018a and references in COP Section 6.2.2.2.1). In Massachusetts, jaegers and gulls are not species of conservation concern (Mass Audubon 2017). During migration, many bird species, including song birds, likely fly at heights well above the rotor swept zone (89 to 696 feet [27 to 212 meters] above sea level) (COP Volume III; Epsilon 2018a and references in COP Section 6.2.2.2.1).

If the Proposed Action were to be implemented with 10 MW turbines, collision risk to the limited number of birds that may encounter operating WTGs would be minimized as this would allow for greater distances between individual WTGs and increased distance from sea level to the RSA—which would, in turn, reduce the probability of a fatal interaction with an operating WTG. Considering the healthy populations of the only bird species that are likely to collide with operating WTGs (jaegers and gulls), these impacts would likely be **minor**. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on birds by implementing a mitigation measure of installing bird deterrent devices (e.g., anti-perching), where appropriate, to minimize attraction to operating turbines (see Section 2.2.1 and Appendix D).

Some bird species might avoid the WDA during its operation, leading to an effective loss of habitat. Loons, grebes, seaducks, and northern gannets typically avoid offshore wind developments, resulting in loss of habitat and reduced risk of collision. However, as depicted in Figure 3.3.2-2, modeled use of the offshore portion of the proposed Project area by bird species with high displacement sensitivity is low. Since the MA WEA avoids high-value sea duck habitat and is not likely to contain important foraging habitat for the other species susceptible to displacement, BOEM expects this loss of habitat to be insignificant (COP Volume III; Epsilon 2018a and references in COP Section 6.2.2.2.2). Population-level impacts as a result of habitat loss would likely be **negligible**.

While the significance level of impacts would remain the same as discussed above, BOEM could further reduce potential impacts on birds by implementing the mitigation measure of long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations and other benthic areas disturbed by the proposed Project, including the movement of and habitat use of protected species (see Appendix D). This information could be used in adaptive management to implement further mitigation measures.

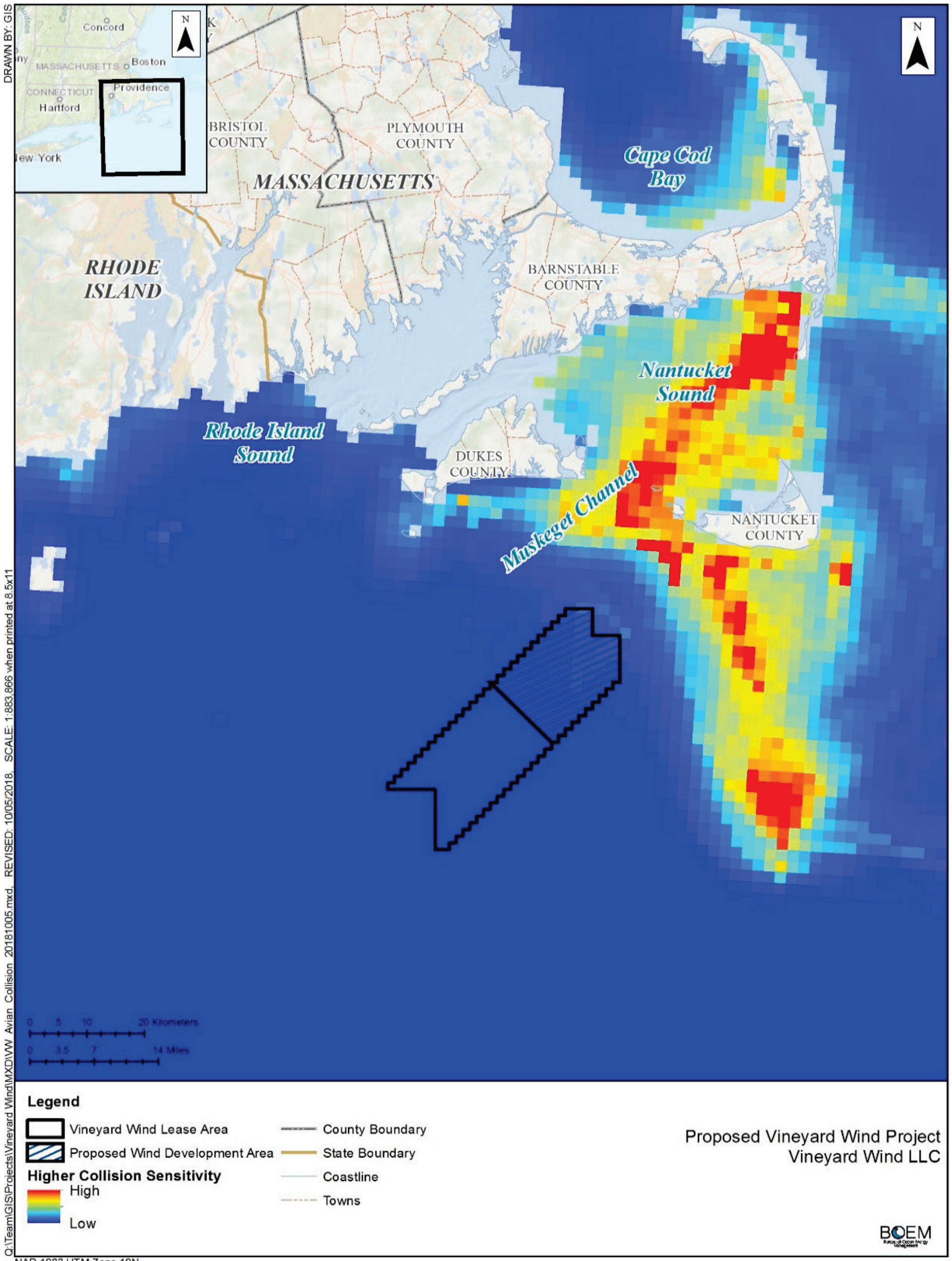
Operations and Maintenance of Onshore Project Components

BOEM does not expect normal onshore operations and maintenance activities to involve further habitat alteration or otherwise impact birds. Normal operation of the substation would generate continuous noise, but BOEM expects **negligible** associated impacts when considered in the context of the other commercial and industrial noises near the proposed substation. Vineyard Wind would typically accomplish maintenance and any necessary repairs through manholes at the splice vaults for the transmission line, within the fenced area of the substation site, or well within the existing public utility ROW. Management of the existing utility ROW would continue to involve periodic removal of tree saplings, possibly through mowing and/or prescribed fire. Onshore impacts to birds due to operations and maintenance would be **negligible**.

Indirect effects, namely, temporary habitat loss, may occur as a result of construction activities, which could generate noise sufficient to cause avoidance behavior. Because construction activity would be temporary and highly localized, however, the impacts on birds would be **negligible**.

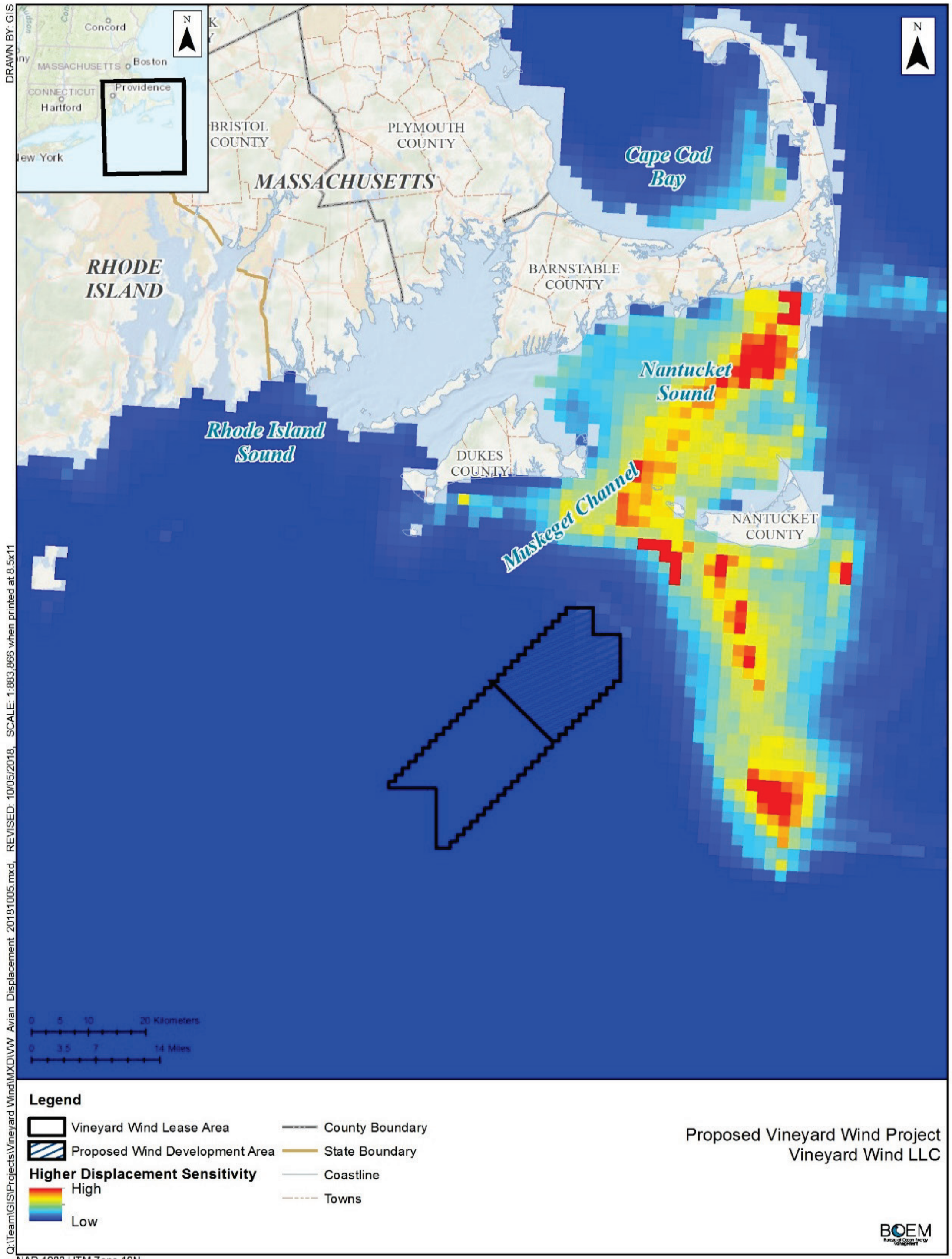
Decommissioning

Vineyard Wind would likely leave onshore facilities in place for future use (see Chapter 2). There are no plans to disturb the land surface or terrestrial habitat during the course of Proposed Action decommissioning. Therefore, onshore impacts of decommissioning would be **negligible**. However, Vineyard Wind would remove the offshore WTGs and ESPs. This impact would likely be similar in nature, extent, and intensity to the impacts of WTG and ESP installation.



Source: Curtice et al. 2018 and Winship et al. 2018
For more information, see: https://www.northeastoceandata.org/data-explorer/?birds|stressor-groups

Figure 3.3.2-1: Total Avian Relative Abundance Distribution Map for the Higher Collision Sensitivity Species Group



Source: Curtice et al. 2018 and Winship et al. 2018
For more information, see: https://www.northeastoceandata.org/data-explorer/?birds|stressor-groups

Figure 3.3.2-2: Total Avian Relative Abundance Distribution Map for the Higher Displacement Sensitivity Species Group

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities would generally require intense, temporary activity to address emergency conditions. The noise made by onshore construction equipment or offshore repair vessels could temporarily deter birds from approaching the site of a given non-routine event. BOEM expects **negligible** impacts on birds because these activities would be temporary and last only as long as repair or remediation activities were necessary to address these non-routine events.

Vessels associated with the proposed Action may potentially generate operational waste, including bilge and ballast water, sanitary and domestic wastes, and trash and debris. Potential releases of these operational wastes, if any, would be infrequent and generally cease following Project construction, with the exception of routine and emergency maintenance required during the course of Project operations. All vessels associated with the Proposed Action will comply with the USCG requirements for the prevention and control of oil and fuel spills. Proper vessel regulations and operating procedures would minimize effects to offshore bird species resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012a). These releases would occur infrequently at discrete locations and vary widely in space and time and BOEM expects **negligible** impacts.

Operational discharges from construction vessels, if any, would occur in the open ocean, where they would be rapidly diluted and dispersed. Sanitary and domestic wastes would be collected and taken to shore for treatment and disposal or processed through on-site waste treatment facilities before being discharged overboard. Deck drainage would also be processed prior to discharge. As such, impacts on bird species from the discharge of waste materials or the accidental release of fuels, if any, are expected to be **negligible**, if any (BOEM 2014c, 2016).

Conclusion

Construction of offshore components is not likely to disturb or displace birds, and would have a **negligible** impact on the resource. Construction of onshore components would result in a small area of permanent habitat loss and conversion, but impacts would be **negligible** to **minor**. Operation of the onshore components would have **negligible** impacts, while operation of the offshore components, especially the rotating WTGs, could result in habitat loss and in collision-induced mortality, leading to **negligible** to **minor** impacts. Onshore decommissioning would hardly have any effect, but offshore decommissioning would have impacts comparable to the construction phase.

Overall, the Proposed Action may result in **minor** impacts on jaegers and gulls. BOEM expects **negligible** adverse impacts on other bird species, if any.

While the significance level of impacts would remain the same, BOEM could further mitigate potential impacts of construction, operations and maintenance, and decommissioning by requiring Vineyard Wind to comply with one or more of the mitigation measures described above as a condition of COP approval (see Appendix D). In addition, the analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.3.2.4. Impacts of Alternative B, C, and D on Birds

Regarding birds, the direct, indirect, and cumulative impacts of the construction and installation, operations and maintenance, non-routine activities, and decommissioning of Alternatives B, C, D1, and D2 would be practically identical to those of the Proposed Action. Based on the analysis above, and under routine circumstances, Alternatives B, C, D1, and D2 would have **negligible** to **minor** impacts on birds. Under Alternatives D1 and D2, the acreage of the WDA would increase compared to the Proposed Action. This could potentially lead to a slightly increased risk of migrating birds encountering the WDA. No loss of suitable habitat for bird species with high displacement sensitivity (see Figure 3.3.2-2) would occur under D1 and D2. While D1 and D2 would increase the acreage of the WDA, the impacts would still likely remain **negligible** to **minor**. While the significance level of impacts would remain the same, BOEM could further mitigate potential impacts of construction, operations and maintenance, and decommissioning by requiring that Vineyard Wind comply with one or more of the additional mitigation measures identified as a condition of COP approval (see Appendix D).

3.3.2.5. Impacts of Alternative E on Birds

With the exception of the number of WTGs, the direct, indirect, and cumulative impacts of the construction and installation, operations and maintenance, non-routine activities, and decommissioning of Alternative E would be practically identical to those of the Proposed Action.

Under Alternative E, the WDA would contain no more than 84 WTGs. This alternative would include approximately 16 percent fewer WTGs than the maximum-case scenario under the Proposed Action. As demonstrated by Johnston et al. (2013), the use of fewer, larger WTGs may be an effective method of reducing collision risk. Thus, this alternative could be less likely to affect birds than the Proposed Action. Impacts from this factor would likely remain **negligible** to **minor**. Mitigation measures identified above would also be applicable to this alternative.

3.3.2.6. Impacts of Alternative F (No Action Alternative) on Birds

As described in Section 3.3.2.1, birds are and will continue to be present in the study area under the No Action Alternative. Maintenance of existing roads and public utilities near the proposed substation and OECRs will continue indefinitely. Outside of currently protected areas, the conversion of natural areas to developed residential, commercial, and industrial uses is likely to continue.

If BOEM does not approve the proposed Project (either the Proposed Action or another action alternative), the above foreseeable actions are likely to continue. The conditions of bird resources would likely continue along their current trends. The region would miss an opportunity to reduce emissions of carbon dioxide, nitrogen oxides, and SO_2 by 1,630,000; 1,050; and 860 tons per year respectively; such reductions in emissions would have had a **negligible beneficial** effect on birds. If wind energy development were to occur elsewhere on land in Massachusetts as a result of the current demand for wind energy going unfulfilled by the proposed offshore Project, the impacts on bird populations would likely be more severe than they would be under the proposed Project. Construction of terrestrial wind facilities require habitat conversion for the WTGs and associated infrastructure. In the Northeast, this would result in a slight increase in forest fragmentation and habitat loss.

3.3.2.7. Comparison of Alternatives for Birds

Compared to the Proposed Action, Alternative B would use an OECR that is shorter by approximately 0.5 mile (0.8 kilometer) and would disturb approximately 2.2 acres (8,903 m^2) less land compared to the maximum-case scenario within the Proposed Action. Alternative B would avoid approaching the wetlands, the stream, and the high-quality habitat within the Hyannis Ponds WMA, whereas the eastern OECR under the Proposed Action would not. Other aspects of the potential impacts of Alternative B would be practically identical to those of the Proposed Action.

With respect to birds, Alternatives B and C are identical to the Proposed Action.

Alternatives D1 and D2 could potentially lead to a slightly increased risk of migrating birds encountering the WDA, but the difference compared to the Proposed Action is unlikely to be significant.

The risk of migrating birds encountering the WDA under Alternative E would be slightly less than the Proposed Action's PDE; however, the difference from the Proposed Action is unlikely to be significant.

The No Action Alternative would avoid the negative impacts of the Proposed Action and the negligible beneficial effect on birds due to the reduction of emissions.

3.3.2.8. Cumulative Impacts

The analysis area for birds includes a 100-mile (161-kilometer) buffer around the shoreline from Maine to Florida (see Appendix C, Figure C.1-4). Appendix C describes the general activities as well as specific projects that could contribute to cumulative impacts on birds when combined with the Proposed Action. For the purposes of the following assessment, direct impacts are limited to collision mortality associated with operating WTGs (MMS 2008; USFWS 2008).

The following activities included in the cumulative effects scenario associated with the Proposed Action are likely to result in **negligible** adverse effects. As such, BOEM does not expect these actions to result in significant cumulative effects in combination with the Proposed Action.

- Wind energy development activities (see BOEM 2012a, 2012b, 2015; USFWS 2008)
- Construction and decommissioning of offshore wind energy facilities (USFWS 2008)

BOEM considers three offshore wind facilities to be reasonably foreseeable, including two Tier 1 projects and one Tier 2 project (see Appendix C). Although not considered reasonably foreseeable, all four Tier 3 projects could contribute to cumulative impacts if they come to fruition. However, as described above, there would be minimal, if any, temporal overlap with the Proposed Action during construction and only temporary, **negligible** cumulative impacts to birds. While the extent and type of adverse impacts, if any, to migratory birds resulting from fatal interactions with operating WTGs is unclear at this time, some level of mortality can be assumed at operating or future operating offshore wind facilities. Based on the currently available information presented in Appendix C, if the Tier 1 and Tier 2 projects move forward, an additional 21 WTGs could be added to the geographic analysis area. The highest, most conservative estimate of the number of WTGs associated with the Tier 3 projects would contribute an additional

232 WTGs. As described above, the likelihood of an individual encountering the RSA of one or more operating WTGs associated with the Proposed Action when combined with past, present, and future projects is expected to be **negligible** for nearly all bird species that occur along the Atlantic coast. Further, the species at greatest risk (jaegers and gulls) are common species and BOEM does not expect the **negligible** to **minor** impacts to have a significant cumulative effect when the Proposed Action is combined with past, present, and future projects.

To date, four potential offshore wind facilities have identified a submarine export cable route. Reasonably foreseeable impacts on bird species resulting from the installation of new submarine transmission lines, pipelines, or cables would be identical to impacts of these activities described in the Proposed Action. BOEM expects all of these impacts to be temporary and localized in nature and include the same or very similar installation methodologies (see Section 4.2.3.3.2, COP Volume I; Epsilon 2018a). Therefore, BOEM expects these actions, the Proposed Action combined with past, present, and future projects, to result in **negligible** adverse impacts on bird species (USFWS 2008).

Currently there are two operating tidal energy projects and one reasonably foreseeable in the cumulative effects area of analysis (see Appendix C). Due to these types of projects being located below the water surface with no potential for collision, the Proposed Action when combined with past, present, and future projects would contribute **negligible**, if any, effects from the construction and operations of tidal energy projects. These impacts are similar in nature, scope, and duration as other actions described herein. As such, these actions are not likely to have significant cumulative effects on bird species in combination with the Proposed Action (see USFWS 2008).

The Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project has been proposed in Muskeget Channel between Martha's Vineyard and Nantucket and could overlap with the OECC corridor. BOEM considers the project speculative because the tidal energy project has not received permits. Appendix C addressed the project as not reasonably foreseeable.

Onshore development activities that may contribute to cumulative impacts are primarily onshore development projects located in proximity to the OECRs, landfalls, and substation locations. These projects include onshore wind facilities, communication towers, and development projects. Reasonably foreseeable impacts resulting from these projects include (1) land use changes, (2) erosion and sedimentation, (3) visual impacts, and (4) traffic delays associated with construction. Given the minimal amount of habitat conversion, the Proposed Action, when combined with past, present, and future projects, would contribute **negligible**, if any, effects from the construction and operations of onshore development projects.

BOEM expects the Proposed Action, when combined with past, present and reasonably foreseeable actions, to result in **negligible** to **minor** impacts on bird species, especially when compared to other sources of bird mortality (e.g. collisions with manmade structures, habitat modification and loss, predation, etc.). Given that (1) adverse impacts on birds resulting from the Proposed Action are expected to be **negligible to minor**, (2) new onshore and offshore wind facilities would require independent environmental reviews, and (3) all other developments in the OCS (e.g. submarine cables, transmission, and gas lines) would result in short-term, temporary impacts on bird species; no actions provided in Appendix C and summarized herein are likely to have a significant cumulative effect in combination with the Proposed Action.

3.3.2.9. Incomplete or Unavailable Information for Birds

Although population status and trends, as well as risk of collision with operating WTGs, are incompletely known for some species, the available information was adequate to assess the potential impacts of the proposed Project.

3.3.3. Bats

3.3.3.1. Description of the Affected Environment for Bats

The COP (Volume III; Epsilon 2018a), BOEM 2012a, and BOEM 2015 provide a full discussion of the bat resources within the proposed Project area, potential impacts on bat resources that could occur as a result of the proposed Project, and analysis of those potential impacts. The sections below incorporate and summarize independently BOEM-reviewed or -certified documents by reference. Appendix B also provides an introduction to bats in the proposed Project area (Section B.5.2.3).

Nine species of bats occur within Massachusetts, eight of which may be present in the proposed Project area (see COP Volume III, Table 6.3-1; Epsilon 2018a). The endangered Indiana Bat (*Myotis sodalis*) does not occur in the greater Cape Cod region and this section therefore does not discuss it further. Bat species consist of two distinct groups based upon their overwintering strategy: cave-hibernating bats (cave bats) and migratory tree bats (tree bats). Potential impacts on these two groups of bats resulting from the construction, operations and maintenance, and decommissioning of the proposed Project are described beginning in Section 3.3.3.2. The *Biological Assessment for Construction of the*

Vineyard Wind Offshore Wind Project submitted to USFWS discusses potential impacts on the threatened Northern Long-Eared Bat (*Myotis septentrionalis*) (BOEM 2018a).

Regional Setting

Recent studies, combined with historical anecdotal accounts, indicate that migratory tree bats sporadically travel offshore during spring and fall migration, with 80 percent of acoustic detections occurring in August and September (Hatch et al. 2013; Pelletier et al. 2013; Stantec 2016; Dowling et al. 2017). However, unlike tree bats, the likelihood of detecting a *Myotis* species or other cave bat is substantially less in offshore areas (Pelletier et al. 2013). Regionally, both resident and migrant bat species occur on islands within Nantucket Sound, indicating that over-water crossings do occur (MMS 2008). Dowling et al. (2017) documented little brown and eastern red bats leaving Nantucket Island and crossing open-water in August and September, which is consistent with the migratory chronology of these species. In all cases, these movements were towards shore and away from the offshore portions of the Project area. Pre-construction studies at the Block Island Wind Farm indicate that bat use of Block Island is largely limited to the island and nearshore waters, with limited acoustic detections in offshore habitats (TetraTech 2012). Similarly, no identifiable bat echolocation calls were detected at the Cape Wind Energy Project area or adjacent open water in Nantucket Sound during monthly surveys in 2013 conducted by Cape Wind Associates from April to October (ESS 2014).

Existing data from meteorological buoys provide the best opportunity to further define bat use of open-water habitat where Vineyard Wind would site the proposed Project WTGs. Stantec (2016) found that despite significant distance from any suitable terrestrial habitat, all five meteorological buoy-sampling locations in the Gulf of Maine detected bats; however, detection rates were the lowest at these sites when compared to sites located on offshore islands, and use was sporadic. Given these data, the potential exists for some migratory tree bats to encounter offshore facilities during spring and fall migration. BOEM expects this exposure risk to be limited to very few individuals and to occur, if at all, during migration. Given the distance of offshore portions of the Project area from shore, BOEM does not expect foraging bats to encounter operating WTGs.

The onshore areas in the region of the Proposed Action include forested habitats that provide features suitable for use by roosting and/or foraging bats (COP Volume III; Epsilon 2018a) as well as dense residential, industrial, and commercial development. All eight species of bats with the potential to occur in eastern Massachusetts may be present in onshore areas within the region (see Appendix B, Table B.5-4). There are no known occupied hibernation sites located on Cape Cod (MNHESP 2016b).

Project Area

The proposed WDA of the Proposed Action is located in open-water habitat far from shore and is representative of regional conditions. The WDA does not provide suitable roosting or foraging habitat for bats. A possibility exists that migratory tree bats could encounter operating WTGs associated with the Proposed Action. Given the distance from shore, however, this possibility is remote.

The Proposed Action includes two alternative landfall sites and associated OECRs that would connect the WDA to the new onshore substation and ultimately to the Barnstable Switching Station (see Figure 2.1-1). Vineyard Wind would locate all proposed Project onshore facilities, except the new substation, within existing, previously disturbed, linear corridors (public road, rail, and electric ROW) and buried below grade.

The proposed Project's onshore substation would be 7 acres (28,328.1 m^2) (See Figure 2.1-1) in area. The proposed onshore substation is comprised of forested habitat potentially suitable for use by roosting and/or foraging bats. Site vegetation is comprised primarily of pitch pine (*Pinus rigida*) and scarlet oak (*Quercus coccinea*) in the tree layer with black huckleberry (*Gaylussacia baccata*) and lowbush blueberry (*Vaccinium angustifolium*) dominant in the understory. Bracken fern (*Pteridium aquilinum*) and teaberry (*Gaultheria procumbens*) are present as ground covers. This type of Pitch Pine-Oak-Heath forest is very common and widespread throughout southeastern Massachusetts (EEA 2016). The onshore substation site lacks any available water source, but some small ponds are located within approximately 1,400 feet (427 meters) of the substation site and would remain available to resident and migrating bats (see Section 3.2.2). The proposed substation site provides only moderate-quality habitat for roosting and/or foraging bats, given the disturbed nature of the substation site as well as the immediate vicinity (see COP Volume III for a detailed description of current on-site conditions at the substation site).

Aspects of Resource Potentially Affected

While the likelihood of an individual migratory tree bat encountering an operating WTG during migration is very low, potential impacts to migrating bats may result from the construction, operations and maintenance, and decommissioning of the proposed Project. Limited potential also exists for migrating bats to encounter vessels during construction and decommissioning of WTGs, ESPs, and OECCs, although WTG and vessel lights may attract bats due to increased prey abundance.

Given historical and recent documentation of migratory tree bats using offshore open-water habitats, some migratory tree bats may encounter the RSA of WTGs during spring and fall migration. Therefore, the operations of the proposed Project may result in direct impacts (collision with operating WTGs or barotrauma) and/or indirect impacts (avoidance) on migratory tree bats.

Potential impacts on bat species may occur during construction and decommissioning of the new onshore substation. Construction of the new onshore substation would require the removal of 7 acres (28,328.1 m^2) of forested habitat that is potentially suitable for use by roosting and/or foraging bats. Such habitat removal would have the potential for direct impacts resulting from the removal of an occupied roost tree, as well as indirect impacts resulting from the removal of potentially suitable habitat.

Threatened and Endangered Bats

The federally threatened northern long-eared bat occurs throughout Massachusetts, including Cape Cod, Martha's Vineyard, and Nantucket. The USFWS listed the species as threatened in 2015 and published a final 4(d) rule in 2016, allowing for incidental take of the northern long-eared bat under certain scenarios, pending compliance with required conservation measures. Please refer to the BA for further details on this species (BOEM 2018a).

Several state endangered species—the eastern small-footed bat (*Myotis leibii*), the little brown bat (*Myotis lucifugus*), and the tri-colored bat (*Perimyotis subflavus*)—may occur within the proposed Project area and may have been heavily impacted by White Nose Syndrome (WNS).

The terrestrial ecology of northern long-eared bats is generally understood; these bats forage under closed canopy ridges and hillsides, typically relatively close to occupied roost trees (Broders et al. 2006; Brack and Whitaker 2001; Henderson and Broders 2008; Lacki et al. 2009; Owens et al. 2002). Although the presence of northern long-eared bats on Martha's Vineyard and Nantucket illustrate that the species has the ability to cross open water habitats, there are no records of northern long-eared bats migrating to and from islands to the mainland (Dowling et al. 2017; Pelletier et al. 2013; BOEM 2015). Therefore, it is extremely unlikely that northern-long eared bats would fly over the open ocean near the offshore portion of the Project area. Similarly, it is very unlikely that state-endangered eastern small-footed, little brown, or tri-colored bats would encounter offshore facilities during migration (Pelletier et al. 2013; BOEM 2015).

A review of the Commonwealth's Natural Heritage & Endangered Species Program's online database of known occupied northern long-eared bat habitat indicates that the closest occurrence is approximately 11.5 miles (18.5 kilometers) northwest of the proposed onshore substation site (EEA 2016).

Current Condition and Trend

Bats are terrestrial species that spend almost their entire lives on or over land. On occasion, tree bats may potentially occur offshore during spring and fall migration and under very specific conditions like low wind and high temperatures.

All eight species of bats that occur in coastal Massachusetts, including the northern long-eared bat, may be present near the onshore facilities. Cave bat species are experiencing drastic declines due to WNS, a fungal bat disease in the United States resulting in mortality as high as 90 percent at some hibernation sites (Blehart et al. 2009; Gargas et al. 2009; Turner et al. 2011). In Massachusetts, the eastern small-footed bat's population status is unknown, but WNS and other disturbances of hibernation threaten it (Mass Wildlife 2015a). The little brown bat was once the most abundant bat species in this region, but has suffered greatly from WNS (Mass Wildlife 2015b). Likewise, WNS has devastated the tri-colored bat in the last ten years (Mass Wildlife 2015c). Proposed Project-related impacts have the potential impacts on cave bat populations already affected by WNS. Conversely, the unprecedented mortality of more than 5.5 million bats in northeastern North America as of 2015 reduces the likelihood of many individuals being present within the proposed Project area (USFWS 2015).

3.3.3.2. Environmental Consequences

Relevant Design Parameters

The primary proposed Project-design parameters that would influence the magnitude of the impact on bats are shown in Appendix G and include the following:

- The new onshore substation, which would require the removal of forested habitat that is potentially suitable for roosting and foraging;
- The number, size, and location of WTGs; and
- The time of year during which construction occurs.

Potential Variances in Impacts

Variability of the proposed-Project design exists as outlined in the PDE (see Appendix G). Below is a summary of potential variances in impacts:

- WTG number, size, and location: The level of hazard related to WTGs is proportional to the number of WTGs installed; fewer WTGs would present less hazard to bats.
- OECRs: The route chosen (including variants within the general route) would determine the amount of habitat affected. The western OECR from the Covell's Beach landfall site to the proposed new substation site includes two options, and the eastern OECR from the New Hampshire Avenue landfall site to the proposed new substation includes five options. The sections below detail the pertinent differences among the options with respect to bats.
- Season of construction: The active season for bats in this area is from May through October. Construction outside of this window would have a lesser impact on bats than construction during the active season.

3.3.3.3. Impacts of Alternative A (Proposed Action) on Bats

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations and maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct impacts would include direct mortality as a result of collision with WTGs. Indirect impacts would include temporary or permanent alteration, or loss, of habitat, including that due to avoidance behavior. BOEM has prepared a BA for the potential effects on the USFWS federally listed northern long eared bat (BOEM 2018a).

The Proposed Action has the potential to adversely affect one federally listed bat, the northern long-eared bat, during the course of Project construction and decommissioning. However, as discussed in the BA, BOEM expects no direct impacts to northern long-eared bats as a result of the construction, operations and maintenance, or decommissioning of the offshore portions of the Proposed Action (BOEM 2018a); therefore, **negligible** impacts would occur. This determination is contingent upon the use of seasonal restrictions related to tree-clearing time of year, which BOEM could condition as part of COP approval. To be protective of the northern long-eared bats, tree-clearing activities can occur between November 16 and March 31 of any given year, when the species is not present on the landscape. This time of year would also benefit non-listed species, none of which would be present on the landscape during tree clearing activities.

<u>Construction and Installation</u>

Although vessels, ESPs, or WTG towers might attract bats during construction, the bats' echolocation abilities and agility make it unlikely that any of these objects would pose a collision risk. Impacts of offshore construction and installation would therefore be **negligible**.

Direct impacts could occur when Vineyard Wind fells trees and snags during the construction of the onshore substation. The proposed substation could potentially affect up to 7 acres (28,328.1 m^2). If Vineyard Wind fells trees or snags during the active season (generally May through October), this could kill bats roosting in the trees/snags, especially juveniles that are too young to fly away. Pursuant to USFWS requirements, Project related tree-clearing activities would not occur from June 1 to July 31 to be protective of young bats that are unable to fly. Outside of this window, bats would likely be able to flush from occupied roost trees to avoid direct impacts, and this risk would therefore be **negligible**. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts if the mitigation measure of no tree clearing (greater than 5 inches [15.2 centimeters] diameter at breast height) from April 15 through October 31 to minimize effects to species and/or their habitat (see Section 2.2.1 and Appendix D).

Clearing of the substation site would also result in a loss of potentially suitable summer roosting habitat. However, the habitat that Vineyard Wind would remove is of moderate quality as it is near an already developed area and is characterized by an extremely cluttered understory. Furthermore, plenty of similar forest habitat is available nearby. Therefore, impacts would be **negligible**.

Indirect effects (i.e., displacement from potentially suitable habitats) could occur as a result of construction activities, which could generate noise sufficient to cause avoidance behavior. Because construction activity would be temporary and highly localized, however, the impacts on bats would be **negligible**.

Long-term habitat loss or alteration could also result from the Proposed Action. Widening part of an existing public utility ROW by clearing trees and shrubs would convert forest and scrubland habitat into managed grassland. The proposed Project expects to affect approximately 0.2 acres (740 m^2) of the eastern OECR under the maximum-case scenario; the effects could be less if another route variant were implemented by Vineyard Wind under the Proposed Action. The proposed new substation site would require the clearing of 7 acres (28,328.1 m^2) of pitch pine-oak forest habitat that is potentially suitable for use by roosting and/or foraging bats. This type of forest is very common throughout southeastern Massachusetts (Commonwealth of Massachusetts 2016). In addition, the proposed substation site would be located on the edge of a previously developed site within the Independence Park commercial/industrial area in the Town of Barnstable. These changes would be expected to have a minimal effect on bats because this type of forest habitat is common across Cape Cod and is available as a high-quality, contiguous block in the nearby Hyannis Ponds WMA, which lies as near as 0.25 mile (0.4 kilometer) from the proposed substation area. As a result, BOEM anticipates **negligible** potential impacts.

A larger amount of habitat loss and fragmentation may result if the proposed eastern OECR were to follow a proposed bike path that the MassDFW is considering constructing through the Hyannis Ponds WMA. This option would involve the clearing of a corridor through a pine-oak forest community that is currently managed by MassDFW for the benefit of wildlife. This corridor would likely be 40 feet (13 meters) wide by approximately 1.3 miles long (2.1 kilometers), and would lead to the conversion of approximately 7 acres (28,328.1 m^2) of forested habitat to forest edge habitat. Removal of forested habitat may remove potentially suitable roosting and/or foraging habitat for northern long-eared bats. As stated in the HCA with the Town of Barnstable, Vineyard Wind would coordinate construction with trail proponents, and would conduct preparatory work to facilitate subsequent bike path installation (Town of Barnstable 2018b). Potential impacts on bats would be **minor** if Vineyard Wind selected this route as part of the Proposed Action before MassDFW cleared the potential bike path. If Vineyard Wind selected this route after MassDFW cleared the potential bike path and committed to that new use, BOEM would expect the Proposed Action to have **negligible** incremental impacts in this area. It is important to note that impacts associated with the proposed bike path, if any, could occur regardless of the OECR selected. However, if BOEM conditions the COP approval with the mitigation measure of no tree clearing from April 15 through October 31, impacts could be reduced to **negligible** because this would minimize effects to species and/or their habitat (see Section 2.2.1 and Appendix D).

Operations and Maintenance

Cave bats, which rarely move offshore even during fall migration, would not be exposed to the RSA of WTGs in the Project area. Tree bats, however, may pass through the WDA during the fall migration. Tree bat species that may encounter the WDA include the eastern red bat, the hoary bat, and the silver-haired bat. Offshore operations and maintenance would present a seasonal risk factor to migratory tree bats that may utilize the offshore portions of the Project area during fall migration. Further, the potential collision risk to migrating tree bats varies with climatic variables. While the existing literature demonstrates that some potential exists for migrating tree bats to encounter operating WTGs during fall migration, the overall occurrence of bats on the OCS is very low, and the likelihood of an individual encountering operating WTGs under adverse weather conditions would be so low as to be **negligible**. Although little is known about overall population levels of tree bats, BOEM anticipates that the expected rarity of bats encountering WTGs would lead to only **negligible** impacts, if any, on migratory tree bat populations.

BOEM does not expect normal onshore operations and maintenance activities to involve further habitat alteration or otherwise impact bats. Normal operation of the substation would generate continuous noise, but BOEM expects **negligible** associated impacts in the context of other commercial and industrial noises near the proposed substation. Vineyard Wind would typically accomplish maintenance and any necessary repairs through manholes, within the fenced area of the substation site or well within the existing public utility ROW. Management of the existing utility ROW would continue to involve periodic removal of tree saplings, possibly through mowing and/or prescribed fire. Onshore impacts on bats due to operations and maintenance would be **negligible**.

Decommissioning

Vineyard Wind would likely leave onshore facilities in place for future use (see Chapter 2). There are no plans to disturb the land surface or terrestrial habitat during the course of Proposed Action decommissioning. Therefore, onshore impacts of decommissioning would be **negligible**. However, Vineyard Wind would remove the offshore WTGs and ESPs. This impact would likely be similar in nature, extent, and intensity to the impacts of WTG and ESP installation.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities would generally require intense, temporary activity to address emergency conditions. The noise made by onshore construction equipment or offshore repair vessels could temporarily deter bats from approaching the site of a given non-routine event. BOEM expects **negligible** impacts on bats because these activities would be temporary and last only as long as repair or remediation activities were necessary to address these non-routine events.

Conclusion

Construction, installation, and decommissioning of the Proposed Action would have **negligible** impacts on bats, especially if conducted outside of the active season. The main significant risk would be from operation of the offshore WTGs, which could lead to **negligible** impacts in the form of direct mortality, although BOEM anticipates this to be rare.

Based on the analysis above, and under routine circumstances, the Proposed Action would have **negligible** impacts on bats; however, if the eastern OECR were chosen and construction occurred before MassDFW cleared the potential bike path, the Proposed Action would have **minor** impacts on bats. However, if BOEM conditions the COP approval with the mitigation measure of no tree clearing from April 15 through October 31, impacts could be reduced to **negligible** as this would minimize effects to species and/or their habitat (see Section 2.2.1 and Appendix D).

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.3.3.4. Impacts of Alternative B, C, and D on Bats

The direct, indirect, and cumulative impacts of the construction and installation, operations and maintenance, non-routine activities, and decommissioning of Alternatives B, C, and D1 on bats would be practically identical to those of the Proposed Action. Based on the analysis above, and under regular circumstances, Alternatives B, C, and D1 would have **negligible** impacts on bats. Under Alternatives D1 and D2, the acreage of the WDA would increase compared to the Proposed Action. This could potentially lead to a slightly increased risk of migrating bats encountering the WDA. While D2 would increase the acreage of the WDA, the impacts from this factor would likely remain **negligible** to **minor**. While these alternatives may result in differing numbers of WTGs and/or differing Project footprints, no significant increase in collision risk would be expected given the presumed lack of use by migratory tree bat species. While the significance level of impacts would remain the same, BOEM could further mitigate potential impacts of construction, operations and maintenance, and decommissioning by requiring Vineyard Wind to comply with one or more of the additional mitigation measures identified as a condition of COP approval (see Appendix D).

3.3.3.5. Impacts of Alternative E on Bats

With the exception of the number of WTGs, the direct, indirect, and cumulative impacts of the construction and installation, operations and maintenance, non-routine activities, and decommissioning of Alternative E would be practically identical to those of the Proposed Action.

Under Alternative E, the WDA would contain no more than 84 WTGs. This alternative would include approximately 16 percent fewer WTGs than the maximum-case scenario under the Proposed Action. As demonstrated by Johnston et al. (2013), the use of fewer, larger WTGs may be an effective method of reducing collision risk; thus, this alternative could be less likely to affect bats than the Proposed Action. Impacts from this factor would likely remain **negligible** to **minor**. Mitigation measures identified above would also be applicable to this alternative.

3.3.3.6. Impacts of Alternative F (No Action Alternative) on Bats

As described in Section 3.3.3.1, bats will continue to be present in the study area under the No Action Alternative. If BOEM does not approve the proposed Project (either the Proposed Action or another action alternative), the conditions of bat resources would likely continue along their current trends. In the case of most species of cave bats, WNS would continue to strain populations. For several tree bat species, expansion of terrestrial wind energy development would continue to result in some incidental take each year during migration.

The region would miss an opportunity to reduce emissions of carbon dioxide, nitrogen oxides, and SO_2 by 1,630,000; 1,050; and 860 tons per year, respectively; such reductions in emissions could have a **negligible beneficial** effect on birds. If wind energy development were to occur elsewhere on land in Massachusetts as a result of the current demand for wind energy going unfulfilled by the proposed Project, the impacts on bat populations would likely be more severe than under the proposed Project. Construction of terrestrial wind facilities require some habitat conversion for the WTGs and associated infrastructure. In the northeast, this would result in a slight increase in forest fragmentation and habitat loss.

3.3.3.7. Comparison of Alternatives for Bats

With respect to bats, Alternatives B and C are identical to the Proposed Action. Alternatives D1 and D2 could potentially lead to a slightly increased risk of migrating bats encountering the WDA, but the difference from the Proposed Action is unlikely to be significant.

The risk of migrating tree bats encountering the WDA under Alternative E would be slightly less than the Proposed Action's PDE; however, the difference from the Proposed Action is unlikely to be significant.

The No Action Alternative would completely avoid the negative impacts of the Proposed Action on bat species described herein. However, potential adverse impacts associated with other activities that still may occur could result in impacts on bats.

3.3.3.8. Cumulative Impacts

The analysis area for bats includes a 100-mile (161-kilometer) buffer around the shoreline from Maine to Florida (see Appendix C, Figure C.1-4). Appendix C describes the general activities as well as specific projects that could generate cumulative impacts on bats. For the purposes of the following assessment, direct impacts are limited to collision mortality associated with operating WTGs (see MMS 2008; USFWS 2008).

As described herein, the following activities included in the cumulative effects scenario associated with the Proposed Action are likely to result in **negligible** adverse effects. As such, BOEM does not expect these actions to result in significant cumulative effects in combination with the Proposed Action.

- Wind energy development activities (see BOEM 2012a, 2012b, 2015; USFWS 2008)
- Construction and decommissioning of offshore wind energy facilities (USFWS 2008)

BOEM considers three offshore wind facilities to be reasonably foreseeable, including two Tier 1 projects and one Tier 2 project (see Appendix C). Although not considered reasonably foreseeable, all four Tier 3 projects could contribute to cumulative impacts if they come to fruition. As described above, there would be minimal temporal overlap during construction and only temporary, **negligible** cumulative impacts to bats.

As described above, cave bat species are unlikely to occur on the OCS; as such, BOEM does not expect any cumulative impacts associated with offshore wind development on these species. While the extent and type of adverse impacts, if any, to migratory tree bats resulting from fatal interactions with operating WTGs is unclear at this time, BOEM assumes some level of mortality during operation of offshore wind facilities. Based on the currently available information presented in Appendix C, if the Tier 1 and Tier 2 projects move forward, an additional 21 WTGs could be added to the geographic analysis area. The highest, most conservative estimate of the number of WTGs associated with the Tier 3 projects would contribute an additional 232 WTGs. As described above, the likelihood of an individual encountering the RSA of one or more operating WTG associated with the Proposed Action when combined with past, present, and future projects is expected to be so low as to be **negligible** for migratory tree bats, and BOEM does not expect these impacts to have a significant cumulative effect.

In addition to the low likelihood of individual bats encountering operating WTGs associated with the Proposed Action, any new operating offshore wind facilities would require a thorough regulatory and environmental review to appropriately site the facility to avoid, minimize, and mitigate adverse impacts on bat species, further reducing the likelihood of adverse cumulative impacts in combination with the Proposed Action.

To date, four potential offshore wind facilities have identified a submarine export cable route. Reasonably foreseeable impacts on bat species resulting from the installation of new submarine transmission lines, pipelines, or cables would be identical to impacts of these activities described in the Proposed Action.

BOEM expects all of these impacts to be temporary and localized in nature and include the same or very similar installation methodologies (see Section 4.2.3.3.2, COP Volume I; Epsilon 2018a). Therefore, BOEM expects these actions, the Proposed Action combined with past, present, and future projects, to result in **negligible** adverse impacts on bat species (USFWS 2008).

Currently there are two operating tidal energy projects and one reasonably foreseeable in the cumulative effects area of analysis (Appendix C). Due to these types of projects being located below the water surface with no potential for collision, the Proposed Action when combined with past, present, and future projects would contribute **negligible**, if any, effects from the construction and operations of tidal energy projects. Reasonably foreseeable impacts on bat species resulting from the construction and operation of tidal energy projects would include increased vessel traffic and associated effluent discharges, air emissions, and noise (FERC 2011, 2012a, 2012b); however, BOEM expects these actions to result in **negligible** adverse impacts.

These impacts are similar in nature, scope, and duration as other actions described herein. As such, these actions are not likely to have significant cumulative effects on bird species in combination with the Proposed Action (USFWS 2008).

The Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project has been proposed in Muskeget Channel between Martha's Vineyard and Nantucket and could overlap with the OECC corridor. BOEM considers the project speculative because the tidal energy project has not received permits. Appendix C addressed the project as not reasonably foreseeable.

Onshore development activities that could contribute to cumulative impacts are primarily onshore development projects located in proximity to the OECRs, landfalls, and substation. Onshore development projects with potential cumulative impacts could include visible infrastructure such as onshore WTGs and cell towers, and other energy projects such as transmission and pipeline projects. Coastal development projects permitted through the Massachusetts regional planning commissions and towns may also contribute to cumulative impacts. These may include residential, commercial, and industrial developments spurred by population growth in the region. Given the extremely small percentage of potentially suitable habitat that would be removed, **negligible** impacts associated with the Proposed Action when combined with past, present, and future projects are not expected to result in adverse cumulative effects in combination with reasonably foreseeable onshore development outlined in Appendix C.

BOEM expects the Proposed Action when combined with past, present, and reasonably foreseeable actions to result in **negligible** impacts on bat species, especially cave bats, which do not typically occur in the WDA. Given that (1) adverse impacts on migratory tree bats resulting from the Proposed Action are expected to be **negligible**, (2) new onshore and offshore wind facilities would require independent environmental reviews, and (3) all other developments in the OCS (e.g., submarine cables, transmission, and gas lines) would result in short-term, temporary impacts to migratory tree bat species; no actions provided in Appendix C and summarized herein would likely have a significant cumulative effect on bats in combination with the Proposed Action.

3.3.3.9. Incomplete or Unavailable information for Bats

Although estimates of population size, survival rates, reproductive rates, and other biological parameters are lacking for many species of bats, existing information seems adequate to assess the potential impacts of the proposed Project.

3.3.4. Coastal Habitats

3.3.4.1. Description of the Affected Environment for Coastal Habitats

This section describes the coastal habitats of the proposed Project's offshore facilities, which includes the landfall locations and a portion of the proposed offshore export cable. See Section 3.3.5 for a discussion on benthic resources, and see Section 3.3.6 for a discussion on finfish, invertebrates, and essential fish habitat within the Project area. See Section 3.3.1 for the discussion on terrestrial habitat and wetlands.

Regional Setting

The Massachusetts Office of Coastal Zone Management (CZM) manages coastal habitat within the proposed Project area. The CZM defines the coastal zone as the area that "includes the lands and waters within the seaward limit of the state's territorial sea [3 nautical miles from land] to generally 100 feet beyond (landward of) the first major land transportation route encountered (a road, highway, rail line, etc.)" (CZM 2011). The proposed Project's coastal habitat is defined as the affected area out to the 3-nautical-mile limit and includes the portions of the two proposed OECCs and the two proposed landfall sites (see Figures 2.1-1 and 2.1-4). The offshore portion of the proposed Project area approaches coastal waters of Rhode Island, but it is so far offshore that it does not approach any coastal habitats of Rhode Island.

Project Area

The proposed offshore Project area is subdivided into five geological zones based on physical characteristics and benthic substrate. Coastal habitat is present in Zones 2, 3, 4, and 5 (see COP Table 2.1-4 and COP Figure 2.1-11 (Volume II-A; Epsilon 2018a). Typically, water depth in the proposed Project area's coastal habitat ranges from 0 to 49.2 feet (15 meters), but can be as deep as 131.2 feet (40 meters). Benthic grab samples and underwater video transects collected during the 2016–2017 biological surveys helped determine habitat type (COP Volume II-A, Section 5; Epsilon 2018a). See Section 3.3.5 for a discussion of benthic organisms associated with these types of habitats.

Aspects of Resource Potentially Affected

Seafloor habitat types, based on the habitat categories defined in COP Table 5.1-1 (Volume II-A; Epsilon 2018a), are primarily sandy, but vary across geographical zones. Zone 2 is subject to high currents and exhibits a mainly sand and gravel bed with ripples and sand waves mostly 3.3 to 4.9 feet (1 to 1.5 meters) high. Some Zone 2 habitats include biogenic structures (e.g., burrows and sessile unshelled organisms), shell aggregates, or gravel-cobble beds. Zone 3 exhibits mostly flat sand and silt substrate with ripples and sand waves 3.3 to 6.6 feet (1 to 2 meters) high; biogenic structures are less common. Zone 4 is also primarily flat sand and silt. A minority of areas include small sand waves, shell aggregates, or gravel-cobble beds. Zone 5 is subject to very high currents, exhibits coarser bed material with some hard bottom patches, and sand waves. The sand waves are mostly 6.6 to 13.1 feet (2 to 4 meters) high, but range up to

22.9 feet (7 meters) high. This complex habitat also includes shell aggregates, cobble beds with and without sponge cover, sulfur sponge (*Cliona celata*) beds, and a few isolated boulders.

Vineyard Wind would bury the proposed offshore export cable within the OECC at 5 to 8 feet (1.5 to 2.5 meters) below the seafloor. Both proposed OECCs would contain up to two cables laid within a 3,280-foot (1,000-meter) corridor, which would be the maximum width; the overall majority of the corridor width would be 2,657 feet (810 meters). The substrate is generally flat with unconsolidated sand and silt substrates, with the exception of the areas near Zone 5, which are more coarse and diverse (see COP Figure 5.1-2 (Volume II-A; Epsilon 2018a). The substrates within the OECCs differ slightly; for example, there are biogenic structures (e.g., burrows, depressions, cerianthid anemones, and hydroid patches) along the western OECC leading to the Covell's Beach landfall site, but these are not known along the eastern OECC leading to the New Hampshire Avenue landfall site. These differences could be due to tidal currents, which can potentially influence seabed morphology and grain size of the local substrates. As the survey of the proposed OECC approached the mainland shore, pebble-cobble substrate was found mostly along the eastern OECC, and was generally associated with shell aggregates further from shore (approximately 2 nautical miles from the mouth of Lewis Bay) or with flat sand and silt substrate closer to shore (near the mouth of Lewis Bay) (COP Volume II-A; Epsilon 2018a). These coarser substrates provide complex interstitial spaces for shelter and generally exhibit greater faunal diversity.

"Special, sensitive, and unique" (SSU) habitats (living bottom, hard/complex bottom, eelgrass [*Zostera marina*] areas, and marine mammal habitats) are considered high priorities for avoidance if possible. Vineyard Wind's cable corridor survey data from 2017 were compared to existing data to assess the potential for SSU habitats in the immediate vicinity of the two proposed OECCs (Epsilon 2018a). The proposed Project area and historically mapped sensitive areas provided by Massachusetts are shown on COP Figure 5.2-1 (Volume II-A; Epsilon 2018a). Vineyard Wind routed the two proposed OECCs to avoid sensitive habitat (Figure 3.3.4-1).

Although there were a few targeted surveys between 2016 to 2018 (see COP Appendix II-H, Epsilon 2018a), there were no observations of living bottom (coral, macroalgae, mussels, serpulid worms, sabellarrid worms, or other biogenic reef structures) in the OECC, with the exception of a single slipper limpet reef in the eastern OECC (see COP Volume III Section 6.5.1.1 and 6.5.1.3, and Appendix II-H, Epsilon 2018a). The next closest known living bottom is a patch of stony cup coral (*Astrangia* sp.) in Zone 3, approximately 5.6 miles (9 kilometers) west of the OECC.

Vineyard Wind's survey data indicate hard/complex bottom habitat in the coastal habitat of the proposed Project area, but not eelgrass. Hard/complex bottom habitat is composed of a majority of coarse material (e.g., gravel, cobbles, and boulders combined in a sand substrate). This habitat type provides attachment sites for sessile benthic organisms. This habitat supports fish because the larger boulders and sponges rise above the seabed and are resistant to movement by currents. The Muskeget Channel area includes several pebble-cobble-sponge habitats and other hard/complex bottom habitats. Both proposed OECC routes would encounter hard/complex bottom habitats. Based on underwater video transects, two slipper limpet reef habitats were identified south of Point Gammon on the south shore of the Cape, which is located within the proposed eastern OECC. Additionally, an artificial reef is located outside the proposed Project area in Zone 4, approximately 5.3 miles (8.5 kilometers) east of the eastern OECC near the mainland.

Eelgrass is a marine flowering plant that lives below the surface in less than 16.4 feet (5 meters) of water. Eelgrass beds provide (1) nursery ground and refuge for commercially important organisms, such as bay scallops (*Argopecten irradians*), flounders, striped bass (*Morone saxatilis*), tautog (*Tautoga onitis*), and seahorses; (2) habitat and food for waterfowl, shellfish, and finfish; and (3) sediment and shoreline stabilization (Heck et al. 1989). Strands of eelgrass observed in underwater video transects at depths of 26 to 33 feet (8 to 10 meters) were dead, had dark brown-black leaves, and were drifting. No evidence of eelgrass was detected in the sonar data or the underwater video transects inside the proposed Project area, although there are eelgrass beds nearby (COP Figure 6.4-1 [Volume III; Epsilon 2018a]). See Section 3.3.6 for a discussion of essential fish habitat and eelgrass beds.

The Covell's Beach landfall site would not require any disturbance to sensitive habitats in the coastal zone of the proposed Project (Epsilon 2018a). No mapped hard/complex bottom habitat or eelgrass beds are located in this vicinity except for a small eelgrass bed near Spindle Rock, approximately 0.4 mile (0.6 kilometer) offshore, which Vineyard Wind would avoid during construction. Proposed Project activities would be limited to paved surfaces, including a public roadway and a parking lot, with impacts on an adjacent sandy public beach unlikely.

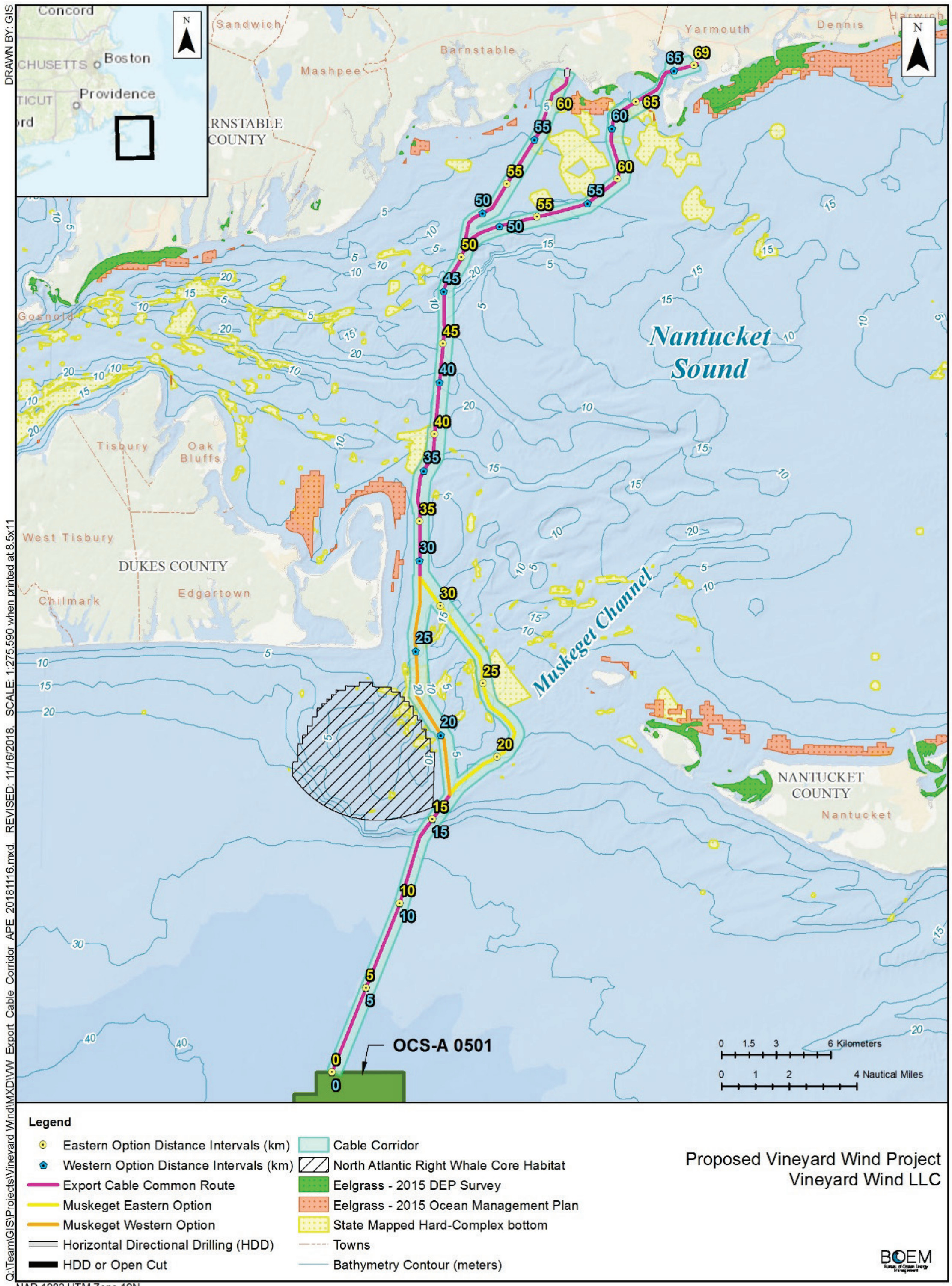


Figure 3.3.4-1: Coastal Habitat Areas near the Proposed OECC

The New Hampshire Avenue landfall site has a more limited workspace, which the proposed Project could affect if conventional open-cut trenching were used (Epsilon 2018a). The proposed Project could affect approximately 1,500 square feet (140 square meters) of beach, and temporary riprap removal could be required at the existing seawall. The remaining work at this landfall location would occur in already paved or otherwise developed areas. If Vineyard Wind used HDD instead of trenching, potential impacts on the local area would be less and would be limited to existing paved surfaces (Epsilon 2018a).[9] Vineyard Wind did not identify hard/complex bottom habitats or eelgrass beds in this area.

Condition and Trend

The lack of any major river in the area to discharge water and sediment contributes to the relative consistency of local geology and coastal habitats over time. Flat sand beds are regionally common, locally abundant, and not expected to change significantly. Sand waves are locally abundant and are mobile over the course of days to years. There is often significant patchiness and sample-to-sample variability in habitats and benthos across space and time (USDOI MMS 2009).

Strong tidal currents near Muskeget Channel lead to more temporal variability, as each turn of the tide rearranges the finer substrates in the area. BOEM expects this process to be in a state of dynamic equilibrium over the coming decades. In areas with moderate current outside Muskeget Channel, sand waves naturally migrate across the seafloor.

Hard/complex bottom habitats are less common and better studied. Historical maps of hard/complex bottom (CZM 2014) indicated its presence in all of Muskeget Channel proper. However, surveys conducted in 2017 (see COP Volume II-A and Appendix II-H, Epsilon 2018a) found hard/complex bottom covering much of the Eastern Muskeget Option of the OECC route, but not most of the Western Muskeget Option, which was mostly composed of sand waves. Therefore, the hard/complex bottom coastal habitat in this area is subject to change over time.

Development, commercial fishery activities, and tourism in the area could affect the sensitive habitats in the proposed Project's coastal area (e.g., hard/complex bottom and eelgrass beds). Eelgrass habitats in this region cover much less area than historically estimated (Cape Cod Commission 2011). A long-term study of eelgrass beds in Massachusetts reported a decline in coverage at 30 of the 46 sites, with a total loss of 20.6 percent since 1994 (Costello and Kenworthy 2011). Eelgrass beds are threatened by anthropogenic activities, and declines in this habitat have been correlated with "physical disturbances (i.e., dredging, construction, shell fishing, propeller damage from boating), turbidity (i.e., topsoil runoff, activities that re-suspend sediments), pollution, and most notably, eutrophication as a result of nutrient loading" (Center for Coastal Studies 2017).

Landward of the intertidal zone, coastal habitat near the proposed Project area is mostly a mixture of sandy beaches, rocks, and developed spaces. Coastal habitats on Martha's Vineyard and Chappaquiddick Island also include sand dune habitats, salt ponds, salt marshes, and scattered maritime forest. Sandy beaches in these areas are subject to erosion and are vulnerable to the effects of projected climate change and relative sea-level rise (Roberts et al. 2015). Mainland coastal habitat near the proposed Project area is almost completely developed with groins, jetties, seawalls, residences, and light commercial establishments (Thieler et al. 2013). Development is likely to continue as the resident and vacationer populations expand. Section 3.4.4 and Section 3.4.6 provide further discussions of these subjects.

3.3.4.2. Environmental Consequences

Relevant Project Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on coastal habitats are shown in Appendix G and include the following:

- The landfall site chosen;
- The routing variants within the OECC within state waters; and
- The dredging and cable installation method(s) used.

Potential Variances in Impacts

Variability of the proposed-Project design exists as outlined in the PDE (see Appendix G). Below is a summary of potential variances in impacts:

- Landfall site selection and associated OECC route: The size and the nature of impacts would likely differ for the two proposed landfall sites; the landfall site selected would also determine the route for the OECC as it approaches landfall. The Covell's Beach landfall site might generate fewer overall impacts on coastal habitat. The

[9] As described the Section 3.3.4.2, BOEM could reduce potential impacts by requiring the use of HDD at landfall sites as a condition of COP approval.

New Hampshire Avenue landfall site could potentially affect a greater area of coastal habitat at the shoreline, along the OECC within Lewis Bay, and along the OECC in northern Nantucket Sound. This OECC would also be approximately 4.8 miles (7.8 kilometers) longer.

- Landfall site construction method: Using HDD for construction would likely lead to fewer impacts than using conventional open-cut trenching. Vineyard Wind prefers open-cut trenching at the proposed New Hampshire Avenue landfall site.
- OECC route near Muskeget Channel: The OECC route may travel around (Eastern Muskeget Option) or through Muskeget Channel (Western Muskeget Option). The Eastern Muskeget Option is approximately 1.8 miles (2.9 kilometers) longer and contains more hard/complex bottom habitat than the Western Muskeget Option (COP Volumes I-III; Epsilon 2018a).
- Dredging and cable installation methods: Among the several methods proposed (see Construction and Installation of Offshore Components, below), the TSHD would likely cause greater impacts, both in the dredging corridor and in the spoils dumping areas, than would mass flow excavation. Likewise, Vineyard Wind might be able to accomplish cable burial with fewer impacts if jet plowing were the primary burial method used.

3.3.4.3. Impacts of Alternative A (Proposed Action) on Coastal Habitats

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with Project construction, operations, maintenance, and decommissioning.

Direct and Indirect Effects of Routine Activities

The sections below summarize the potential direct and indirect impacts of the Proposed Action on coastal habitats during the various phases of the Proposed Action. Direct impacts would include physical alteration or loss of coastal habitat. Indirect impacts would include changes to nearby areas that could eventually cause alteration of coastal habitat, (e.g., sedimentation).

Construction and Installation of Offshore Components

The process of cable laying and burial would affect seafloor coastal habitats along the OECC (see Figure 2.1-3). Although some of the OECC area is outside the 3-nautical-mile line that defines coastal habitat, cable installation and sand wave dredging along the entire OECC may directly affect up to 117 acres temporarily (0.47 km^2) in the maximum-case scenario, which includes the New Hampshire Avenue landfall site and the East Muskeget Option. Impact-generating factors during cable installation include vessel anchoring, dredging and cable burial, sediment suspended by the burial process, and the installation of rock or concrete protection.

Plans call for anchoring in Muskeget Channel and Lewis Bay, although anchoring may also occur anywhere along the OECC (COP Volume II; Epsilon 2018a). Anchors would leave a temporary mark on the seabed. The frequency of anchoring and extent of potential impacts are difficult to predict. If the proposed Project anchored upon any hard/complex bottom, eelgrass beds, or cobble-sponge beds, damage or destruction of that part of the habitat could result in **moderate** impacts. For those areas outside of SSU habitats, the proposed Project impacts would be **minor**. While the significance level of impacts would remain the same, BOEM could reduce potential impacts by requiring all vessels deploying anchors to use, whenever feasible and safe, mid-line anchor buoys to reduce the amount of anchor chain/line that touches the seafloor (see Appendix D). See Section 3.3.5 for a discussion on benthic habitat effects.

Cable burial would lead to a direct impact on coastal habitats. Where Vineyard Wind would install the cable over coarse substrates (shell aggregates, pebble-cobble, etc.), the coarser material would likely settle first and become covered by the finer sandy and silty materials that settle more slowly. Thus, the proposed Project would likely convert some surface area to a simpler surface of lower habitat value. At locations with large sand waves, dredging of the top 1 to 14 feet (0.5 to 4.5 meters) may be necessary. The maximum-case scenario of the immediate burial corridor through the use of dredging is proposed to affect up to approximately 69 acres (0.3 km^2) of bottom habitat. Considering the area affected in relation to the expanse of surrounding habitat, impacts would likely be **minor**.

Vineyard Wind has proposed several dredging techniques and cable burial methods that would be used in different portions of the OECC or in combination. TSHD would remove sediment using suction, store the sediment in a hopper, and dump the sediment in piles on the sea bottom at a different place within the OECC, several hundred yards away from the dredged area. Jetting, or mass flow excavation, uses water jets to push sediment aside, but this method is not able to remove as much sediment as a TSHD, which may be required on larger sand waves. For cable burial, jet plowing, which is a similar method, uses water pumped into the seabed to fluidize the bed and allow the cable to sink to the appropriate depth. Mechanical plowing would bury the cable behind a cutting edge that is pushed through the seabed. Mechanical trenching, which would be mostly used for coarser sediments, uses a rotating cutting tool to create a trench in which the cable can be installed and buried. Other possible installation techniques include using a blunt plow to push aside boulders and a special shallow-water tractor that crawls along the seafloor and uses one of the above tools to perform installation in areas that are too shallow for vessels (e.g., Lewis Bay) (COP Volume I, Section 4.2.3.3.2; Epsilon 2018a).

Although difficult to predict quantitatively, dredging and burial impacts would likely be minimized if the jet excavation and plowing methods were used, resulting in **minor** impacts. However, under the maximum-case scenario, dredging of up to 69 acres (0.3 km^2) would have a **moderate** impact. Dredging would involve removing the top of the (primarily sandy) seabed, moving the dredge vessel several hundred yards (meters) away, and dropping piles of the dredged material in a different place within the OECC (COP Volume III; Epsilon 2018a). In addition to the area covered by the main part of each dredge spoils pile, sedimentation is predicted to extend a considerable distance from the pile; deposition up to 0.8 inches (20 millimeters) may extend up to 0.5 miles (0.9 kilometers) from each disposal site and cover up to 34.6 acres (0.1 km^2) (Appendix III-A; Epsilon 2018a). Alternatively, jet excavation and/or jet plowing would minimize the movement of sediment outside of the immediate burial corridor, and thus would affect less area of coastal habitat along the OECC. A sediment disturbance model constructed for the Proposed Action indicated that sediment deposition greater than 0.04 inches (1 millimeter) would be mostly limited to within approximately 328 feet (100 meters) of the cable centerline (Appendix III-A; Epsilon 2018a). Deposition of 0.04 to 0.2 inches (1 to 5 millimeters) would probably have a **minor** impact on seafloor habitat, and deposition of lesser amounts would probably have a negligible impact on coastal habitats or organisms (Wilber et al. 2005). Deposition of 0.04 to 0.2 inches (1 to 5 millimeters) of sediment could potentially occur on up to 2,594 acres (10.5 km^2), while deposition of more than 0.2 inches (5 millimeters) would be limited to 101 acres (0.4 km^2). As a potential additional mitigation measure, BOEM could require that all dredging and cable installation activities use the least environmentally harmful method that would be effective in each area (see Appendix D). Even if jet excavation and plowing were the primary methods used, it is likely that dredging would still be required along a minority of the OECC (Epsilon 2018a).

Sedimentation of seagrass beds would negatively impact habitat quality, and any seagrass beds within approximately 328 feet (100 meters) of the cable centerline would be vulnerable; however, the closest seagrass bed is the Spindle Rock eelgrass bed and hard-bottom complex approximately 380 feet (100 meters) from the proposed OECC approaching the Covell's Beach landfall site (see Figure 1-4 in Epsilon 2018c). Because this habitat would lie just outside the predicted zone of significant sedimentation, the resulting impacts would be **negligible**. The OECC approaching the New Hampshire Avenue landfall site would proceed through Hyannis Harbor and Lewis Bay, where surveying for seagrass in July 2018 found no viable beds. Overall, sedimentation due to cable installation would likely result in **negligible** impacts, as currents within the Proposed Action area tend to redistribute sediments over time.

Vineyard Wind has conservatively assumed that up to 10 percent of the offshore export cable would require cable protection where proper cable burial depths are not achievable. Given that most of the seabed in and near the proposed OECC is flat sand and silt, the addition of rock or concrete protection atop sections of the buried cable would change the nature of the seabed habitat. Vineyard Wind estimates that up to 35 acres (0.1 km^2) of cable corridor within the OECC would need protection. By adding hard surfaces, vertical relief, and habitat complexity, such changes could lead to increases in faunal diversity (Langhamer 2012; Taormina et al. 2018). This conversion to rare hard-bottom habitat, and the increase in faunal diversity that is likely to result, would be considered a beneficial impact. However, if Vineyard Wind installed protection atop existing hard/complex bottom habitat, alteration of that portion of the habitat could occur; the change in habitat quality at any one of those sites might be positive or negative (Sheehan et al. 2018). In any case, there would likely be a period of reduced ecological function during installation and for some time afterward as the processes of colonization and succession occurred on the new substrate (*idem*). Considering that most of the proposed OECC lacks hard/complex bottom, it is likely that Vineyard Wind would add more hard-bottom area than would be damaged by protective installations. Thus, the hard protection aspect might result in a **minor beneficial** or **negligible** impact on coastal habitats.

Vineyard Wind has committed to performing post-construction monitoring for examining the disturbance of and recovery of coastal and benthic habitats (COP Appendix III-D; Epsilon 2018a) in the Proposed Action area. Although this would involve localized disturbances of the seafloor habitat, the results of this mitigation effort would provide an understanding the Proposed Action's effects, which would benefit future management of coastal resources in this area and could inform planning of other offshore developments.

The OECC route in the vicinity of Muskeget Channel may affect the level of impact. The Eastern Muskeget Option is approximately 1.8 miles (2.9 kilometers) longer and contains more hard/complex bottom habitat than the Western Muskeget Option; therefore, the effects on the hard/complex habitat within the Eastern Muskeget Option could result in **moderate** impacts while the use of the sandier Western Muskeget Option would likely result in **minor** impacts.

Construction and Installation of Onshore Components

The relevant onshore components include the landfall site(s) and the seaside Operations and Maintenance Facility in Vineyard Haven. Given that all of these onshore components would be located in and underneath areas that are already developed and are practically devoid of coastal habitat, the impacts of the onshore components on coastal habitats would likely be **negligible**.

However, the proposed Project could affect the New Hampshire Avenue landfall site during construction if conventional open-cut trenching were used instead of HDD (COP Volume III; Epsilon 2018a). Trenching would involve the temporally removal of approximately 1,500 square feet (140 m^2) of beach habitat and riprap. It is possible, but unlikely, that a failure of sedimentation control measures or other construction BMPs at this site could result in sedimentation of rocky shoreline habitat in the immediate vicinity. Spills of fluids from construction equipment also present a risk; Vineyard Wind would mitigate this risk by following BMPs designed to reduce the likelihood of a spill, and Vineyard Wind has prepared a spill response plan detailed in the COP Appendix I-A (Epsilon 2018a) to respond to such an event. After construction, Vineyard Wind would restore the site as closely as practicable to the original conditions, including replacement of submerged riprap/concrete seawall. Considering the marginal quality of the existing habitat at this site, and the proposed avoidance and mitigation measures, the Proposed Action is likely to have a **minor** impact on coastal habitat at this site if Vineyard Wind implemented the open-cut trenching method. If Vineyard Wind used HDD instead of trenching, potential impacts on coastal habitat at this site would likely be **negligible**; therefore, BOEM could reduce potential impacts of the Proposed Action by requiring the use of HDD at landfall sites as a condition of COP approval (see Section 2.2.1). If Vineyard Wind selected the Covell's Beach landfall site, onshore impacts on coastal habitat would be **negligible** because of the use of HDD to transition from offshore to onshore and avoid coastal habitats of Covell's Beach area.

Operations and Maintenance

Maintenance of the offshore export cables could have an impact on submerged coastal habitats if vessel anchoring, seafloor dredging, or the removal of scour protection were necessary to effect cable repairs. The effects would be similar in nature to initial cable installation, but would be smaller in physical extent.

The seaside Operations and Maintenance Facility in Vineyard Haven (see Section 2.1.1.2) is located in an area devoid of valuable coastal habitat, so no indirect impact would be likely in that area; therefore, BOEM expects impacts to be **negligible**. Vineyard Wind would typically accomplish maintenance and any necessary repairs at the landfall sites through manholes at the splice vaults; BOEM does not expect this to affect coastal habitats.

Decommissioning

As described in Section 2.1.1.3, Vineyard Wind would likely leave onshore facilities in place for future use. There are no plans to disturb the land surface near coastal habitats during the course of Proposed Action decommissioning. However, Vineyard Wind would remove scour protection and hard protection atop cables, and may remove the offshore export cable. This could have an impact on submerged coastal habitats when vessel anchoring, seafloor dredging, and the removal of scour protection are necessary. These impacts would likely be similar in nature, extent, and intensity to the impacts of cable installation.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. The foreseen activities and events that could affect this resource include corrective maintenance offshore, cable displacement or damage by vessel anchors or fishing gear, chemical spills offshore, severe weather and natural events, and terrorist attacks. These activities would generally require intense, temporary activity to address emergency conditions. Non-routine activities could also include accidental spills of fuel, lubricating oils, drilling mud if HDD is used, or other materials used inside equipment during construction, operations and maintenance, and decommissioning. Vineyard Wind's implementation of the draft Oil Spill Response Plan (COP Volume I; Epsilon 2018a) for the Proposed Action is anticipated to limit any effects of accidental spills to **minor** impacts.

Conclusion

Throughout the entire OECC, the Proposed Action could negatively affect up to 186 acres (0.75 km^2), and could positively affect up to 35 acres (0.1 km^2). In summary, BOEM's analysis presented above concludes the following:

- Vessel anchoring would result in **minor** to **moderate** impacts.
- Dredging and cable installation would result in **minor** to **moderate** impacts.
- The addition of hard protection might result in a **negligible** or **minor beneficial** impact.
- Cable landfall would result in **negligible** to **minor** impacts.

Considering the likely balance of potential beneficial and potential negative changes, the Proposed Action would likely result in net **negligible** impacts on coastal habitats, although **minor beneficial** or **minor negative** impacts could occur. Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above; however, doing so would not likely result in different impact ratings than those described above.

3.3.4.4. Impacts of Alternative B on Coastal Habitats

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

The only difference between Alternative B and the Proposed Action is that Alternative B does not permit the use of the New Hampshire Avenue landfall site. Under this alternative, all of the onshore components would be located in and underneath areas that are already developed for human use and are practically devoid of coastal habitat.

Cable installation within the final approach of the OECC leading to the Covell's Beach landfall site would likely generate few, if any, impacts on coastal habitat. Plans for cable installation within the remainder of the OECC under this alternative differ from those under the Proposed Action only in OECC location and length. The OECC would be approximately 4.8 miles (7.8 kilometers) shorter under Alternative B than under the maximum-case scenario of the Proposed Action using the New Hampshire Avenue landfall site. According to the results of the sediment dispersion model (Epsilon 2018a), deposition of 0.04 to 0.2 inches (1 to 5 millimeters) of sediment could potentially occur on up to 2,248 acres (9.1 km^2), while deposition of more than 0.2 inches (5 millimeters) would be limited to 91 acres (0.4 km^2) along the western OECC to the Covell's Beach landfall site. Although slightly reduced compared to the Proposed Action, the effects would remain measurable until the impacting agents were removed; therefore, impacts due to construction and installation of Alternative B would likely be **minor**.

Operations and Maintenance

The impacts due to operations and maintenance under this alternative would be the same as those under the Proposed Action.

Decommissioning

Vineyard Wind would likely remove the offshore export cable during the course of Project decommissioning. This could have an impact on submerged coastal habitats when vessel anchoring, seafloor dredging, and the removal of scour protection are necessary. These impacts would likely be similar in nature, extent, and intensity to the impacts of cable installation, and would be slightly less than under the maximum-case scenario within the Proposed Action.

Direct and Indirect Effects of Non-Routine Activities

The impacts due to non-routine activities under this alternative would be the same as those under the Proposed Action.

Conclusion

Alternative B, using the Covell's Beach landfall site and OECC, could negatively affect up to 160 acres (0.65 km^2), the extent of sedimentation and dredging. Under the maximum-case scenario for Alternative B OECC, Vineyard Wind estimates that up to 27 acres (0.1 km^2) of cable corridor within the OECC would need protection. This would be a lesser impact compared to the maximum-case scenario of the Proposed Action. Compared to the Proposed Action, making landfall under this alternative would result in **negligible** impacts. Sedimentation could affect the largest area, and would likely result in **minor** impacts. Considering the potential beneficial and potential negative changes, Alternative B seems most likely to result in **negligible** impacts on coastal habitats, although **minor beneficial** or **minor negative** impacts could occur.

3.3.4.5. Impacts of Impacts of Alternatives C, D, and E on Coastal Habitats

Alternatives C, D (including sub-alternatives D1 and D2), and E differ from the Proposed Action only within the WDA. Because the WDA lies offshore of any coastal habitat, the impacts on coastal habitat under these alternatives would be the same as those of the Proposed Action: likely **negligible**, but possibly **minor beneficial** or **minor negative.**

3.3.4.6. Impacts of Alternative F (No Action Alternative) on Coastal Habitats

As described in Section 3.3.4.1, coastal habitats are and will continue to be present in the study area under the No Action Alternative. Maintenance of existing public and private beaches, seawalls, roads, and public utilities will continue indefinitely. Outside of currently protected areas, the conversion of coastal natural areas to developed residential, commercial, and industrial uses is likely to continue.

If BOEM does not approve the proposed Project (either the Proposed Action or another action alternative), the above present and foreseeable actions are likely to continue. The conditions of coastal habitat resources would likely continue along their current trends.

3.3.4.7. Comparison of Alternatives for Coastal Habitats

Under Alternative B, the OECC would be approximately 4.8 miles (7.8 kilometers) shorter than under the maximum-case scenario under the Proposed Action (the New Hampshire Avenue landfall site), and would affect approximately 26 acres (40,469 m^2) less of coastal habitat. Furthermore, Alternative B would avoid negative impacts on coastal habitat at and above the shoreline, as HDD would be utilized.

Alternatives C, D, and E are identical to the Proposed Action with respect to coastal habitats.

Alternative F would entirely avoid the negative impacts and potential environmental benefits (e.g., the creation of new hard/complex bottom habitat in the form of rock cable protection) of the proposed Project, although other changes to coastal habitat may continue to occur.

3.3.4.8. Cumulative Impacts

The analysis area for coastal habitat includes the lands and waters within the seaward limit of the state's territorial sea to 100 feet landward of the first major land transportation route encountered (e.g., a road, highway, rail line). The cumulative impact analysis area includes all such areas that overlap the proposed Project area, plus a 1-mile buffer on all sides (see Appendix C, Figure C.1-5). Appendix C describes projects that could generate cumulative impacts on coastal habitats.

The past projects that have contributed impacts on coastal habitats near the Proposed Action area were mostly management plans for state waters of Massachusetts. These past projects have resulted in beneficial impacts along the shoreline and in Massachusetts's state waters.

Present factors that could contribute to cumulative impacts on coastal habitats include:

- Vessel traffic (especially anchoring), including commercial and recreational boating traffic and military use;
- Fishing activities using bottom trawls and dredge methods; and
- Commercial regulations for finfish, lobster, crab, and other shellfish implemented and enforced by either Massachusetts or local towns such as Barnstable and Yarmouth, depending on whether the fishery is within state or town waters.

Vessel traffic, especially anchoring, associated with commercial fishing and other boating traffic, along with the vessel traffic of the Proposed Action, would be the primary factor that could affect coastal habitat. However, vessel anchoring would be temporary and may be temporarily restricted. BOEM does not anticipate vessel traffic related to the Proposed Action to affect the commercial, recreational, or military traffic in the area. In addition, Vineyard Wind is working with the Massachusetts School for Marine Science and Technology, BOEM, and the National Marine Fisheries Service (NMFS) to develop coordination strategies with fisheries monitoring programs for pre- and post-construction activities (see COP Appendix III-D; Epsilon 2018a). Given the highly localized nature of each instance of anchoring, trawling, or dredge fishing, BOEM does not anticipate the cumulative impact of these activities to significantly increase the cumulative impacts on this resource. These ongoing factors in combination with the Proposed Action or Alternative B would likely lead to **minor** impacts.

The following proposed or reasonably foreseeable projects and factors (see Appendix C) could contribute to cumulative impacts on coastal habitats near the Proposed Action area:

- New undersea transmission lines, gas pipelines, and other submarine cables;
- Shoreline development projects;
- Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project;
- Sea level rise; and
- Ocean acidification.

Other offshore wind energy development projects (including all Tier 1 and Tier 2 projects) and associated port upgrades described in Appendix C, including the MCT, are outside of the geographic analysis area.

Undersea transmission lines, gas pipelines, and other submarine cables represent both past and potential future impacts. New lines of this type could lead to temporary disturbance of benthic habitat during installation and temporary sediment disturbance during installation and/or maintenance. However, all potential submarine lines and cables currently under consideration would lie outside the cumulative analysis area for the proposed Project; therefore, BOEM anticipates cumulative impacts associated with the Proposed Action or Alternative B in combination with these projects to be **negligible**.

Massachusetts regional planning commissions and towns could permit shoreline development projects, and residential, commercial, and industrial developments will likely continue due to population growth in the region. Such development could affect maritime forests, coastal wetlands, lagoons, beaches, and nearshore seagrass beds. Although most shoreline properties in the analysis area have already been developed, remaining natural areas on Muskeget Island, Chappaquiddick Island, and isolated areas near Yarmouth and Barnstable could potentially be developed in the future. The results of development may include temporary habitat loss, temporary or permanent sedimentation, and permanent habitat conversion. Although it is difficult to predict the level of these potential impacts until development plans are established, combined with the Proposed Action or Alternative B, they would likely be **minor** to **moderate**.

One proposed tidal energy project, the Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project, is adjacent to the OECC. Because the tidal energy project has not received permits, BOEM considers it speculative and addresses it in the cumulative analysis as not reasonably foreseeable (see Appendix C).

Increased sea level rise could negatively impact nesting and spawning sites of some animals by inundating the existing shoreline. Ocean acidification from increased carbon dioxide absorbed by the ocean may affect habitat availability; specifically, it may reduce the abundance and vitality of reef-building animals, including shellfish and worms, possibly leading to a decrease in the coverage of moderately complex seabed types.

3.3.4.9. Incomplete or Unavailable Information for Coastal Habitats

Information is incomplete regarding the extent of different seafloor habitat types, as well as the areas over which the Project would use different dredging and cable burial methods, and how Vineyard Wind would manage anchoring in light of sensitive seafloor habitats (but see COP Volume II-C Appendix A and Volume I Section 4.2.3.3.2; Epsilon 2018a). Nevertheless, Project engineers are reviewing recent mapping data to avoid hard/complex bottom to the greatest extent possible.

Although the above information was not available at the time of the preparation of this document, sufficient information exists to support the findings presented herein.

3.3.5. Benthic Resources

3.3.5.1. Description of the Affected Environment for Benthic Resources

This section describes benthic resources present within the WDA and the OECC other than demersal fishes and commercially important benthic invertebrates, which are covered in Section 3.3.6. See Section 3.3.4 for a discussion of nearshore coastal resources.

Benthic resources include the seafloor surface, the substrate, and the communities of bottom-dwelling organisms that live within these habitats. Benthic habitats include soft-bottom (i.e., unconsolidated sediments) and hard-bottom (e.g., cobble, rock, and ledge) substrates, as well as biogenic habitat (e.g., eelgrass, mussel beds, and worm tubes) created by structure-forming species. Benthic invertebrate communities found in these habitats are an essential part of marine ecosystems. They perform important functions such as water filtration and nutrient cycling, and are also a valuable food source for many species. The spatial and temporal variation in benthic prey organisms can affect the growth, survival, and population levels of fish and other organisms. Benthic organisms are commonly characterized by size (e.g., megafauna, macrofauna, or meiofauna). In soft-bottom habitats, these organisms are also characterized by whether they live on (epifauna) or within (infauna) the substrate (Rutecki et al. 2014).

Regional Setting

Detailed descriptions of regional characteristics are available in Appendix B. The proposed Project area is located within the greater Georges Bank area (though not part of the bank itself) of the U.S. Northeast Shelf Large Marine Ecosystem (Kaplan 2011). Table 4-7 in Guida et al. 2017 describes the seven benthic habitat types found in Georges Bank and the characteristic assemblages of each habitat type. Typical faunal assemblages in the region include polychaetes, crustaceans (particularly amphipods), mollusks (gastropods and bivalves), echinoderms (e.g., sand dollars, brittle stars, and sea cucumbers), and various other groups (e.g., sea squirts and burrowing anemones) (Guida et al. 2017). Guida et al. (2017) reported that amphipods and polychaetes numerically dominated infaunal communities in the MA WEA, while sand shrimp (*Crangon septemspinosa*) and sand dollars dominated benthic epifaunal assemblages. Grab samples taken in 2011 south of Cape Cod, in the vicinity of the proposed Project area, found abundant nut clams, polychaetes, and amphipods, as well as oligochaetes and nemertean ribbon worms (AECOM 2012). The region experiences strong seasonal variations in water temperature and phytoplankton concentrations (see Section 3.2.2), with corresponding seasonal changes in the densities of benthic organisms.

COP Sections 2.1.1.3 and 5.1.1 characterize the sediment types and benthic habitat in the region (Volume II; Epsilon 2018a). The seafloor in the proposed Project area is predominantly composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel. Local hydrodynamic conditions largely determine sediment types, with finer materials in low-current areas and coarser materials in high-current areas. Coarse glacial till is found in the high-current portions of Nantucket Sound. Coarser materials on the seafloor surface in the proposed Project area include gravel, cobble, and boulders, which are typically mixed with discontinuous patches of sand (COP Volume II, Section 2.1.1.3; Epsilon 2018a). Benthic faunal communities in the proposed Project area are typical for the region and vary according to habitat type along gradients in depth, hydrodynamic conditions, and substrate composition (COP Volume II, Section 5.1.1; Epsilon 2018a).

Project Area

The seafloor in the WDA is mostly flat and featureless soft-bottom habitat, interrupted by sand ripples and mega-ripples (COP Volume II, Table 3.2-2; Epsilon 2018a) as it slopes offshore to the south/southwest. Water depths range from 114.6 to 170.6 feet (35 to 52 meters). The sediment is homogenous, unconsolidated substrate dominated by fine sand and silt-sized sediments that become finer in deeper water (COP Volume II, Section 2.1.2.1; Epsilon 2018a). COP Figure 5.1-3 depicts primary habitat types within the WDA (COP Volume II; Epsilon 2018a). Vineyard Wind did not identify any hard-bottom habitat in the WDA. The NOAA Deep-Sea Coral Data Portal does not document any live-bottom habitat (e.g., living corals) or state-managed artificial reefs (considered unique or sensitive habitat) (NOAA 2018b), although the portal is presence-only (i.e., absence of coral in the portal is not a confirmed absence of coral; instead it may indicate that the area has not been surveyed for coral). COP Figure 6.5-1 (Volume III; Epsilon 2018a) indicates that there are no known deep-sea coral locations in the WDA, which Vineyard Wind has confirmed through benthic sampling (grabs and imagery) (COP Volume II-A, Appendix H; Epsilon 2018a).

The WDA is part of the Southern New England Shelf as described by Theroux and Wigley (1998), which has a higher biomass and density of benthic fauna than neighboring geographic areas such as the Gulf of Maine and Georges Bank. Video surveys of benthic epifauna from 2010 to 2013 found common sand dollars (*Echinarachnius parma*) to be one of the most abundant epifauna in the WDA, as well as hydrozoans, bryozoans, hermit crabs, euphausids, sea stars, and anemones (COP Volume III, Section 6.5.1.2; Epsilon 2018a). These fauna are all common in the Nantucket Shelf Region; therefore, the area is not a biologically unique area. New England Fishery Science Center (NEFSC) benthic trawls of the MA WEA from 2014 found 59 taxa, of which sand shrimp, sand dollars, pandalid shrimp, and monkey dung sponge were the most abundant species. Grab samples (which target infauna) from the same survey found polychaete worms and amphipod crustaceans dominated infaunal assemblages in the WDA (COP Volume III, Table 6.5-2 and Figure 6.5-4; Epsilon 2018a). A 2016 grab sample survey by ESS Group, Inc. targeting macroinvertebrates in the WDA found a mean density of 118,370 individuals per cubic meter, which consisted of polychaete worms, crustaceans, mollusks, echinoderms, nematode roundworms, and nemertean ribbon worms. More than 50 percent of individuals were nematode roundworms, lumbrinerid polychaetes (*Scoletoma* sp.), or paranoid polychaetes (Paraonidae) (COP Volume III, Section 6.5.1.2; Epsilon 2018a). The WDA is a subset of the greater MA WEA (addressed above), and Guida et al. (2017) further describes benthic communities within the MA WEA.

COP Figure 2.1-12 shows the water depths along the OECC. COP Table 2.1-5 and associated figures describe the geology and sediment characteristics (Volume II; Epsilon 2018a). Much of the OECC is unconsolidated sediment habitat with low complexity: approximately 67 percent of video transects found mostly flat sand/mud, sand waves, and biogenic structures, while 27 percent found pebble-cobble bottom and 24 percent found shell aggregate bottom (COP Volume II, Appendix H-3; Epsilon 2018a). COP Figures 5.1-2 and 2.1-11 map this habitat (Volume II; Epsilon 2018a). The OECC is largely within Nantucket Sound, which has lower-than-average invertebrate density compared to the rest of the Southern New England Shelf (Theroux and Wigley 1998). Soft-bottom grab sampling found 104 different macroinvertebrate families present, 99 percent of which came from four phyla: Arthropoda (amphipods, 30 percent), Annelida (polychaete worms, 27 percent), Mollusca (clams and snails, 25 percent), and Nematoda (round worms, 16 percent) (Normandeau 2017). Mean-calculated abundance per cubic meter was 17,015 individuals. Epifauna communities varied by habitat type; COP Table 5.1-4 provides a detailed habitat and species account by cable corridor (Volume II; Epsilon 2018a). Sand dollars and burrowing anemones dominate some soft-bottom areas, while amphipods, slipper limpets (*Crepidula fornicata*), whelks, sponges, polychaetes, and spider crabs dominate others.

Earlier surveys (2001-2005) in Nantucket Sound done for the Cape Wind project overlap with areas of the OECC; these surveys found communities were highly variable from sample-to-sample, likely due to numerous microhabitats. Presence or absence of sand waves was the largest determinant of macroinvertebrate abundance. More abundant fauna (mostly filter feeders such as mussels and bivalves) were found in the troughs between sand waves, with a lower density of mobile species (such as amphipods) on the waves themselves (USDOI MMS 2009).

Sections of the OECC in the vicinity of Muskeget Channel overlap with SSU habitat that consists of hard/complex seafloor. Hard/complex bottom is important habitat for attachment of sessile (immobile) organisms and increases community complexity. State-mapped hard/complex bottom is shown in COP Figure 5.2-1 and was compared with video surveys done for Vineyard Wind to identify habitat along OECC that may classify as SSU, mapped in COP Figures 5.2-2 and 5.2-3 (Volume II; Epsilon 2018a). There are approximately 3.7 to 4.4 linear miles of coarse deposits along the OECC in Muskeget Channel; sediment that is greater than 50 percent coarse material is considered hard/complex bottom (COP Volume II, Figure 5.2-2; Epsilon 2018a). The 2017 video surveys found pebble-cobble habitat with sponges in Muskeget Channel and slipper limpet reef south of Point Gammon. Observed hard-bottom habitat contained primarily sponges and bryozoans (COP Volume III, Section 6.5.1.4; Epsilon 2018a). Additional video surveys conducted in summer of 2018 documented abundant sulfur sponge in Muskeget Channel, as well as less frequent observations of bryozoans, sand sponge, invasive white tunicate, barnacles, bread crumb sponge, amphipods, moon snails, tube worms, and plume worms (COP Volume III Appendix H-5; Epsilon 2018a). The fourth-highest species richness (ten species) was in one of the Muskeget channel transects (composed of sand waves and pebble-cobble habitat), while the lowest species counts included four transects in the sand wave habitat of Muskeget Channel. No artificial reefs were found along the OECC.

The OECC must pass through the intertidal zone to reach landfall (although Vineyard Wind may use HDD to minimize impacts on intertidal areas). Vineyard Wind would use one of two landfall sites to connect the OECC to the onshore substation: Covell's Beach in Barnstable or New Hampshire Avenue in Yarmouth. Aerial eelgrass surveys show eelgrass beds on the eastern and western ends of Covell's Beach, but not along the OECC (COP Volume II, Figure 5.2-1; Epsilon 2018a). More recent (summer 2018) underwater transects within the OECC found a sparse to moderate distribution of eelgrass around Spindle Rock off of Covell's Beach, and very sparse isolated strands around Egg Island in Lewis Bay (COP Volume II, Section 5.2.2 and Appendix H-5; Epsilon 2018a). Vineyard Wind does not expect to encounter eelgrass beds in other portions of the cable route.

Aspects of Resource Potentially Affected

Benthic resources utilize different areas of the water column and seafloor habitat (e.g., soft bottom and/or hard bottom complex). The proposed-Project activities could possibly impact the habitat, abundance, diversity, community composition, and percent cover of benthic macrofauna and macroflora.

Current Condition and Trend

An understanding of how benthic resources are already changing is necessary for interpreting the results of potential future monitoring. There is limited data on trends within the WDA and OECC, though larger trends within coastal New England likely apply to the entire proposed Project area. Studies of the Atlantic Coast from 1990 to 2010 show endemic benthic invertebrates shifting their distribution northwards in response to rising water temperatures, resulting in changes to benthic community structure (Hale et al. 2016). Temperatures are predicted to continue to rise in the region (see Section 3.2.2), so this trend is likely to continue, leading to changes in the distributions of some species.

Historical data on Centerville Harbor, which includes the Covell's Beach landfall site, show a slow decline in eelgrass bed habitat since 1951 (MassDEP 2011). The New Hampshire Avenue site is located within Lewis Bay, which experienced significant decline in eelgrass bed habitat from 1951 to 2001 from 245 to 3.6 acres (1 to 0.01 km^2) (MassDEP 2011).

New England horseshoe crab stocks are in decline (ASMFC 2013). According to MA DMF (2016, 2018b), nesting horseshoe crabs use Covell's Beach and the west entrance to Lewis Bay beach from late spring to early summer. The New Hampshire Avenue site is not a spawning beach, but horseshoe crabs use the adjacent waters of Lewis Bay for overwintering and to stage for spawning (MA DMF 2018a).

3.3.5.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters (maximum-case scenario) that would influence the magnitude of the impact on benthic resources include the following and are discussed further in Appendix G:

- The route chosen for the OECC, which would determine the amount of SSU habitat affected by cable installation.
- The total amount of long-term habitat alteration from scour protection for the foundations, inter-array cables, and OECC.

- The total amount of habitat temporarily altered by installation method of the export cable in the OECC and for inter-array and inter-link cables in the WDA.
- The number and type of foundations used for the WTGs and ESPs. Vineyard Wind could construct a maximum of 100 WTGs and two ESPs using either monopile (10.3 meter) or four jacket piles (9.8-foot [3-meter] pins).
- The methods used for cable laying, as well as the types of vessels used and the amount of anchoring.
- The amount of pre-cable-laying dredging and its location.
- The time of year when foundation and cable installations occur. The greatest impact would occur if installation activities coincided during sensitive life stages for benthic organisms.
- The level of risk posed by non-routine events such as spills.
- The landfall site chosen and the associated nearshore benthic resources. The size and nature of impacts would likely differ for the two proposed landfall sites; the landfall site selected would also determine the route for the OECC as it approaches landfall.
- The landfall site construction method chosen. Using HDD for construction would likely lead to fewer impacts than using conventional open-cut trenching. Vineyard Wind prefers open-cut trenching at the proposed New Hampshire Avenue landfall site.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the path and total area of the OECC, the total number of WTGs and ESPs, and the amount of dredging needed. The extent of the impact would depend on the area and types of benthic habitat affected. The impact assessment analyzes the maximum-case scenario; any potential variances in the proposed-Project build-out as defined in the PDE (i.e., numbers and spacing of WTGs and ESPs, length of inter-array cable) or construction activities would result in lower impacts than described below.

3.3.5.3. Impacts of Alternative A (Proposed Action) on Benthic Resources

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with Proposed Action construction, operations and maintenance, and decommissioning.

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations and maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct impacts on benthic resources would include both temporary disturbance and permanent alteration of benthic habitat related to the Proposed Action. Installation of the WTG and ESP foundations and burial of the inter-array and inter-link cables within the WDA would likely result in localized mortality of non-mobile benthic fauna, either directly through crushing or indirectly through smothering by displaced sediment. Installation may also disturb fish or invertebrate eggs deposited on the sediment (i.e., demersal eggs). The degree of potential impact would vary seasonally depending on the life histories of benthic organisms. The WTGs, foundations, and associated scour protection would introduce more hard-bottom habitat to the area, which would likely be reversed during decommissioning. In areas where Vineyard Wind could not bury the cable to the target depth, rock or concrete cable protection would also alter bottom habitat. Heat and electromagnetic fields (EMFs) from transmission cables could affect some benthic organisms (Taormina et al. 2018; Normandeau et al. 2011). Use of anchoring vessels and jack-up barges during installation, maintenance, and decommissioning, as well as benthic sampling, would all result in habitat disturbance and impacts on benthic organisms. Adverse impacts on benthic fauna would include both mortality and sub-lethal effects from impact-producing factors, including habitat disturbance, turbidity, sedimentation, entrainment, noise, and EMF. Invertebrate organisms that colonize hard substrate would likely benefit from the "reef effect" of introducing hard substrate (e.g., foundations) to seafloor areas that are largely composed of unconsolidated sediments. Indirect impacts would include longer-term effects that may result from the Proposed Action.

Similar to within the WDA, cable burial procedures within the OECC (including dredging if necessary) would temporarily displace sediment. Any potential dredging that may occur as part of the installation would entail sidecast of dredge material (COP Volume I, Section 4.2.3.3.2; Epsilon 2018a). Cable armoring may be necessary, including in hard-bottom habitat. Anchoring of vessels or use of jack-up barges may occur during installation, maintenance, and/or decommissioning. Installation equipment uses water withdrawals, which can entrain planktonic benthic larvae (e.g., larval polychaetes, mollusks, and crustaceans; with assumed 100 percent mortality of entrained individuals) (COP Volume III, Section 6.5.2.1.3; Epsilon 2018a).

Vineyard Wind may use HDD or direct bury near landfall; the former would have the least impact on benthic resources. Onshore construction or increased nearshore boat traffic may impact intertidal benthic communities through noise disturbance, anchoring activities, or discharge/wastewater release. Although not considered benthic habitat, beaches may be used for spawning by benthic species such as horseshoe crab (*Limulus polyphemus*), and shoreline development could impact access to spawning areas but not impact the spawning beaches themselves (MA DMF 2016, 2018b).

Although some indirect impacts (e.g., localized predation on soft-bottom benthic invertebrates by fish species attracted to the structure provided by foundations) may result from Proposed Action activities, these impacts are not expected to result in measurable effects on the benthic resources. Therefore, any indirect impacts on benthic resources are expected to be **negligible**.

Construction and Installation of Offshore Components

Cable laying and foundation installation would result in the mortality of benthic organisms. Installation activities would result in direct mortality, injury, or displacement of benthic fauna in the direct path of construction. The maximum direct impact of the OECC is expected for the Western Muskeget Option to the New Hampshire Avenue landfall site, with a total area of 221 acres (approximately 0.9 km^2) disturbed (combining the impact of trench zones, skid tracks, dredging, anchoring, and cable protection; see Table 3.3.5-1 and Table 3.3.5-2). BOEM expects similar impacts in the WDA from foundation installation for the WTGs and ESPs, which Vineyard Wind would install by pile driving, and from the placement of scour protection at the foundations. The footprint of bottom disturbance, scour protection, and cable protection in the WDA and OECC are shown in Tables 3.3.5-1 and 3.3.5-2.

Table 3.3.5-1: Maximum Areas of Impact Predicted from Installation, Vessels, and Dredging

Bottom Disturbance Due to Installation, Jack-up Vessels, and Dredging	Maximum Area of Disturbance	
	Acres	km^2
Export Cables	117	0.47
Inter-link Cable	7	0.03
Inter-array Cables	204	0.83
Dredging [a]	69	0.28
Jack-up Vessels (WTG Installation)	65	0.26
Jack-up Vessels (ESP Installation)	0.3	0.001
Total in the WDA (Cables and Jack-up)	277	1.12
Total in the OECC (Cables and Dredging)	186	0.75

Source: Modified from COP Table 6.5-5 (Volume III; Epsilon 2018a).
ESP = electrical service platform; km^2 = square kilometers; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area; WTG = wind turbine generator
[a] Dredging prior to cable installation. The corridor with the maximum-case scenario of dredging is along the Western Muskeget Option, west through Muskeget Channel to New Hampshire Avenue landfall site. To avoid double-counting impacts, Vineyard Wind's total area of dredging disturbance does not include the 6.6-foot (2-meter) wide export cable.

Table 3.3.5-2: Maximum Areas of Impact Predicted from Cable Protection

Bottom Disturbance Due to Addition of Rock or Structures (Protection)	Total Area of Protection	
	Acres	km^2
WTG Foundations and Scour Protection	52	0.21
ESP Foundations and Scour Protection	1	0.01
Export Cables [a]	35	0.14
Inter-link Cable	2	0.01
Inter-array Cables	61	0.25
Total Scour and Cable Protection in the WDA	117	0.47
Total Cable Protection along the OECC	35	0.14

Source: Modified from COP Table 6.5-5 (Volume III; Epsilon 2018a).
km^2 = square kilometers; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area
[a] Maximum length of export cable includes the length for both export cables to be installed within the corridor.

Cable laying and construction would also result in the resuspension and nearby deposition of sediments. In areas where displaced sediment is thick enough, organisms may be smothered, which would result in mortality. Benthic organisms' tolerance to being covered by sediment (sedimentation) varies among species. The sensitivity threshold for demersal eggs (such as fish or squid eggs) is sediment deposition greater than 0.04 inches (1 millimeter); the sensitivity threshold for shellfish is deposition greater than 0.79 inches (20 millimeters) (COP Volume III, Section 6.5.2.1.3; Epsilon 2018a). Certain benthic species, such as corals, may have an even lower sensitivity threshold to sedimentation. Corals have not been reported within the WDA, although the non-reef forming Star Coral (*Astrangia poculata*) is known to occur in the region (COP Volume III, Section 6.5.2.1.3; Epsilon 2018a). Modeling of cable installation predicts that a maximum of 329 acres (1.33 km^2) would exceed the 0.04 inches (1 millimeter) deposition threshold, and that 36 acres (0.14 km^2) would exceed the 0.79 inches (20 millimeters) threshold (see Table 1-5 in Epsilon 2018c). Sedimentation would only exceed 0.79 inches (20 millimeters) due to dredging via TSHD, which Vineyard Wind would only use on mobile sand waves. Deposition over 0.04 inches (1 millimeter) would mostly occur within 260 to 330 feet (79 to 101 meters) of the route centerline (COP Volume III, Section 5.5.2.1; Epsilon 2018a), so the impact on benthic habitat would be limited spatially to the vicinity of the cable corridor. BOEM expects unavoidable, **moderate** impacts on benthic resources from construction and cable laying. Despite unavoidable mortality, damage, or displacement of invertebrate organisms, the area affected by the construction footprint in the WDA (394 acres [1.6 km^2]) would be just 0.5 percent of the WDA (75,614 acres [306 km^2]). BOEM does not expect population-level impacts on benthic species (i.e., generally accepted ecological and fisheries methods would be unable to detect a change in population, which is the number of individuals of a particular species that live within the Project area) as a result of the Project. Benthic fauna would recolonize disturbed areas that have not been displaced by Proposed Action structures. While the significance level of impacts would remain the same, BOEM could monitor potential impacts on benthic resources by implementing mitigation measure of monitoring initiatives to ensure documentation of potential effects (see Appendix D). Other mitigation measures were considered (e.g., time-of-year restrictions); however, time-of-year restrictions on cable laying and burial may not be warranted in light of an existing determination that up to 81 trawling vessels in a single month in a single statistical area had no effect on squid EFH (NMFS 2011).

The benthic resources of Lewis Bay are of particular concern due to their value to neighboring communities. Cable laying would disturb about 1.7 acres (2.7 km^2) of seafloor in Lewis Bay even though there would be no dredging within the bay (see Table 10-3 in Epsilon 2018c). Due to the shallowness of Lewis Bay, it may not be possible to use dynamic positioning vessels, requiring the use of anchoring instead. Because direct effects to benthic habitat from cable laying in the Bay would be unavoidable, BOEM expects **moderate** impacts on benthic resources. However, the footprint of disturbance to Lewis Bay would be limited and short-term, and BOEM anticipates full recovery of benthic resources. As a condition of COP approval, BOEM could reduce potential impacts by requiring all vessels deploying anchors to use mid-line anchor buoys whenever feasible and safe to reduce the amount of anchor chain/line that touches the seafloor (see Appendix D). Impacts on specific species may depend on the time of year the activity is conducted. For example, horseshoe crabs overwinter in the Bay and could be impacted by winter cable laying. Time-of-year restrictions for Lewis Bay would minimize potential impacts on horseshoe crabs and shellfish such as bay scallop, which spawn during spring and summer months. BOEM could reduce potential impacts by requiring time-of-year restrictions for these species, which would protect the spawning period, larval settlement, and juvenile development of winter flounder as well as adult horseshoe crabs staging to spawn. BOEM could implement a time-of-year restriction on all in-water work within Lewis Bay from January 15 to June 30. Additional time-of-year restrictions could be required to protect shellfish spawning and settlement within Lewis Bay. Combined shellfish time-of-year restrictions covering all identified species would extend the time-of-year restriction for the Lewis Bay portion of the Project to September 30 to protect bay scallops from the spawning through larval settlement phases. See Section 3.3.6 for discussion specific to commercially important species such as winter flounder.

Offshore construction could also cause adverse impacts on benthic communities from loss or conversion of habitat. Based on Proposed Action activities described in the COP, Vineyard Wind would avoid all eelgrass and there is no unavoidable SSU at either landfall site (COP Volume III, Epsilon 2018a; Sections 1.3.1.2 and 1.4.1.3 in Epsilon 2018c). Complex bottom in the form of sand waves is present through much of the OECC; however, loss of sand waves from dredging would be temporary given that sand waves are changing, mobile features. Cable installation would avoid hard-bottom habitat when possible, although hard bottom and complex bottom extend the full width of possible routes between Martha's Vineyard and Nantucket Island and cannot be entirely avoided (COP Volume II, Section 5.2.1; Epsilon 2018a). The maximum total area of hard/complex bottom and rugged seafloor that exists within the installation corridor in Muskeget Channel ranges from approximately 2,003 acres (8.1 km^2) if using the Eastern Muskeget Option to 2,022 acres (8.2 km^2) if selecting the Western Muskeget Option (see Table 1-3 in Epsilon 2018c). Installation would only affect a small subset of this area, no greater than the expected areas of impact described in Tables 3.3.5-1 and 3.3.5-2 (the maximum area of cable armoring is for the entire OECC; therefore, the amount Vineyard Wind would use in Muskeget Channel would be smaller). COP Figure 5.2-2 depicts the location of hard-bottom habitat within the two options through Muskeget Channel, demonstrating that only portions of the corridor have hard-bottom that extends the width of the corridor (where crossing hard-bottom would be required) (COP Volume II; Epsilon 2018a). The final cable alignment would determine the exact impacted area. See COP Volume III, Appendix H-5 (Epsilon 2018a) for more information in Muskeget Channel.

Cable protection and scour protection on the WTG and ESP foundations would result in long-term alteration to benthic habitat because these structures would be in place for the duration of the Proposed Action. Vineyard Wind has selected rock placement, or "rock dumps," as the primary cable protection for larger areas needing protection. This type of armoring can cause beneficial impacts by serving as hard-bottom habitat, and in particular can act as attachment sites for sessile benthic fauna (Epsilon 2018c; Section 4.3.1.4 in Epsilon 2018b). Vineyard Wind has conservatively estimated that a maximum of 10 percent of total cables routes would require protection through the use of rock armoring or concrete mattresses. The OECC could require protection along a maximum of 9.8 miles (15.8 kilometers) of the corridor, resulting in 35 acres (141,640.5 m^2) of cable protection; the inter-array and inter-link cables could require a maximum of 17.7 miles (28.5 kilometers) of protection, resulting in 63 acres of protection (see Tables 3.3.5-1 and 3.3.5-2). Cable protection would primarily be needed where the cable cannot be laid deep enough, which is likely to be in hard-bottom habitat: the addition of rock dumps would alter these areas but ultimately still provide a form of hard-bottom habitat (COP Volume III, Section 5.3.2.1.4; Epsilon 2018a). Most of the WDA is soft bottom, so WTG and ESP foundation scour and cable protection (117 acres) would result in a conversion of 0.15 percent of the WDA from soft-bottom habitat to hard-bottom habitat. With self-imposed impact reduction measures in place (described in COP Volume III, Section 6.5.2.1.5; Epsilon 2018a) and additional proposed mitigation measures (described in Chapter 2) to limit the impact on sensitive habitats, BOEM anticipates **moderate** impacts due to long-term habitat alteration. The conversion of soft-bottom habitat to new hard bottom would be unavoidable, but this effect would be localized and should not have a population-level adverse impact on soft bottom communities, while hard bottom communities could increase from the additional substrate.

Increased turbidity in the immediate area could have an adverse impact on filter-feeding fauna such as bivalves. Most of the corridor is coarse-grained sediment that would settle out of the water column quickly, making increased turbidity brief (Epsilon 2018b). Section 3.2.2 describes the impact on water quality due to increased turbidity, which BOEM predicts would be brief and **minor**. The impact of turbidity on benthic fauna depends on both concentration of suspended sediment and the duration of exposure (Epsilon 2018b). For example, mollusk eggs do not experience sub-lethal effects until an exposure of 200 mg/L for 12 hours; for other life stages, 24 hours of exposure is the minimum threshold for sub-lethal effects (Wilber and Clarke 2001). Modeling done for Vineyard Wind (COP Volume III, Appendix A; Epsilon 2018a) predicts that suspended sediment should usually settle well before 12 hours have elapsed; therefore, BOEM expects **minor** impacts from increased turbidity (separate from the impact of sediment deposition).

Vineyard Wind would use jet plow and mechanical plow for cable burial (see Section 1.4.1.1 in Epsilon 2018c). Hydraulic jet plowing uses water withdrawals that can entrain benthic larvae (USDOI MMS 2009). An estimated 450 to 1,200 million gallons (1703 to 4542 million liters) of water would be withdrawn during cable installation (COP Volume III; Epsilon 2018a). If the Proposed Action is approved, cable laying and pre-cable laying activities are anticipated to occur in the spring (Rachel Patcher, Pers. Comm., August 14, 2018), which would overlap with the spawning season of a number of benthic invertebrates and fish that lay demersal eggs, including commercially important species described in Section 3.3.6. **Moderate** impacts could result from the unavoidable entrainment of benthic organisms or their planktonic larvae during cable installation using the hydraulic jet plow. Due to the limited time and area involved, BOEM does not expect population-level impacts on any given species.

BOEM does not anticipate routine vessel discharges during construction and installation to have negative impacts on benthic resources. BOEM expects these discharges to have limited impacts on water quality, with any measureable effects likely contained to surface waters. Therefore, BOEM does not anticipate impacts on benthic resources. Section 3.2.2 describes water quality and self-imposed impact reduction measures related to vessel use.

Benthic recovery processes are relevant to understanding the likely duration of impacts to benthos. Neighboring benthic communities that have similar habitats and assemblages would recolonize disturbed areas. The restoration of marine soft sediment habitats occurs through a range of physical (e.g. currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003a). Impacts and recovery times would vary depending on habitat types, which can generally be separated into the high-energy oceanic environment versus the low-energy estuarine environment. In general, physical processes are more important in high-energy environments, while biological processes dominant in low-energy ones. In high-energy environments, repopulation can often be largely attributed to bedload transport of adult and juvenile organisms. Restoration of invertebrate communities in low-energy environments is more dependent upon larval settlement and recruitment and adult migration. Therefore, rates of recolonization and succession can vary considerably among benthic communities.

Full recovery of the benthos would likely require several months to a year or more (Dernie et al. 2003b; Lewis et al. 2002, 2003). Recovery to a pre-construction state may take 2 to 4 years (Van Dalfsen and Essink 2001). Fauna in dynamic environments such as Nantucket Sound are prone to natural sediment movement and deposition due to strong tidal currents and waves. Therefore, they are able to recover from disturbances more rapidly. Assemblages in sandy areas recover more rapidly (sometimes within 100 days of the disturbance) than muddy/sandy areas (Elliott et al. 2017). Benthic meiofauna are known to recover from sediment disturbances more rapidly than the macrobenthos; recolonization up to pre-disturbance densities has occurred within weeks or less, and entire assemblages have recovered within 90 days (USDOI MMS 2009). A benthic monitoring plan is outlined in Attachment D of the Vineyard Wind Supplemental Draft EIS (Epsilon 2018c), including a pre-construction survey and post-construction surveys for years 1, 3, and (potentially) 5, which would allow monitoring and assessment of benthic recovery in the WDA and along the OECC. Despite benthic mortality and temporary or permanent habitat alteration, BOEM expects the overall long-term impact of construction and installation on benthic communities in the WDA and OECC to be **minor** to **moderate**. BOEM could reduce potential impacts of construction to **minor** by requiring the following mitigation measures as a condition of COP approval (see Appendix D): (1) adaptive management involving refinement of exclusion zones, and (2) long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations and other benthic areas disturbed by the proposed Project, including the movement of and habitat use of protected species. See COP Table 4.2-1 for measures that Vineyard Wind's would implement to reduce potential impacts on benthic resources (Volume III; Epsilon 2018a).

Port upgrades to support the development of the offshore wind energy industry are likely to occur. At this time, BOEM lacks the information necessary to perform a detailed indirect impact assessment of the modifications to and potential operations out of Vineyard Haven. However, BOEM expects minimal potential impacts on benthic resources from this port if current regulations regarding construction and vessel discharges are followed. See Appendix C for additional information on port upgrades.

Construction and Installation of Onshore Project Components

Vineyard Wind may use either direct bury or HDD to make the transition from the OECC to the onshore substation at the New Hampshire Avenue site and HDD at the Covell's Beach site. Both transition method would have **negligible** impacts on nearshore benthic habitats because the New Hampshire Avenue site is largely manmade and HDD at Covell's Beach would minimize effects to benthic habitats.

Operations and Maintenance of Offshore Components

Once Vineyard Wind has completed construction, the presence of the WTG and ESP foundations would result in some alteration of local water currents, which could produce scouring of the sediment and alter benthic habitat. These effects, if present, would exist for the duration of the Proposed Action and would be reversed only after the Project has been decommissioned. Indirect effects caused by scour could be mitigated by the addition of scour protection (COP Volume I, Section 4.2.3.2; Epsilon 2018a), which would not only protect the foundations, but also minimize the effect on local sediment transport. Vineyard Wind would prepare pre-construction and post-construction surveys, and would conduct inspections during the life of the Proposed Action to ensure adequate scour protection around the foundations. Even without scour protection, minimal scour is predicted in the WDA due to fine sediments and low velocity currents, which modeling estimates at under 0.7 feet (0.2 meters) per second (COP Volume II, Section 3.2.2; Epsilon 2018a). COP Appendix III-K details modeling of anticipated scour in the WDA (Volume II; Epsilon 2018a). With scour protection in place, the impact of scouring on benthic resources should be **minor**.

BOEM does not anticipate negative impacts on benthic resources from routine vessel use for operations and maintenance. Vineyard Wind would avoid anchoring whenever possible and, if used, impacts on the seafloor would be temporary and localized. A predicted maximum of 887 round trips would be necessary per year, considerably less than during construction. Maintenance may require uncovering of cables or foundations, generating disturbances similar to during construction, but substantially more limited in area. Overall, BOEM anticipates **minor** impacts from routine operations and maintenance.

During the operations and maintenance phase of the Proposed Action, powered transmission cables would produce EMF and heat (Taormina et al. 2018). The Proposed Action description cites measures to mitigate these impacts. To minimize EMF generated by cables, all cabling would be contained in grounded metallic shielding to prevent detectable direct electric fields. Vineyard Wind would also bury cables to a target burial depth of approximately 6.6 feet (2 meters) below the surface, well below the aerobic sediment layer where most benthic infauna live. The scientific literature provides some evidence of faunal responses to EMF by marine invertebrates, including crustaceans and mollusks (Taormina et al. 2018; Normandeau et al. 2011). The consequences of this apparent detection of EMF have not been well studied in invertebrates. Based on the shielding employed and the burial depth of the cables, however, BOEM expects **negligible** impacts related to powered transmission cables.

Operations and Maintenance of Onshore Project Components

The primary mechanism through which onshore operations may affect benthic resources would be through negatively impacting water quality in nearshore waters. Section 3.2.2 delineates impacts on water quality. BOEM expects onshore operations and maintenance to have a **negligible** effect on benthic resources.

Decommissioning

Vineyard Wind would complete decommissioning within 2 years of lease termination, and it would be the reverse of the installation process, restoring the seafloor to its original state. Decommissioning of WTGs and ESPs would involve dismantling and removing them, and cutting the monopile and/or jacket foundations below the seabed, following BOEM's removal standards (30 CFR § 250.913) (COP Volume I, Section 4.4.3; Epsilon 2018a).

The entire offshore cable system and cable protection may be removed during decommissioning. Removing the cables would have a similar impact as the installation process, both in the temporary disturbance to habitat and the mortality to benthic fauna that have recolonized the area. Removal of rock and concrete mattresses from cable and scour protection could be viewed as detrimental since it would involve removing any hard-bottom communities that would have been established over the previous 30 years. However, removal of cables would return the benthic environment to its previous soft-bottom community despite the temporary impacts due to the removal process. Information gained on benthic recovery from post-construction monitoring by Vineyard Wind may potentially be used to inform decommissioning procedures and assist Vineyard Wind in selecting the least impactful method(s). A literature review by Latham et al. (2017) found that full recovery of benthic habitats following decommissioning of offshore wind facilities usually takes between 3 months to 2.5 years. Thus, the overall impact of decommissioning is anticipated to be **minor** and short-term.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. Non-routine activities that could impact benthic resources include large-scale corrective maintenance that would require exposing the cable or foundations for maintenance, or require extensive anchoring. This would require the same tools used in installation and would have similar impacts via disturbance to the seafloor (e.g., direct mortality, sedimentation). However, the disturbance would not exceed that caused by the initial installation, and the impacted area should be substantially smaller. Due to the brief duration and limited area, BOEM expects **minor** impacts.

Non-routine events such as oil or chemical spills can have adverse or lethal effects on marine life. However, modeling by Bejarano et al. (2013) predicts that the impact of smaller spills on benthic fauna would be low. Spills are expected to occur at the surface, and impacts on the water column would be mostly limited to the surface-mixed layer, or approximately 33 feet (10 meters). Oils in particular tend to stay at the surface, and other chemicals are predicted to dilute to non-toxic levels before they would reach benthic fauna. Small spills should therefore have a **negligible** impact on benthic fauna. Larger spills are unlikely, but could have a **moderate** impact on benthic fauna due to negative effects on water quality (Section 3.2.2.2).

Conclusion

BOEM anticipates that the following direct benthic impacts including long-term habitat alteration due to activities of the Proposed Action:

- **Minor** to **moderate** overall Proposed Action impacts on benthic resources. Impacts would include physical disturbance of soft sediments and habitat conversion from soft to hard substrate. Direct mortality, damage, or displacement of invertebrate organisms would result from cable placement, WTG installations, and vessel anchoring and positioning; however, the extent of this impact is small in comparison to the total available habitat in the area. Removal of structures during decommissioning would have similar impacts. Nonetheless, these impacts would be local and transient, and BOEM expects complete recovery of habitats and communities. Implementing adaptive management techniques in combination with benthic monitoring could reduce impacts to **minor**.
- **Minor** to **moderate** sedimentation impacts on benthic resources from Proposed Action activities.
- **Moderate** impact on benthic resources due to habitat conversion with Vineyard Wind's self-imposed impact reduction measures in place (such as avoidance of SSU habitats when possible and minimizing dredging). Soft-bottom habitat is abundant in the WDA and the loss of a small amount of it and conversion to hard-bottom habitat may be **beneficial** to some benthic assemblages.
- **Minor** impacts from scouring on benthic habitats.
- **Minor** impacts due to turbidity, which would be brief and below levels of concern.
- **Minor** to **moderate** impacts from entrainment due to jet plowing.
- **Negligible** to **minor** impacts from vessel activity throughout the Proposed Action due to the expected **minor** impact on water quality.
- **Negligible** impacts due to small-scale oil or chemical spills, while larger spills may have **moderate** impact.
- **Moderate beneficial** impacts on hard bottom invertebrate communities could occur due to the increase in hard surfaces these communities require. The surfaces of WTG foundations would provide substrate to support hard bottom benthic communities in a region of the OCS where little such habitat exists.

Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

3.3.5.4. Impacts of Alternative B on Benthic Resources

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

Offshore impacts of Alternative B should be the same as, or less than, those of the Proposed Action. Vineyard Wind would use the same construction and installation methods, and the maximum cable length would not exceed that already described in the Proposed Action. Impacts from sedimentation, turbidity, entrainment, and scouring would be the same as, or less than, those from the Proposed Action as the Covell's Beach landfall site is shorter than New Hampshire Avenue.

Alternative B completely avoids Lewis Bay. Vineyard Wind would use HDD, which has **negligible** impacts on benthic habitats, to make the transition at Covell's Beach. The proposed Project's shore-landfall window for the export cable is anticipated to be from early April to mid-October (see Section 5.3.1 in Epsilon 2018c), and onshore construction would be restricted from June through September (unless authorized by Barnstable). Therefore, the potential exists during May for the landfall transition to overlap with the spawning season for horseshoe crabs. Horseshoe crabs use Covell's Beach as a spawning site (Section 3.3.5.1) and if there is temporal overlap, there may be **minor**, localized impacts on their spawning as the spawning beaches themselves are not anticipated to be impacted. BOEM could further reduce potential impacts by restricting work in the nearshore and shoreline areas of Covell's Beach from May 1 to July 31, which would protect horseshoe crab eggs, larvae, and newly settled juveniles (see Appendix D). This time-of-year restriction would also protect adult horseshoe crabs that are in the area to spawn. With these measures in place, BOEM anticipates **negligible impacts on benthic habitats** from the landfall transition to Covell's Beach. Other mitigation measures identified for the Proposed Action would also be applicable to this alternative.

Operations and Maintenance

Operations and maintenance for Alternative B would be the same as for the Proposed Action. With appropriate self-imposed measures in place by Vineyard Wind (i.e., restrictions on vessel discharges, avoidance of anchoring in sensitive habitats), vessel use and routine maintenance would have the same, **minor** impact on benthic habitats.

Decommissioning

Decommissioning of Alternative B would be mostly identical to that of the Proposed Action. Depending on the time of year, there may be a **minor** impact on horseshoe crabs during decommissioning of onshore and nearshore facilities, unless they are retired in place. Overall, BOEM anticipates the same **minor** impact on benthic resources.

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impact as in the Proposed Action. The exception is if corrective maintenance (i.e., cable repairs) were necessary for the landfall transition to Covell's Beach, which could result in a **minor** impact on spawning horseshoe crabs.

Oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

The impact of Alternative B on benthic resources would be the same as, or less than, the predicted impact of the Proposed Action:

- Offshore impacts would be identical to those of the Proposed Action.
- Nearshore impacts would differ in that Vineyard Wind is only considering HDD for the landfall transition, which would have a **negligible** impact.
- There may be a **minor** impact on spawning horseshoe crabs if there is temporal overlap with construction or maintenance activities near or on Covell's Beach; time-of-year restrictions would reduce this impact to **negligible**.
- The risk posed by oil or chemical spills would be identical to that of the Proposed Action (**negligible** for small spills, **moderate** for larger spills).

3.3.5.5. Impacts of Alternative C on Benthic Resources

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction and Installation

The only relevant change from the Proposed Action in Alternative C is the relocation of six WTGs and their inter-array cables within the WDA to the southern portion of the WDA. The surface sediment of the WDA is soft bottom with sand waves, though there are some coarser-grained sediments below the surface at depths of 60 feet (18 meters) or greater, mostly in the southwestern end of the WDA (COP Volume III; Epsilon 2018a). The character of the sediment changes throughout the WDA; depths greater than 98.4 feet (30 meters) are predominantly fine sand with some silt, and generally become finer grained as depth increases. Figure 1 in COP Appendix F (Volume II; Epsilon 2018a) depicts the trend of decreasing water depth from north to south. The northernmost point of the WDA is approximately 118 feet (36 meters) deep, while parts of the southern end of the WDA reach approximately 164 feet (50 meters) deep. Both depth and sediment type are characters that influence benthic assemblages; it is therefore possible that the relocation of the WTGs to the southern WDA would affect slightly different benthic communities (although with overall similar composition) than they would for the Proposed Action (COP Volume II, Appendices H-3 and H-5; Epsilon 2018a). However, the impact on these communities is not anticipated to exceed the impact in the Proposed Action given that all construction methods would be the same, and there is no evidence that the assemblages found in the southern WDA are of greater ecological importance than assemblages in the northern WDA. Ultimately, the relocation of the WTGs would result in differences in the communities affected and habitat altered, but the overall level of impact (generally **minor**) from each impacting factor is anticipated to be the same as in the Proposed Action.

Operations and Maintenance

Operations and maintenance of Alternative C would be identical to those of the Proposed Action (although the communities affected may be different) and would have the same **minor** impact on benthic resources.

Decommissioning

Decommissioning of Alternative C would be identical to that of the Proposed Action (although the communities affected may be different) and would have the same **minor** impact on benthic resources.

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impact as in the Proposed Action. Oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

The impact of Alternative C on benthic resources would be the same as the predicted impact of the Proposed Action for both routine and non-routine activities. The relocation of the WTGs would likely result in different benthic communities and habitats being affected by proposed Project activities. Additional surveys may be required to determine the new WTG and inter-array cable locations and thus the exact benthic communities and habitats affected. The impact of additional surveys on benthic resources should be **negligible** given that there is no anticipated impact on water quality (Section 3.2.2) and anchoring would be limited.

3.3.5.6. Impacts of Alternative D1 and D2 on Benthic Resources

Incremental Contribution of Alternative D1 and D2

The only relevant change for Alternative D1 from the Proposed Action would be the location of the WTGs and inter-array cables, which would be spaced to a minimum of 1 nautical mile apart. The only relevant change of Alternative D2 from the Proposed Action would be the arrangement of the WTGs and inter-array cables within the WDA.

Direct and Indirect Effects of Routine Activities

Construction and Installation

As described in Section 3.3.5.5, sediment character and water depth change throughout the WDA (though in general, the entire WDA is soft-bottom habitat with sand waves) and, given the importance of microhabitat characteristics for benthic assemblages (Section 3.3.5.1), changing the placement of the WTGs may result in slightly different soft bottom benthic communities being impacted than in the Proposed Action.

It is unlikely that the Proposed Action would use the maximum amount of inter-array cable identified in the maximum-case scenario; therefore, Alternatives D1 and D2 would use more inter-array cable (because of the wider spacing of WTGs) than the Proposed Action and may have a greater footprint on benthic resources (due to bottom disturbance). However, cable lengths for Alternatives D1 and D2 would not exceed the maximum-case scenario for the Proposed Action and the degree of impact on benthic communities, and the overall impact of Alternatives D1 and D2 on benthic resources should still be **minor**. Prior to construction, additional surveys (necessary to determine the new WTG placements) may result in a small, temporary increase in vessel use and bottom disturbance unaccounted for in the Proposed Action. BOEM anticipates that this disturbance would be brief and localized, particularly compared to other proposed-Project activities, and have **negligible** impacts.

Operations and Maintenance

Operations and maintenance of Alternatives D1 and D2 would be identical to those of the Proposed Action (although the communities affected may be different) and should have the same **minor** impact on benthic resources.

Decommissioning

Decommissioning of Alternatives D1 and D2 would be identical to that of the Proposed Action (although the communities affected may be different) and would have the same **minor** impact on benthic resources.

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impact as in the Proposed Action. Alternatives D1 and D2 are intended to improve vessel movement through the proposed Project area, which may reduce the likelihood of spills. Should they occur, oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

The impact of Alternatives D1 and D2 on benthic resources would be the same as the predicted impact of the Proposed Action for both routine and non-routine activities. The relocation of the WTGs would likely result in slightly different benthic communities and habitats being affected by proposed Project activities, and the additional surveys required should have a **negligible** impact on benthic resources.

3.3.5.7. Impacts of Alternative E on Benthic Resources

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and Installation

Construction methods would be identical to those for the Proposed Action, but the proposed Project footprint should be considerably less due to the reduced number of WTGs and associated inter-array cabling. By using 84 of the potential 106 turbine placements proposed by Vineyard Wind, Alternative E would impact only a subset of the local benthic communities within the WDA. The maximum footprint of the WTG and ESP foundations and associated scour protection would be approximately 45 acres (0.2 km^2), which is an 8-acre (32,375-m^2) reduction (7.0 percent) in comparison to the Proposed Action. In actuality, the maximum footprint would likely be slightly smaller, since there would be a reduced amount of inter-array cabling and presumably a reduction in the necessary amount of cable protection within the WDA. Alternative E would likely result in a reduced construction and installation footprint given the fewer number of WTGs to be installed, and would require less use of jack-up vessels and other impactful equipment. BOEM cannot at this time calculate the magnitude of reduction; however, impacts would be less than the Proposed Action as the maximum-case scenario has been assumed. BOEM does not anticipate that this change would have a greater adverse impact than the impact on the benthic communities that would result from the Proposed Action.

The impact of each of the impact-producing factors of Alternative E (the same as those described for the Proposed Action) would be the same as or less than they would be for the Proposed Action. Therefore the impacts of installation for Alternative E would be overall **minor**, with a reduced maximum footprint relative to the Proposed Action. Mitigation measures identified above would also be applicable to this alternative.

Operations and Maintenance

Operations and maintenance of Alternative E would be identical to those of the Proposed Action, except fewer WTGs may result in less routine vessel use and preventative maintenance during the life of the proposed Project. Overall, it should have the same **minor** impact on benthic resources.

Decommissioning

Decommissioning of Alternative E would be identical to that of the Proposed Action, aside from the reduction in the proposed Project footprint described under Construction and Installation. Therefore, it should have a **minor** impact on benthic resources with fewer WTGs to remove.

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impact as in the Proposed Action. The reduced number of WTGs and assumed reduction in vessel activity may result in a reduced likelihood of spills. Should they occur, oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

The impact of Alternative E on benthic resources would be the same as or less than the predicted impact of the Proposed Action for both routine and non-routine activities. Alternative E would reduce the footprint of the WTGs and cabling within the WDA, and there would be an assumed reduction in associated vessel use and maintenance activities. If additional surveys are necessary, they should have a **negligible** impact on benthic resources.

3.3.5.8. Impacts of Alternative F (No Action Alternative) on Benthic Resources

Under the No Action Alternative, none of the described impacts on benthic resources would occur. In the absence of the Proposed Action or an alternate accepted Project, changes to benthic resources would be primarily subject to current trends in the area.

3.3.5.9. Comparison of Alternatives for Benthic Resources

Most alternatives are effectively identical in terms of the level of impact that routine activities would have on benthic resources: a **minor** to **moderate** localized impact due to construction activities; a **negligible** (from cable laying) to **minor** (from dredging) impact of sediment deposition on shellfish; a **minor** impact of sediment deposition on demersal eggs; a **minor** impact from long-term habitat alteration; a **minor** indirect impact on benthic habitats from scouring; a **minor**, brief impact due to increased turbidity; a **minor** impact from entrainment of eggs and larvae during hydraulic jet-plowing; and a **negligible** to **minor** impact of vessel discharges. Part of the characterization of many of these impacting factors as **minor** is due to the localized nature of the disturbance, the lack of population-level effects, and the known rapid recovery of benthic communities following a disturbance in this part of the OCS with very mobile sediments (see Section 3.3.5.3; additional information on benthic recovery following dredging can be found in Brooks et al. 2004).

Though the level of impact of routine activities is the same for the Proposed Action and all alternatives, the benthic communities that receive that impact may differ. Although Alternatives D1 and D2 have different WTG placements from each other and from the Proposed Action, the impacts on localized soft bottom benthic communities in the WDA would be similar. The greater spacing of the WTGs may require a greater length of inter-array cable than is necessary for the Proposed Action. However, the lengths would not exceed that of the maximum-case scenario. There may also be a **negligible** impact from additional surveys conducted prior to construction for Alternatives D1 and D2.

The Proposed Action and Alternative B differ in their impact on Lewis Bay and potential impact on horseshoe crabs. The Proposed Action may have **moderate** impact on benthic resources in Lewis Bay and time-of-year restrictions would reduce the impact to **minor** on horseshoe crabs in the bay. Alternative B would have no impact on Lewis Bay because it bypasses the bay entirely, but depending on the time of year of the landfall transition, it may have a **minor** or **negligible** impact on spawning horseshoe crabs on Covell's Beach.

Alternatives D1 and D2 may have a reduced likelihood of oil and chemical spills if the altered arrangement of WTGs successfully improves navigation through the area, though the impact of a spill on benthic resources if it occurred would be the same for all alternatives and for the Proposed Action: **negligible** for small-scale spills and **moderate** for larger spills. BOEM anticipates **minor** impacts from non-routine maintenance for the Proposed Action and all alternatives.

The impact levels for Alternative E are the same for each impact-producing factor as for the Proposed Action. While there would likely be a reduction in impacts from construction activities, BOEM cannot quantify the magnitude of reduction at this time. Overall, Alternative E has the potential for the least impact on benthic resources due to the reduced footprint with the WDA.

3.3.5.10. Cumulative Impacts

The Proposed Action, when combined with past, present, and future projects, may have cumulative impacts that differ from the impacts predicted by proposed Project activities alone. The cumulative analysis area for benthic resources includes a radius of 10 miles (16.1 kilometers) around the WDA and OECC (see Appendix C, Figure C.1-6). Sources of bottom disturbance would be the primary cause of potential cumulative impacts on benthic resources. Appendix C describes projects that could generate cumulative impacts on benthic resources. Cumulative impacts to bottom disturbance would include:

- Vessel Transit: BOEM expects the cumulative effects of vessel transit, which have the potential to affect the benthos from vessel discharge and chemical or oil spills, to have a **negligible** impact on benthic resources because both vessel discharges and spills are unlikely to have impacts at the seafloor.
- Offshore Wind Energy Development: Tier 1 (the Atlantic City Wind Farm and CVOW) and Tier 2 (South Fork Wind Farm) projects, although reasonably foreseeable, are outside of the geographic analysis area defined above. The BSW project, a Tier 3 project (see Table C-4 in Appendix C), would be adjacent the WDA and reside within the geographic analysis area. BSW plans to begin construction in 2022 while Vineyard Wind anticipates completing offshore construction in early 2022 (COP Volume I; Epsilon 2018a). Based on the criteria presented in Appendix C, BOEM does not consider this project or three other Tier 3 projects to be reasonably foreseeable.[10] If the project comes to fruition, potential impacts to benthic resources associated with the installation of BSW's 110 WTGs and two export cables could be similar to that of the Proposed Action. A portion of BSW's Export Cable 2 (as it approaches landfall) may be near enough to the OECC that the areas of potential effects from these cables may overlap (assuming a 10-mile [16.1-kilometer] radius around both cables) (see the Bay State Wind Project Overview map in Evans 2018). Disturbed sediment from BSW construction may affect recovering benthic resources in the WDA, but assuming similar installation procedures, the duration and range of cumulative impacts would be limited and benthic assemblages would recover following the disturbance. Routine operations of the Proposed Action would have **negligible** to **minor** impact on benthic resources, and would be unlikely to overlap spatially or temporally with the routine operations of BSW. The presence of both projects may cumulatively increase vessel activity in the area, but routine vessel discharges would not affect benthic resources. Maintenance activities of both projects could cause sediment disturbance, but this disturbance would be brief and unlikely to overlap temporally (i.e., it is unlikely that major cable maintenance would occur simultaneously for both projects); the area with a cumulatively greater sediment deposition from simultaneous activities would be limited. Overall, BOEM expects **minor** cumulative impacts when the Proposed Action is combined with future projects because of limited temporal and spatial overlap of activities.
- Other Lease Areas: OCS-A 0502 (directly adjacent to the east of the WDA) and two other leases within the MA WEA are scheduled to be auctioned on December 13, 2018, and site characterization and site assessment activities would be anticipated in the following years. Bottom disturbance from surveying would be localized and have no cumulative impact, while potential installation of future offshore wind facilities would cause disturbance similar in scope to the Proposed Action. The timeline for development of such projects would be approximately 5 to 10 years, and potential impacts from those projects are speculative at this time.
- Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables: Existing submarine cables that pass near the WDA are unlikely to have cumulative impacts with Proposed Action activities except during maintenance, which would result in temporary, localized sediment disturbance and increased vessel activity. Sediment disturbance from the Proposed Action would also be limited in duration and localized, so unless maintenance of transmission cables occurred simultaneously with installation, maintenance, or decommissioning within the WDA, there should be **negligible** cumulative impacts.
- Tidal Energy: One proposed tidal energy project, the Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project, is adjacent to the OECC. Because the tidal energy project has not received permits, BOEM considers it speculative and addresses it in the cumulative analysis as not reasonably foreseeable (see Appendix C).

A **moderate** cumulative impact from long-term habitat alteration in the general area may occur from foundation installation and armoring of structures for South Fork. Development of the Project would presumably cause a conversion of soft-bottom habitat to hard-bottom habitat, similar to that described for the Proposed Action. Soft bottom is the dominant habitat type in the region, and species that rely on this habitat would not likely experience population-

[10] The other three Tier 3 projects are outside of the geographic analysis area described in Appendix C.

level cumulative impacts (Guida et al. 2017; Greene et al. 2010). The introduction of new hard bottom would likely result in a **moderate beneficial** cumulative impact to benthic organisms that require hard substrate. Other potential offshore wind developments in adjacent leases would likely lead to similar impacts; however, these projects are not reasonably foreseeable at this time.

Numerous Fisheries Use and Management projects within both Massachusetts state waters and federal waters overlap with project areas. These projects generate rules that affect fishing effort and vessel traffic, and set limits for take on selected commercial finfish and invertebrates. Commercial fishing can negatively impact bottom habitats via anchoring, trawling, or other activities that cause bottom disturbance, so fisheries management measures resulting in reducing bottom-disturbing activities in project areas would have a **beneficial** impact on benthic habitats. These beneficial impacts would not negate or alter the impact level of activities described for the Proposed Action, but it may reduce the degree of impact. Existing fishing practices would likely have a **minor** beneficial cumulative impact on bottom habitats through additional disturbance when the Proposed Action is combined with past, present, and future project activities, but the management of fishing activities should ensure that the cumulative impact would be unlikely to cause population-level effects.

BOEM expects onshore operations and maintenance of the Proposed Action to have a **negligible** effect on benthic resources. It is therefore unlikely that there would be cumulative impacts of onshore developments with offshore Proposed Action activities. BOEM expects any cumulative impacts related to identified onshore developments to be **negligible**.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, and D2 to be the same as under the Proposed Action. BOEM anticipates that the cumulative impacts under Alternative E would be the same as or less than under the Proposed Action. BOEM anticipates the reduction in the proposed Project footprint under Alternative E would result in an overall reduction in cumulative impacts.

3.3.5.11. Incomplete or Unavailable Information for Benthic Resources

Vineyard Wind has completed surveys of benthic habitat and Project engineers are using maps from the Massachusetts Ocean Management Plan (CZM 2014) to avoid hard/complex bottom to the greatest extent possible (Epsilon 2018c). The final cable alignment would determine the amount of hard/complex bottom that the proposed Project must cross in Muskeget Channel; however, Vineyard Wind would minimize the amount to the greatest extent possible (COP Volume III, Table 4.2-1; Epsilon 2018a). Sufficient information exists to support the findings presented herein.

3.3.6. Finfish, Invertebrates, and Essential Fish Habitat

3.3.6.1. Description of the Affected Environment for Finfish, Invertebrates, and Essential Fish Habitat

This section identifies existing finfish, invertebrate resources, and designated EFH in the WDA and OECC, including state and federally managed resident and migratory species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 CFR § 600). Pursuant to scoping comments from the NMFS (April 7, 2018), BOEM prepared an expanded EFH Assessment for the Proposed Action (BOEM 2018f); this section summarizes and discusses the assessment's key findings. The following are agencies, commissions, councils, and regulations responsible for managing the finfish, invertebrates, and EFH in the WDA and OECC:

- The Atlantic States Marine Fisheries Commission (ASMFC) is responsible for managing or co-managing 27 coastal shellfish, marine, and diadromous fish species in cooperation with NOAA (ASMFC 2018a).
- The New England and Mid-Atlantic Fishery Management Councils manage a total of 40 species.
- NOAA implemented a Fisheries Management Plan (FMP) under the MSA (NOAA 2018c) to manage 43 highly migratory species in the Exclusive Economic Zone (EEZ), which extends from the 3-nautical-mile limit to the 200-nautical-mile limit.
- Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize, fund, or carry out is unlikely to jeopardize an endangered or threatened species, in consultation with the relevant Service(s). NOAA has identified four listed species and 15 candidate species or species of concern as potentially occurring in the proposed Project area (BOEM 2018b).

Please refer to Section 3.4.5 for a discussion of commercial fisheries and for-hire recreational fishing.

Regional Setting

The WDA and OECC are located within the Southern New England sub-region of the Northeast U.S. Shelf Ecosystem, which extends from the Gulf of Maine to Cape Hatteras, North Carolina (BOEM 2014a). This sub-region differs from others in productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). Sandy substrate dominates, a characteristic reflected in the finfish and invertebrate species assemblages found in the WDA and OECC. This region has a very diverse and abundant fish assemblage that can be generally categorized according to life habitats or preferred habitat associations (e.g., pelagic [inhabit the water column], demersal [bottom feeders], resident, and high migratory species). Many of these same species are federally managed species, meaning they have a designated EFH. EFHs delineate important marine and diadromous (migratory between salt and fresh waters) fish habitat for all federally managed finfish and invertebrate species mandated through the MSA (50 CFR § 600) (BOEM 2018f).

The major demersal fish species found in the region are either shallow or intermediate finfish assemblages (Overholtz and Tyler 1985; see Table 4-8 in BOEM 2014a). Many of these species are common to shallow and intermediate finfish assemblages and are thought to be important in the commercial and recreational fishing industry, or are considered of special concern due to depleted regional populations (BOEM 2014a). Many of the pelagic species in the Southern New England sub-region are valuable commercial or recreational fish. Furthermore, there are numerous federally managed pelagic invertebrate species found in the region, as well as some demersal and benthic species (see Appendix B, Table B.5-2). The region also contains finfish and invertebrates that are not federally managed (i.e., no EFH), but that provide a valuable resource to the food web and species that do in fact have designated EFH, or are of recreational or commercial value. COP Table 6.6-1 also lists a summary of the major finfish and invertebrate species identified in the vicinity of the proposed Project (Volume III, Section 6.6.1; Epsilon 2018a).

Table B.5-2 in Appendix B presents several finfish and invertebrate species that are important ecologically as well as commercially in the region. Some of these species are managed by state and/or federal (NMFS) agencies while others are listed as threatened or endangered under the ESA. Other species, while not having commercial value, are important to the ecosystem (e.g., forage fish).

Finfish and invertebrate studies identifying the most prevalent species regionally include the 2003 to 2016 NEFSC bottom trawl surveys as summarized in Guida et al. (2017) and trawl surveys (1978 to 2018) conducted by the Massachusetts Division of Marine Fisheries (MA DMF). The NEFSC identified 101 taxa, including 40 managed species (Guida et al. 2017). Dominant species in both cold (winter/spring) and warm seasons (fall) included little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*), and silver hake (*Merluccius bilinearis*). Summer/fall dominant species included longfin squid, spiny dogfish (*Squalus acanthias*), red hake (*Urophycis chuss*), Atlantic butterfish (*Peprilus triacanthus*), and scup (*Stenotomus chrysops*), while winter dominant species included Atlantic herring (Guida et al. 2017). All of these species have designated EFH within the region (COP Volume III, Appendix F; Epsilon 2018a; BOEM 2014a).

The American lobster (*Homarus americanus*) (Southern New England stock) is present in this region and the MA WEA contains important commercial lobster fishing grounds. However, catches in southern New England have declined sharply since the late 1990s, with the largest declines occurring in the inshore fishery (see Figure 1.1 in ASMFC 2015a; this figure shows statistical area 538, which includes large portions of the OECC, and statistical areas 539 and 611, which are outside of the WDA and OECC). The commercial importance of species like Jonah crab (*Cancer borealis*) has increased with the decline of the American lobster fishery, with Massachusetts accounting for 68 percent of the 15 million pounds landed in 2016 (ASMFC 2015b). More than 70 percent of the Jonah crab catch landed in southern New England came from the region that includes portions of the WDA and OECC (see statistical area 537 of Figure 4 in ASMFC 2015b). Jonah crab are typically associated with rocky habitats as well as soft sediment along the continental slope (ASMFC 2015b), while lobster prefer hard-bottom habitat (ASMFC 2015a). Only small amounts of hard-bottom habitat exist in the WDA and OECC, and the WDA (75,520 acres [306 km^2]) amounts to only 1.4 percent of statistical area 537 (5,309,419 acres [21,487 km^2]).

Southern New England also has commercially important invertebrates such as bay scallops, Atlantic sea scallops, blue mussels, ocean quahogs, and soft shell clams (*Mya arenaria*) (BOEM 2014a) and a variety of commercially important whelks (COP Volume III, Section 6.6.2.1; Epsilon 2018a; BOEM 2014a). Horseshoe crab, state managed under conservation measures set by the Interstate FMP (ASMFC 1998), are an invertebrate species found in the Project area that are valuable for biomedical applications and as bait. Several of the invertebrates commonly found in this region (e.g., longfin squid, shortfin squid, Atlantic sea scallop) have EFH designations while other important commercial and recreational species (e.g., American lobster, whelks, and bay scallops) do not since they are not managed under the MSA. Four federally listed species under the ESA that are likely to occur in the region include giant manta ray (*Manta birostris*), Atlantic salmon (*Salmo salar*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and shortnose sturgeon (*Acipenser brevirostrum*). Candidate species and species of concern include 15 marine and diadromous fish, many of which are commercially and recreationally valuable (e.g., bluefin tuna, alewife [BOEM 2018b]); however, none are currently proposed to be listed under the ESA. In January 2018, the giant manta ray was included as a threatened species that might be encountered in the northeast (50 CFR § 223).

Project Area

The proposed Project area includes a region south of Martha's Vineyard (northern Mid-Atlantic Bight) and extends north through Muskeget Channel to landfall in south-central Cape Cod, Massachusetts (COP Volume III, Section 6.6.1; Epsilon 2018a). The benthic habitat is predominantly flat with sand or sand-dominated substrate that becomes increasingly muddy toward the south end of the proposed Project area and increasingly gravelly toward the northwest corner (Guida et al. 2017). Chart 2 in COP Volume II, Appendix II-I, provides an overview of the bathymetry within the WDA (Epsilon 2018a).

The MA DMF spring and fall trawl surveys included sampling locations specific to the proposed Project area (see Figure 1, Region 2, in King et al. 2010). MA DMF identified a total of 85 species (or higher taxa) during spring sampling (1978 to 2018) and 115 taxa during fall sampling (1978 to 2017). The top five most commonly encountered species in spring samples based on percent occurrence in descending order were spider crab (Majidae), longfin squid, winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), and northern sea robin (*Prionotus carolinus*). During fall sampling, the most commonly encountered species were scup, longfin squid, Atlantic butterfish, black sea bass (*Centropristis striata*), and spider crab (Matt Camissa, Pers. Comm., July 25, 2018).

Highly migratory species with ranges overlapping the Project area are identified and described within the MA WEA EA (BOEM 2014a) and COP (Volume III, Section 6.6.1.1; Epsilon 2018a). Several of these highly migratory species have designated EFH within the Project area (see Appendix B, Table B.5-2). NEFSC captured a total of 71 taxa during the winter/spring trawl and 81 taxa in the summer/fall trawl (Guida et al. 2017), indicating the WDA is located within an area of relatively high species richness, as shown in COP Figure 6.6-1 (Volume III, Section 6.6.1.1; Epsilon 2018a). Biomass is low across the WDA (COP Volume III, Figure 6.6-2; Epsilon 2018a).

The finfish and invertebrate resources identified in the MA DMF OECC trawl surveys vary seasonally, with commercial species like longfin squid and winter flounder more prevalent in the spring, and scup, longfin squid, and butterfish more commonly captured in the fall (Matt Camissa, Pers. Comm., July 25, 2018). Longfin squid occurred in 89.6 percent of the spring surveys (1978 to 2018) and in 99.7 percent of the fall surveys (1978 to 2007). Longfin squid are typically most abundant in southern New England in the spring through fall while shortfin squid juveniles are typically found in spring and summer (BOEM 2014a). Longfin squid egg mops, which are demersal, were more prevalent during spring surveys, (8.2 percent occurrence) than in fall surveys (5.5 percent occurrence) (Matt Camissa, Per. Comm., July 25, 2018). Egg mop mapping by MA DMF indicates that egg mops are routinely identified along the OECC route (COP Volume III, Section 6.6, Figures 6.6-8, 6.6-9; Epsilon 2018a)

State-managed finfish and invertebrate resources also inhabit the WDA, including several invertebrate species with commercial and recreational value (e.g., American lobster, Jonah crab, horseshoe crab, sea scallops, and ocean quahog) (ASMFC 2015a; ASMFC 2015b; ASMFC 2013; Guida et al 2017). State-managed species with commercial and recreational value such as horseshoe crab (ASMFC 2013) and American lobster (ASMFC 2015a) are present in the OECC, as well as finfish such as striped bass.

The proposed Project contains at least one life stage of a total of 47 federally managed finfish and invertebrate species with EFH designation (at least one life stage for 42 species in the OECC and 46 along the WDA [BOEM 2018f]). Furthermore, Habitat Areas of Particular Concerns (HAPCs) are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation (50 CFR § 600). The EFH assessment also includes HAPC for adult and juvenile summer flounder (*Paralichthys dentatus*) and inshore juvenile Atlantic cod (*Gadus morhua*) for portions of the OECC (BOEM 2018f). In October 2017, the New England Fishery Management Council established a new juvenile Atlantic cod HAPC for the New England coastline out to a depth of 66 feet (20 meters) (NEFMC 2017). In scoping comments, (April 27, 2018) NMFS indicated that these measures were approved on January 3, 2018, and implemented on April 9, 2018. HAPC designations for adult and juvenile summer flounder include areas of macroalgae, seagrasses, or freshwater and tidal macrophytes in any size bed or in loose aggregations (NOAA 2018d); some of these habitat types are located within the Project area. The HAPC for juvenile Atlantic cod includes the majority of the OECC, which includes areas of rocky or vegetated habitats and sandy areas for feeding next to these habitats (BOEM 2018f). The EFH assessment shows the intersection of the OECC cable route with the juvenile Atlantic cod HAPC and mapped hard-bottom complex (see Figure 1 in BOEM 2018f). Overall, the proportion of juvenile cod HAPC affected by the OECC is small considering the entire HAPC extends from the Canadian border to southern New England (see map 245 in NEFMC 2017).

Using the best available data, the only two ESA fish and invertebrate species likely to occur in the proposed Project area are Atlantic sturgeon and giant manta ray, which are discussed in detail in the BA (BOEM 2018b).

Aspects of Resource Potentially Affected

COP Table 6.6-3 lists the impact-producing factors from the construction, operations and maintenance, and decommissioning of the proposed Project on the finfish and invertebrate resources (Volume III, Section 6.6.2; Epsilon 2018a); COP Table 3-1 lists the factors that would affect the EFH in the WDA and OECC (Volume III, Appendix F; Epsilon 2018a).

Long-term habitat loss would occur as Vineyard Wind alters soft-bottom habitat to hard-bottom habitat by constructing WTGs, ESPs, and armoring portions of the OECC (COP Volume III, Section 6.6.2.1; Epsilon 2018a). Mobile finfish and invertebrate species (e.g., winter flounder, summer flounder, longfin squid, quahog, surfclam) rely on soft-bottom habitat, and construction and altered habitat conditions would reduce the available habitat. Changes in habitat conditions could also alter the finfish and invertebrate community as species preferring hard-bottom structure (American lobster, black sea bass) displace the soft-bottom community. Sessile or less mobile species and life stages (mollusks, fish/squid egg mops, larvae) that are unable to escape construction areas would be subject to greater mortality.

Increased turbidity, noise, sediment deposition, water withdrawal, and EMF are likely to temporarily alter the behavior of finfish and invertebrate species within the WDA and OECC. Mobile species and life stages (e.g., Atlantic herring, longfin squid) would likely be displaced as they move away from noise or turbidity, while sessile species and life stages (whelks, surfclam, demersal fish/invertebrate eggs, and larvae) would likely suffer greater mortality due to sediment deposition and water withdrawal during the construction phase.

Current Condition and Trend

The most recent assessment of 20 groundfish species in the Southern New England sub-region indicates that while the number of overfished stocks has generally decreased, depletion continues for certain stocks (NEFSC 2015). In particular, winter flounder, yellowtail flounder, and wolffish (*Anarhichas lupus*) remain overfished (NEFSC 2015). COP Section 7.6.1.1 describes some of the more prominent fisheries in Massachusetts in landings and revenue, with Atlantic sea scallop and American lobster counting as the two most valuable commercial fisheries (Volume III; Epsilon 2018a). Stock assessments of the Southern New England American lobster indicate sharp declines in catch since the late 1990s (ASMFC 2015a). These declines have increased the importance of the Jonah crab fishery (ASMFC 2015b). Low abundance of Atlantic sea scallops were observed from 2003–2012 in the MA WEA based on video surveys conducted by the School of Marine Science and Technology at the University of Massachusetts, Dartmouth (SMAST 2016). Striped bass, once depleted regionally due to overfishing in the early 1980s, are now important regional recreational and commercial fisheries, with 3 million pounds harvested in 2016 (Nelson 2017). The understanding and rebuilding of finfish and invertebrate stocks are complicated by variables such as long-term shifts occurring at the base of the food web (Perretti et al. 2017) and warming ocean temperatures (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold (20°C) may affect the recovery of the American lobster stock (ASMFC 2015a).

3.3.6.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on fish, invertebrates, and EFH include the following and are discussed further in Appendix G:

- The total amount of long-term habitat alteration from scour protection for the foundations, inter-array cables, and OECC.
- The total amount of habitat temporarily altered by installation method of the export cable in the OECC and for inter-array and inter-link cables in the WDA.
- The number and type of foundations used for the WTGs and ESPs. Vineyard Wind could construct a maximum of 100 WTGs and two ESPs using either monopile (34-feet [10.3-meter]) or jacket piles (four 9.8-foot [3-meter] pins).
- The time of year construction activities occur in relation to migrations and spawning for fish and invertebrate species.
- The level of risk associated with non-routine events.
- The landfall site chosen. The size and the nature of impacts would likely differ for the two proposed landfall sites; the landfall site selected would also determine the route for the OECC as it approaches landfall.
- Landfall site construction method. Using HDD for construction would likely lead to fewer impacts than using conventional open-cut trenching. Vineyard Wind prefers open-cut trenching at the proposed New Hampshire Avenue landfall site.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the WTG pile foundation arrangement, number of WTGs, scour protection height and rock or stone size, the number of ESPs, inter-array and export cable lengths and installation methods used, and the landfall location. This assessment analyzes the maximum-case scenario; any potential variances in the proposed-Project build-out as defined in the PDE (i.e., numbers and spacing of WTGs and ESPs, length of inter-array cable) or construction activities would result in lower impacts than described below.

3.3.6.3. Impacts of Alternative A (Proposed Action) on Finfish, Invertebrates, and Essential Fish Habitat

Incremental Contribution of the Proposed Action

This section discusses direct and indirect impacts on fish, invertebrates, and EFH associated with routine and non-routine activities associated with construction and installation, operations and maintenance, and decommissioning.

Direct and Indirect Effects of Routine Activities

Routine activities include construction and installation, operations and maintenance, and decommissioning of the Proposed Action. Direct impacts would include temporary and long-term consequences directly resulting from habitat alteration, increased turbidity, sediment deposition, entrainment, increased noise, vessel strike, and EMF. Indirect impacts associated with the Proposed Action may occur as a result or consequence of routine activities after Vineyard Wind completes the Proposed Action. While indirect impacts can be a result of Proposed Action activities, the overall impact on fish, invertebrates, and EFH is likely to be **negligible** at a stock level based on the size of the impacted habitat within the WDA in relation to the size of the MA WEA. Impacts discussed in this section would be direct unless otherwise stated.

Construction and Installation of Offshore Components

Habitat Alteration

Long-term habitat alteration would occur in the form of installation of the foundations, scour protection around the WTG and ESP foundations, as well as cable protection for the inter-array and export cables. Temporary habitat alteration would occur from activities associated with WTG and ESP construction and installation of the inter-array and export cable. As described in Section 3.3.5, the total area of alteration within the WDA due to foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation is 393 acres (1.6 km^2), which is 0.5 percent of the entire WDA (see Tables 3.3.5-1 and 3.3.5-2). As listed in Tables 3.3.5-1 and 3.3.5-2, the amount of permanent bottom habitat altered within the OECC by rock protection or concrete mattresses would be approximately 35 acres (0.1 km^2). The OECC installation and sand wave dredging along the route would result in a temporary disturbance of a maximum of 117 acres (0.5 km^2) and 69 acres (0.3 km^2) of bottom habitat, respectively.

Replacement of soft-bottom habitat with hard-bottom habitat would benefit some species (i.e., American lobster, Atlantic cod) while reducing habitat for others (i.e., winter flounder, American sand lance). The installation of foundations and scour protection would cause some displacement of mobile finfish and invertebrate species that prefer soft-bottom habitat (i.e., flatfish). Sessile species (i.e., shellfish, demersal eggs) in the immediate area would likely be subject to mortality. Conversely, species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would have increased habitat availability from scour protection around foundations. Although the vertical surfaces on WTG and ESP monopiles would also introduce a source of new hard substrate, the relatively smooth surfaces of steel monopiles are not expected to be favorable to colonization or reef formation due to their low surface complexity and rugosity (MMS 2009). BOEM expects **moderate** impacts from the long-term conversion of habitat. Impacts associated with long-term habitat alteration are an unavoidable consequence of construction and installation. Because the long-term habitat alteration would be temporary and would encompass a proportionally small area, these impacts are unlikely to have major impacts on populations in the WDA footprint and displaced species would have large areas of preferred habitat available nearby (Guida et al. 2017; COP Volume II, Section 2.1.2.1 and Appendix II-I, Chart 2; Epsilon 2018a).

Cable installation impacts would include temporary displacement of mobile benthic species inhabiting the OECC route (i.e., winter flounder, American lobster, monkfish). Impacts on sessile species and life stages (i.e., demersal eggs, squid egg mops, Atlantic surfclam) would include a reduction in fitness or mortality. Impacts related to habitat disturbance in the immediate area of construction activities would be unavoidable but short-term. Localized loss of demersal eggs could lead to reduced fish recruitment; however, this would be limited and BOEM does not anticipate impacts on the flounder stock. For the Cape Wind project, seabed scars associated with jet plow cable installation were expected to recover in 1 to 38 days, according to modeling by Applied Science Associates (2005), allowing for rapid recolonization from the surrounding area (MMS 2009).

The estimated impact of installation activities within the OECC includes approximately 2.5 acres (10,117.2 m^2) of Lewis Bay. Habitat in Lewis Bay covers 1,000 acres (4 km^2) of submerged land approaching the New Hampshire Avenue landfall site. The OECC installation would likely impact important resources such as shellfish beds (ocean quahog, American oyster, and bay scallops) and horseshoe crabs (Section 4.1.2.4 in Epsilon 2018b). Lewis Bay also provides EFH for winter flounder; see Section 5.1.2 of the EFH assessment discusses the potential impacts from habitat disturbance (BOEM 2018f). Therefore, BOEM expects **moderate** impacts from the temporary habitat disturbance.

While the significance level of impacts above would remain the same, BOEM could further reduce potential impacts as a condition of COP approval, requiring Vineyard Wind to conduct long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations and other benthic areas disturbed by the proposed Project, including protected species movement and habitat use as well as to centrally fund long-term regional monitoring of population level impacts (see Section 2.2.1 and Appendix D).

Turbidity

COP Appendix A models the potential turbidity resulting from construction activities (Volume III; Epsilon 2018a). Based on the modelling results, impacts associated with turbidity are likely to affect benthic species more than pelagic species, because of the turbidity remaining in the bottom 9.8 feet (3 meters) of the water column (COP Volume III, Appendix A; Epsilon 2018a). Turbidity would likely displace mobile juvenile and adult species (i.e., striped bass, alewife), which could expose them to increased predation, temporarily reduce prey availability, or result in higher energetic costs. For sessile organisms unable to escape the suspended sediment plumes, the impacts could range from mortality to reduced fitness (Wilber and Clarke 2001; Berry et al. 2011). Sub-lethal effects for mollusk eggs occur with an exposure of 200 mg/L for 12 hours; for other life stages, the minimum threshold for sub-lethal effects took 24 hours at 100 mg/L (COP Volume III, Section 6.5.2.1.3; Epsilon 2018a). Based on the modeled concentration of total suspended solids (TSS) and the estimated time it would remain suspended, BOEM expects **minor** impacts. Please refer to the EFH assessment and BA for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2018f; Section 5.3.1 in BOEM 2018b.

Sediment Deposition

Sediment deposition can impact finfish, invertebrates, and EFH by covering habitat, smothering sessile organisms or life stages, and causing mobile species to avoid or abandon habitat. COP Appendix A models sediment deposition in the WDA and OECC from construction and installation activities (Volume III, Appendix A; Epsilon 2018a). Mobile species of finfish and invertebrates (i.e., flatfish, Jonah crab) would likely avoid or abandon deposition areas. Sessile species are often capable of handling some degree of sediment deposition because turbidity and sedimentation occur naturally in soft-bottom habitats (e.g., during storm events; Wilber et al. 2005). Sediment deposition could bury demersal eggs and newly settled bivalve spat (i.e., American oyster; longfin squid egg mops, Atlantic wolffish eggs), leading to sub-lethal effects or mortality. Wilber and Clark (2001) found reduced feeding and respiratory rates in oysters when exposed to deposition from dredging. Mortality can occur to sessile shellfish in sedimentation levels greater than 0.8 inches (20 millimeters) (Wilbur and Clarke 2001; COP Volume III, Section 6.5.2.1.3; Epsilon 2018a). Benthic eggs and larvae (i.e., whelk species, winter flounder, longfin squid egg mops) are more susceptible to increased mortality rates in depositions over 0.04 inches (1 millimeter) (Wilber and Clarke 2001; Berry et al. 2011). Sediment deposition covering hard-bottom habitat along the OECC could temporarily impact juvenile Atlantic cod HAPC (see Figure 1 in BOEM 2018f) and could negatively impact the settlement of bivalve larvae (Wilber and Clarke 2001). Based on the limited distribution of sediment depositions exceeding 0.04 inches (1 millimeter) along the OECC and the overall proportion of the affected soft-bottom habitat in relation to that available regionally, BOEM expects **minor** impacts. Please refer to the EFH assessment and BA for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2018f; Section 5.3.1 in BOEM 2018b.

Water Withdrawal

Water withdrawals are necessary for jet-plow cable installation, one of the primary methods of installing the export cable in the OECC as well as the WDA inter-array and inter-link cables. See COP Section 6.5.2.1.3 for a description of water withdrawal and estimates of quantities (Volume III; Epsilon 2018a). Due to the surface-oriented intake for the jet plow, water withdrawal could entrain eggs and larvae of pelagic finfish and invertebrates, resulting in 100 percent mortality (MMS 2009). Jet plowing would impact species with pelagic eggs or larvae, including numerous flatfish species (e.g., windowpane flounder, winter flounder, witch flounder [*Glyptocephalus cynoglossus*], yellowtail flounder and summer flounder), important commercial groundfish species (e.g., Atlantic cod, haddock, pollock), and other recreationally and commercially important species (e.g., monkfish, Atlantic herring, Atlantic mackerel, silver hake, butterfish). Species with demersal eggs (e.g., longfin squid, Atlantic sea scallops, Atlantic wolffish, ocean pout [*Zoarces americanus*], winter flounder), which adhere to bottom substrate, would not be affected by the water withdrawal aspect of jet plowing. Most jet plowing would take place during summer and could impact eggs and larvae present at that time. See EFH assessment for species with EFH for pelagic eggs (Section 4 in BOEM 2018f). Based on the limited time of jetting and the overall habitat available for pelagic eggs and larvae in comparison to the small area from which water is withdrawn, BOEM expects **minor** impacts. Please refer to the EFH assessment and BA for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2018f; Section 5.3.1 in BOEM 2018b).

Pile Driving

Pyć et al. (2018) modeled the potential noise impacts from pile driving in the WDA on finfish and invertebrates (COP Section 6.6.2.1.2, Volume III; Epsilon 2018a). The NMFS acoustics tool sets the physiological (injury) threshold for large (> 2 g) and small (< 2 g) fish at 187 dB and 183 dB, respectively, and the behavioral response threshold at 150 dB for both categories (NMFS 2016). According to this tool, the radial distance at which physiological injury occurs from pile driving a 34-foot-diameter (10.3-meter) foundation in 24 hours with 6 dB of attenuation (Table A-35, Pyć et al. 2018) is greater for small fish (4.6-5.63 miles [7,400-9,075 meters]) than for large fish (3.6-4.3 miles [5,714-6,894 meters]). The range for behavioral responses to pile driving noise is the same for small and large fish (4.7-5.7 miles [7,598-9,229 meters]).

Noise impacts on fish and invertebrates in the WDA and OECC would vary depending on the ability of the fish to detect sound pressure. Fish with a gas chamber involved in hearing (e.g., Atlantic herring and gadids) are the most susceptible while those without swim bladders (e.g., sharks, rays, flatfish) are the least susceptible (Popper et al. 2014). Research shows that noise can damage the sensory organs responsible for equilibrium and motility in squid species (Solé et al. 2013). The EFH assessment (Table 2 in BOEM 2018f) presents the general groups of finfish and invertebrates that fall within three hearing sensitivity categories as discussed by Popper et al. 2014. Pile driving would occur from May through December during the construction period (Pyć et al. 2018). Noise generated from pile driving would likely affect species present within the WDA during this period, with impacts ranging from avoidance behavior to mortality. The radial distance at which mortality or mortal injury, recoverable injury, and temporary reduction in hearing sensitivity (temporary threshold shift) would occur as a result of modeled peak noise level and 24-hour cumulative pile-driving noise is presented in COP Appendix III-M (Pyć et al. 2018). Table 3.3.6-1 presents the radial distance for injury for fish hearing categories at 6 decibels (dB) attenuation.

Table 3.3.6-1: Radial Distance (meters) to Thresholds for Fish from Impact Hammering

Group	Metric	Threshold (db)	P1 Hammer Energy (kJ)					P2 Hammer Energy (kJ)				
			500	1,000	1,500	2,000	2,500	500	1,000	1,500	2,000	2,500
Mortality and Potential Mortality												
Fish without swim bladder	L_E	219	112					112				
	L_{pk}	213	23	28	28	30	38	9	9	14	18	29
Fish with swim bladder not involved in hearing	L_E	201	451					503				
	L_{pk}	207	41	53	54	57	78	14	14	23	32	56
Fish with swim bladder involved in hearing	L_E	207	752					798				
	L_{pk}	207	41	53	54	57	78	14	14	23	32	56
Eggs and larvae	L_E	201	451					503				
	L_{pk}	207	41	53	54	57	78	14	14	23	32	56
Recoverable Injury												
Small fish (< 2 g)	$L_{E, 12 hr}$	183	7,400					9,075				
	L_{pk}	206	46	59	61	64	87	15	15	26	35	63
Large fish (> 2 g)	$L_{E, 12 hr}$	187	5,714					6,894				
	L_{pk}	206	46	59	61	64	87	15	15	26	35	63
Behavioral Responses												
Small or large fish	L_{pk}	150	4,428	5,438	6,519	7,167	7,598	4,733	6,351	7,760	8,689	9,229

Group	Metric	Threshold (db)	P1 Hammer Energy (kJ)					P2 Hammer Energy (kJ)				
			500	1,000	1,500	2,000	2,500	500	1,000	1,500	2,000	2,500
Temporary Threshold Shift												
All fish	L_E	186			6,121					7,444		

Source: COP Volume III, Appendix M, Tables A-34 and A-35, Epsilon 2018a; Popper et al. 2014; and GARFO 2016
dB = decibel; kj = kilojoule; L_E = cumulative sound pressure; L_{pk} = peak sound pressure
Note: Impact from hammering of a 34-foot (10.3-meter) pile using an IHC S-4000 hammer with 6 dB attenuation

While eggs, larvae, sessile, and less mobile species (i.e., whelks, longfin squid egg mops) are less sensitive than some fish species to pile-driving noise, they are more vulnerable due to a lack of motility. BOEM expects **minor** impacts from pile driving, as it would occur sporadically, the actual area of impact would be small in relation to the overall habitat available, and pile-driving noise would only occur over a relatively short period of time. While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measures conditioned as part of the COP approval (see Section 2.2.1 and Appendix D):

- An attenuation of at least 6 dB along with a soft-start technique and use of fixed passive acoustic monitoring buoys;
- Autonomous passive acoustic monitoring devices to continuously record ambient noise in the lease area (before, during, and immediately after construction); and
- A reduction of impacts on marine trust resources through near-term refinement of exclusion zones based on field measurements of noise reduction systems, and long-term refinements of other pile-driving monitoring protocols based on monthly and/or annual monitoring results.

The use of noise reduction technologies during all pile-driving activities to ensure a minimum attenuation of 6 dB would reduce the area impacted by noise during construction. This would ensure that the maximum distance of potential mortal injury during pile driving would be 2,618.1 feet (798 meters) for the most vulnerable fish (those with swim bladders involved with hearing) (see Section A.12.1.2 and Table A-34 in Pyć et al. 2018).

Vessels and Construction Noise

Pelagic and demersal species may temporarily avoid non-pile driving construction noise and vessel noise, but in general, the noise would not be loud enough for long enough to induce injury or death (MMS 2009). The EFH assessment and BA summarize potential impacts on fish, invertebrates, and EFH from construction and vessel-related noise in the WDA and inter-array and export cable dredging and installation (Section 5.1.1 in BOEM 2018f; Section 5.3.2 in BOEM 2018b). Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet (3 meters) were loud enough to induce avoidance, but not physically harm fish, invertebrates, and EFH (MMS 2009). Vessel and construction noise would most likely impact pelagic species (e.g., Atlantic herring, Atlantic mackerel). To avoid vessel noise, pelagic fish typically swim down in the water column, while demersal species swim laterally along the bottom.

Propeller boats and barges can pose a risk to fish that swim near the water surface. Vessel traffic may be a source of mortality for Atlantic sturgeon as a result of direct collisions with the hull or propeller (Brown and Murphy 2010). The majority of vessel-related sturgeon mortality are likely caused by large transoceanic vessels, with fewer caused by smaller vessels (Brown and Murphy 2010; Balazik et al. 2012). Because the construction vessels (tugboats, barge cranes, hopper scows) have relatively shallow drafts and the vessels and fish (within WDA and OECC) are not confined to a narrow channel, BOEM expects low vessel-related mortalities; therefore, the impact of vessel noise and traffic on finfish, invertebrates, and EFH is likely **minor**.

Construction and Installation of Onshore Project Components

Vineyard Wind expects construction at the landfall site in late 2019. Due to summer construction restrictions on Cape Cod (unless authorized by the Town of Barnstable or the Town of Yarmouth, depending on the landfall site chosen), Vineyard Wind would not make the landfall transition from June through September. Vineyard Wind may use either direct bury or HDD at the New Hampshire Avenue transition site; Covell's Beach would be through HDD. BOEM expects **negligible** impacts from either transition option because the New Hampshire Avenue site is largely manmade and HDD would traverse under the beach at Covell's Beach. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on winter flounder and horseshoe crabs by implementing the following time of year restriction mitigation measures (see Section 2.2.1 and Appendix D):

- Time of year restriction from May 1 to July 31 to avoid the horseshoe crab spawning season at Covell's Beach when conducting nearshore area work on the shoreline to protect adults staging to spawn as well as eggs, larvae, and newly settled juveniles; and
- Time of year restriction from January 15 to June 30 to protect the spawning period, larval settlement, and juvenile development of winter flounder as well as adult horseshoe crabs staging to spawn in Lewis Bay. BOEM could implement additional time of year restrictions to protect shellfish spawning and settlement within Lewis Bay. Combined shellfish time of year restrictions covering all identified species would extend the time of year restriction for the Lewis Bay portion of the proposed Project to September 30 to protect bay scallops from the spawning through larval settlement phases.

Operations and Maintenance of Offshore Components

Vessel Activity/Noise

Noise associated with operations and maintenance vessels (COP Volume II, Section 4.3.4, Table 4.3-2; Epsilon 2018a) would impact fish, invertebrates, and EFH in a similar way to construction vessel traffic. However, the impacts would be smaller than construction because many of the vessels used (i.e., crew transport vessels) are smaller and would be used for shorter time periods. Mobile species/life stages within range of vessel noise capable of initiating physiological stress or noise related impacts would likely move away from the source and not result in population level consequences. BOEM (2018a) determined there would not likely be an adverse effect from noise generated by vessel transit and operations, and no effect for noise generated by vessel engines and thrusters.

WTGs would also produce noise, although sound levels typically low (Madsen et al. 2006). According to measurements at the Block Island Wind project, operation noise is barely detectable at 164 feet (50 meters) (Miller and Potty 2017). Sound pressure level measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 micropascal (µPa) at 46 and 65.6 feet (14 and 20 meters) (Tougaard and Henrikson 2009), which is only slightly higher than the ambient noise levels recorded at the Deepwater WLA and MA WEAs from 2011 to 2015 (95 to greater than 104 dB re 11 µPa) (Kraus et al. 2016b).When operational, WTGs would produce noise that can cause masking effects, but thus far, noise related to operational WTGs have not been found to have a negative impact on finfish (English et al. 2017). Detection distance from noise generated by WTGs depends on several variables (i.e., hearing capability of fish, depth, size and spacing of WTGs, wind speed) and does not create a level of noise capable of injury (Wahlberg and Westerberg 2005). No study has shown any behavioral impact of sound during the operational phase of wind energy facilities. However, due to the lower sound emissions during operation, measurements and research remain a low priority in comparison with pile-driving sound (Thomsen et al. 2015). Based on this and the above impacts associated with WTG and vessel noise, BOEM anticipates **minor** overall impacts.

Reef Effect

WTG and ESP scour foundations scour and cable protection) create an artificial reef affect and attract a different community of fish and invertebrates, and shift the EFH from a benthic soft-bottom to hard-bottom structure. Species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would gain habitat while soft-bottom species (summer flounder, Atlantic surfclam) would see habitat locally diminished. The reef effect has been observed around WTGs, although benefits to fish and invertebrates are inconclusive (Causon and Gill 2018). For the Cape Wind Energy Project, the Minerals Management Service did not anticipate the vertical monopile structures to provide a true artificial reef due to the material and low quantity of interstitial spaces available (MMS 2009). BOEM expects **moderate beneficial** impacts associated with reef effect although impacts on a population level for most species should be minimal based on the amount of habitat converted in relation to the overall habitat still available.

Electromagnetic Fields

Many marine and diadromous species can sense electric and/or magnetic fields, and EMF from power cables may affect their ability to navigate and detect predators/prey, or could cause physiological and developmental effects (Taormina et al. 2018). Buried cables reduce, but do not entirely eliminate, EMF (Taormina et al. 2018). During the operations and maintenance phase of the Proposed Action, powered transmission cables would produce EMF and heat (Taormina et al. 2018). To minimize EMF generated by cables, all cabling would be contained in grounded metallic shielding to prevent detectable direct electric fields. Vineyard Wind would also bury cables to a target burial depth of approximately 6.6 feet (2 meters) below the surface or utilize cable protection (e.g., rock or concrete mattresses), which would diminish the effect of EMF so that it would likely impact only demersal species.

Demersal species living on or near the seafloor, where the magnitude of cable EMF would be highest, are more likely to detect EMF than pelagic species, which live higher in the water column. Cable networks like the inter-array cable in the WDA could potentially have collective impacts on fish that encounter multiple cables on a regular basis as part of their typical movement patterns. However, the minimal distance of EMF radiating from each cable in the WDA (approximately 65.6 feet [20 meters]; Normandeau et al. 2011) and the spacing of the cables (approximately 1 mile [1.6 kilometers] apart) should create a large enough gap between cables to reduce any collective impact from such frequent and repeated encounters.

Atlantic sturgeon have both electro and magneto sensitivity that can affect feeding, predator detection, and navigation (BOEM 2012c), although research suggests marine species may be less likely to detect EMF from AC cables (BOEM 2012c). Although some species-specific avoidance behavior has been observed, no evidence of population scale impacts or adverse physiological impacts have been reported (Taormina et al. 2018). Studies of EMF impacts on invertebrates are scarce (Taormina et al. 2018). American lobster held in cages displayed behavioral differences when exposed to EMF, but the research did not indicate a barrier to movement (Hutchinson et al. 2018). Currently there is no evidence that EMF would result in population-scale negative impacts on fish or invertebrates (Taormina et al. 2018; Hutchinson et al. 2018). BOEM anticipates that, by burying cables and containing them in grounded metallic shielding, the impacts of EMF should be **minor** on finfish, invertebrates, and EFH. Please see the EFH assessment and BA for additional discussion of EMF impacts on Atlantic sturgeon and other fish or invertebrates with EFH in the Project area (BOEM 2018f; BOEM 2018b).

Lost Fishing Gear

A potential indirect effect of the existence of offshore cables and structures is the entanglement and loss of commercial and recreational fishing gear. This could affect finfish, invertebrates, and EFH by modifying habitat and possibly trapping, injuring, or killing finfish and invertebrates. Although these impacts would likely be **negligible**, BOEM could further reduce these impacts by requiring annual monitoring, reporting, and removal of monofilament and other fishing gear around foundations, cables, and scour protection (see Appendix D).

Decommissioning

Impacts associated with WDA and OECC decommissioning would be similar to the construction phase. WTG and ESP foundation and scour protection removal would have the same temporary habitat impacts as construction (with the exception that there would be no pile driving). Decommissioning activities include removing Project components, including WTGs and ESPs, to 15 feet (4.6 meters) below the mudline (see Section 2.1.1.3). The portion buried below 15 feet (4.6 meters) would remain, and Vineyard Wind would refill the depression with sediment. Vineyard Wind would also remove the scour protection and hard protection atop cables. Acoustic effects would reflect those associated with non-pile-driving noise that was associated with construction and installation and the operations and maintenance activities, and are unlikely to have long-term negative impacts. Therefore, BOEM anticipates **minor** impacts.

Removal of the scour protection would result in temporary and long-term habitat alterations from removal of hard bottom and disruption of soft bottom due to cable and scour removal. These temporary and long-term alterations would have similar impacts as those discussed during construction and installation activities. Removal of the hard-bottom habitat would likely result in a recolonization of species preferring soft-bottom sand and fine-sediment habitat and the loss of any species that previously colonized and maintained populations on the hard-bottom habitat. BOEM anticipates **minor** impacts to species and their preferred habitats.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities, if they were to occur, would generally require temporary activity to address emergency conditions, fuel spills, accidental releases of waste material, collisions, and allisions. Impacts from the occasional operation and maintenance activities to repair segments of the OECC or inter-array cables would be similar to those temporary habitat disturbances involved in the installation. Generally, the disturbance to fish, invertebrates, and EFH would be short-term and localized with an abundance of similar foraging habitat and prey available in adjacent areas. Therefore, BOEM anticipates the impacts associated with maintenance and repairs to be **minor.** Non-routine events such as oil or chemical spills can have adverse or lethal effects on marine life. Spills are expected to occur at the surface, and impacts on the water column would be mostly limited to the surface-mixed layer, or approximately 33 feet (10 meters). Oils in particular tend to stay at the surface, and other chemicals are predicted to dilute to non-toxic levels before they would reach most finfish, invertebrates, and EFH. Small spills should therefore have a **negligible** impact while larger spills, which are unlikely, could have a **moderate** impact on species due to negative effects on water quality (Section 3.2.2.2).

Conclusion

Activities associated with the construction and installation, operations and maintenance, and decommissioning of the WDA and OECC would impact fish, invertebrates, and EFH to varying degrees. Impacts associated with Proposed Action activities are often specific to the life stage and habitat requirements of a species. Activities that primarily impact benthic habitat (i.e., cable installation, scour protection) are not as likely to impact species or life stages that depend on pelagic habitats. Conversely, the above-mentioned activities are likely to displace or kill benthic species and life stages such as skates, flatfish, squid egg mops, and Atlantic sea scallops. BOEM anticipates the following impacts during construction and installation of the Proposed Action:

- Long-term habitat alteration impacts would be **moderate**.
- Temporary habitat disturbance impacts would be **moderate**.
- Impacts related to turbidity from of cable installation and dredging would be **minor**.
- Impacts associated with sediment deposition from cable installation and dredging would be **minor**.
- Water withdrawal impacts would be **minor**.
- Pile-driving noise associated with WTG and ESP foundation installation would be **minor**.
- Impacts associated with vessel and construction noise other than pile driving would be **minor**.
- Construction and installation of onshore components would have **negligible** impacts on finfish, invertebrates, and EFH.

Impacts associated with operations and maintenance on finfish, invertebrates, and EFH in the region are likely to be less than construction and installation impacts. In addition to those discussed above (vessel noise, habitat alteration), there would be fewer adverse impacts as there would not be any pile driving or turbidity/sediment deposition from cable installation (with the exception of repairs). WTG and ESP foundation placement could impact future recruitment and settlement of pelagic eggs, larvae, and juveniles. Changsheng Chen (2016) found that WTGs in the region would not have a significant influence on southward larval transport, although foundation placement could cause relatively large cross-shelf larval dispersion during storm events. BOEM anticipates the following impacts during operations and maintenance of the Proposed Action:

- Vessel and WTG/operational noise would be relatively low and at most would cause avoidance but not injury or mortality in finfish or invertebrates. Impacts would be **minor**.
- Reef effects would cause **moderate beneficial** impacts based on the potential of WTG foundations and scour protection to create artificial reef environments.
- Maintenance and repair impacts would be similar (at a smaller scale) to the temporary habitat disturbance from construction and installation. Impacts would be **minor**.
- Impacts associated with EMF would be **minor.**
- Operations and maintenance of onshore components would have **negligible** impacts on finfish, invertebrates, and EFH.

During decommissioning, Vineyard Wind would remove foundations and scour protection, leading to substantial habitat disruption and a return to a soft sediment substrate. There would also be additional temporary impacts (turbidity, sediment deposition, habitat disruption) from cable removal from the OECC. BOEM expects **minor** impacts associated with decommissioning that would be similar in nature to construction activities.

Waste, spills, or vessel discharges could occur offshore or onshore during any phase of the Proposed Action. The rarity and small size of potential spills, along with the measures in place to clean them up, indicate that these impacts would be **negligible**.

Overall, the Proposed Action would be more likely to impact benthic species, life stages, and EFH than pelagic species and EFH, since the majority of activities affect benthic habitat. Turbidity, especially associated with dredging, and water withdrawal from jet plowing could temporarily impact pelagic eggs and larvae and EFH. Pile-driving noise, although temporary, could impact all benthic and pelagic life stages. The adverse impacts associated with the construction and installation, operations and maintenance, and decommissioning of the Proposed Action are likely to be temporary and/or small in proportion to the overall habitat available regionally. Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

3.3.6.4. Impacts of Alternative B on Finfish, Invertebrates, and Essential Fish Habitat

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

Impacts associated with construction and installation under Alternative B would remain the same as the Proposed Action (**negligible to moderate**). By using the Covell's Beach landfall site, Vineyard Wind would avoid shellfish beds within Lewis Bay, reducing impacts on shellfish beds potentially disrupted by construction activities. Overall, however, the impacts associated with cable installation (habitat alteration, sediment deposition, turbidity, water withdrawal) would remain the same as the Proposed Action (**minor** to **moderate**).

Operations and Maintenance

Operations and maintenance for Alternative B would be the same as for the Proposed Action. BOEM anticipates impacts would be the same as the Proposed Action with **minor** impacts on finfish, invertebrates, and EFH.

Decommissioning

Impacts associated with decommissioning of Alternative B would be the same as the Proposed Action, with the exception that cable removal and onshore operations would not impact resources in Lewis Bay. Depending on the time of year, there may be a **minor** impact on horseshoe crabs during decommissioning of onshore and nearshore facilities, unless they are retired in place. Therefore, BOEM anticipates **minor** impacts.

Direct and Indirect Effects of Non-Routine Activities

Impacts from waste, accidental spills, vessel discharge, and non-routine repairs or maintenance would be similar to the Proposed Action (**negligible** to **minor**).

Conclusion

The only change under Alternative B is the selection of Covell's Beach as the landfall site; therefore, impacts to the Lewis Bay shellfish beds would be avoided, and no additional adverse impacts to finfish, invertebrates, and EFH would occur under this alternative.

3.3.6.5. Impacts of Alternative C on Finfish, Invertebrates, and Essential Fish Habitat

Incremental Contribution of Alternative C

Alternative C would exclude six of the northern-most WTG locations and relocate them in the southern portion of the WDA primarily for the purpose of reducing visual impacts and minimizing conflicts with commercial fishing boats. Additional limited surveys necessary to select new WTG and inter-array cable locations would create **minor** disturbances to pelagic and benthic finfish, invertebrates, and EFH that would revert to the baseline condition when surveys are complete.

Direct and Indirect Effects of Routine Activities

Construction and Installation

Impacts associated with construction and installation under Alternative C would remain the same as the Proposed Action (**negligible** to **moderate**). Slight changes in benthic fisheries and invertebrate communities could occur with changing sediment composition and depth in a different portion of the WDA but BOEM anticipates these changes to be similar to other WTGs located in the southern portion of the WDA.

Operations and Maintenance

Operations and maintenance under Alternative C would not alter any of the potential impacts associated with the Proposed Action (**negligible** to **minor**).

Decommissioning

Decommissioning under Alternative C would not alter any of the potential impacts associated with the Proposed Action (**negligible** to **moderate**).

Direct and Indirect Effects of Non-Routine Activities

Impacts from waste, accidental spills, vessel discharge, and non-routine repairs or maintenance are not likely to change from those discussed under the Proposed Action (**negligible** to **minor**).

Conclusion

The shifting of WTGs to a more southern location within the WTG would not alter the size of the WDA footprint, and thus would not impact the amount or quality of habitat altered. An indirect impact of reducing conflict with commercial fishing vessels is the potential for slightly higher harvests of commercial fish species that might be shielded from harvest under the Proposed Action. Overall, the impact from commercial fishing harvest increases should be small in relation to commercial fishing harvests regionally.

3.3.6.6. Impacts of Alternatives D1 and D2 on Finfish, Invertebrates, and Essential Fish Habitat

Incremental Contribution of Alternative D1 and D2

Direct and Indirect Effects of Routine Activities

Construction and Installation

Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. Alternative D2 would align WTGs in an east-west orientation with a 1 nautical mile spacing between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed gear fishing vessels.

New surveys to establish site conditions would temporarily disturb habitat for fish, invertebrates, and EFH, which would cease after completion. Therefore, BOEM anticipates impacts associated with these surveys would be **minor**.

Construction and installation impacts under Alternative D1 and D2 would be the same as the Proposed Action (**negligible** to **moderate**). A slightly wider spacing of WTGs in the WDA would not likely have additional impacts on fish, invertebrates, and EFH. An increase in temporary habitat disturbance would occur with the additional inter-array cable required to connect the WTGs. While increases in turbidity, water withdrawal, and sediment deposition would cover a larger area, the overall impacts would remain the same the Proposed Action.

Operations and Maintenance

Operations and maintenance of Alternatives D1 and D2 would be the same as those of the Proposed Action (**negligible** to **minor**). Alternative D1 and D2 might slightly reduce WTG noise impacts due to the greater spacing between WTGs, although the overall impact of this operational activity would remain **minor**.

Decommissioning

Decommissioning of Alternatives D1 and D2 would be identical to that of the Proposed Action (**negligible** to **moderate**).

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impact as in the Proposed Action. Alternatives D1 and D2 are intended to improve vessel movement through the proposed Project area, which may reduce the likelihood of spills. Should they occur, oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

The impact of Alternatives D1 and D2 on finfish, invertebrates, and EFH would be the same as the predicted impact of the Proposed Action for both routine and non-routine activities. Impacts associated with construction, operations and maintenance, and decommissioning would likely remain the same (**negligible** to **moderate**) as the Proposed Action. Additional pre-construction surveys would be temporary and have a **minor** impact on fish, invertebrates, and EFH. This impact is not likely to adversely affect commercially important finfish, invertebrates, and EFH from a regional standpoint.

3.3.6.7. Impacts of Alternative E on Finfish, Invertebrates, and Essential Fish Habitat

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and Installation

Construction methods would be identical to those of the Proposed Action, but the proposed Project footprint would be considerably less due to the reduced number of WTGs and associated inter-array cabling. Alternative E would convert less habitat to hard-bottom habitat, and impacts associated with temporary habitat disturbance, turbidity, and sediment deposition would be reduced, decreasing the overall impacts on finfish, invertebrate, and EFH resources in the region. While the construction-related activities discussed would be reduced in scope, the overall impacts associated with each activity would remain the same (**negligible** to **moderate**) since the reduction of soft-bottom habitat to hard-bottom habitat would still have a **moderate** impact, just on a smaller scale.

Operations and Maintenance

Impacts associated with operations and maintenance of Alternative E would be the same as the Proposed Action (**negligible** to **minor**). Alternative E would reduce WTG noise impacts due to the reduced number of WTGs, although the overall impact would remain **minor.**

Decommissioning

Impacts associated with decommissioning of Alternative E would be the same as the Proposed Action (**negligible** to **moderate**), but at a reduced scale due to fewer WTGs.

Direct and Indirect Effects of Non-Routine Activities

Non-routine maintenance would have the same **minor** impacts as with the Proposed Action. The reduced number of WTGs and assumed reduction in vessel activity may result in a reduced likelihood of spills. Should they occur, oil and chemical spills would have the same impact as in the Proposed Action: **negligible** for small spills and **moderate** for larger spills.

Conclusion

Alternative E would reduce the area of potential impacts on environmental resources in the WDA. However, impacts would remain the same (**negligible** to **moderate**) on those resources in the reduced Project footprint. Impacts associated with Alternative E, in comparison to the amount of homogenous habitat available regionally, indicates that Alternative E would not have a substantial impact on the loss or conversion of benthic habitat. While there would be reduced impact on fish, invertebrates, and EFH under this alternative, it may not amount to a substantial reduction on a regional scale.

3.3.6.8. Impacts of Alternative F (No Action Alternative) on Finfish, Invertebrates, and Essential Fish Habitat

Under Alternative F, none of the impacts associated with the Proposed Action or any of the alternatives would occur. The resource in the area would continue to follow current regional trends and respond to current and future environmental and societal activities.

3.3.6.9. Comparison of Alternatives for Finfish, Invertebrates, and Essential Fish Habitat

Impacts associated with the Proposed Action do not change substantially under Alternatives B through E. While the alternatives could reduce impacts on fish, invertebrates, and EFH within the WDA, ultimately, the same construction, operations and maintenance, and decommissioning activities would continue to occur, albeit at a reduced scale in some cases. BOEM developed Alternatives B, C, D, and E to potentially reduce conflicts with commercial fishing, which could indirectly expose commercially important finfish and invertebrates to harvest in areas where they otherwise might find refuge under the Proposed Action. The construction and installation, operations and maintenance, and decommissioning of the OECC would be unaltered in these alternatives, which would result in the Proposed Action impacts remaining the same under all scenarios with the exception of Alternative B, which only changes the landfall site.

Overall, impacts discussed under the Proposed Action would remain the same (**negligible** to **moderate**) for construction and installation, operations and maintenance (**negligible** to **minor**), and decommissioning (**negligible** to **minor**) under all of the proposed alternatives. Only the No Action Alternative (Alternative F) would result in a reduction of all impacts.

3.3.6.10. Cumulative Impacts

The analysis area for fish, invertebrates, and EFH includes the entire Northeast Shelf Large Marine Ecosystem (LME) to account for the range of movement of potentially impacted species. This area extends from the southern edge of the Gulf of Maine to Cape Hatteras, North Carolina, and from the coastline offshore to the shelf break at a 328.1- to 656.2-foot (100- to 200-meter) depth (see Figure C.1-7 in Appendix C). Temporary habitat disturbance, long-term habitat alteration, turbidity, sedimentation, noise, EMF, and other impact-producing factors of past, present, or reasonably foreseeable actions in combination with the Proposed Action can result in cumulative impacts. Appendix C describes projects that could generate cumulative impacts on fish, invertebrates, and EFH.

Other potential offshore wind facilities would generate similar impacts as the Proposed Action. Tables C.1-3 and C.1-4 in Appendix C describe the relevant wind leasing activities. Installation activities would produce the most impact, and may overlap temporally with the Proposed Action in the case of the Atlantic City Wind, CVOW (both Tier 1, totaling six potential additional WTGs). The South Fork Wind (Tier 2, totaling 15 potential additional WTGs), Skipjack Wind, U.S. Wind, Revolution Wind, BSW (Tier 3, totaling 232 potential additional WTGs), and University of Maine Aqua Ventus (Tier 4, totaling two potential additional WTGs) projects could also contribute to cumulative impacts. Although the noise, habitat alteration, and sedimentation resulting from various Tier 3 and 4 projects would not all likely overlap, fish, invertebrates, and EFH within the Northeast Shelf LME could be affected by each project. The cumulative impact of installation of the Proposed Action and other offshore wind facilities would be **moderate**. The routine operations of the Proposed Action in combination with the other offshore wind facilities may have **minor** cumulative impacts from vessel traffic, EMF, noise, and the alteration of benthic habitat from soft to hard bottom. Site characterization for potential future offshore wind projects would cause temporary, localized disturbance and is not expected to have cumulative impacts.

Port upgrades to support the development of the offshore wind energy industry could have cumulative effects on finfish, invertebrates, and EFH. Habitat disturbance during construction and increased vessel noise through greater use and capacity are potential impacts associated with upgrading the Vineyard Haven port. At the time of publication, there was not enough information available to perform a detailed indirect impact assessment of the modifications to and potential operations out of Vineyard Haven. However, BOEM expects **minor** impacts associated with this port, as construction would be brief and additional upgrades would not likely greatly increase operations regionally.

Cumulative effects related to submarine cables may also occur. Installation of new cables would result in temporary habitat disturbance similar to cable laying for the Proposed Action. The Atlantic City Wind cable and CVOW export cable are both over 200 nautical miles from the WDA, so cable installation impacts (due to noise, seafloor disturbance, vessel activity, etc.) should not have a detectable cumulative impact even if they overlap temporally. The South Fork Wind export cable and BSW export cable would be nearer to the WDA (approximately 24 nautical miles and 2 nautical miles, respectively), and construction may temporally overlap with Proposed Action activities. Cumulative impacts of temporary habitat disturbance may be **minor**, but short-term. The submarine power cables for the Proposed Action would have the appropriate shielding and burial depth to reduce potential EMF impacts to **negligible** levels of contribution to cumulative effects. Habitat disturbance related to maintenance events for the Proposed Action would be short-term and localized, and any cumulative impacts would be **negligible**.

Several tidal energy projects are proposed in the Northeast Shelf LME. One proposed tidal energy project, the Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project, is adjacent to the OECC. Because the tidal energy project has not received permits, BOEM considers it speculative and addresses it in the cumulative analysis as not reasonably foreseeable (see Appendix C). The Western Passage Tidal Energy Project in Maine has a preliminary permit but construction is not authorized. If the Western Passage Tidal Energy project proceeds, potential impacts on fish, invertebrates, and EFH would be similar to those described for offshore wind projects. The Proposed Action could contribute **minor** levels of cumulative impacts related to these projects.

Table C.1-5 (Appendix C) lists proposed and active leases for marine minerals use and ocean-dredged material disposal, which would generate sporadic seafloor disturbance and vessel traffic. The nearest location is approximately 37 nautical miles from the WDA, so direct impacts are unlikely to be cumulative with the WDA. There could be cumulative impacts if Proposed Action activities affect individuals from the same populations as they move among preferred habitats. However, the areas of disturbed habitat would still be small within the context of the Northeast Shelf LME and impacts would be temporary. Thus, BOEM expects cumulative impacts to be **negligible**.

Several Geological and Geophysical Survey Permit applications are under review, but still speculative. If BOEM ultimately permits geological and geophysical surveys, noise and seafloor disturbance would be unavoidable, as well as other potential impacts detailed in Section C.1.10 (Appendix C). The nearest area under consideration is approximately 217 nautical miles from the WDA and is unlikely to have a cumulative impact, given that the disturbance would be temporary and localized. Liquefied natural gas terminals listed in Table C.1-8 (Appendix C) may generate impacts from noise, vessel use, and seafloor disturbance, but these impacts would also be periodic and localized and do not spatially overlap with the Proposed Action. Therefore, BOEM expects **negligible** cumulative impacts.

Long-term conversion of habitat within the Northeast Shelf LME may result from the projects described above (i.e., other offshore wind projects, tidal energy projects, submarine cables, etc.) due to foundation installation, scour protection, and cable armoring. This may result in conversion of soft-bottom habitat to hard-bottom, or the alteration of existing hard bottom. The occurrences of affected habitat would be minimal and species that prefer soft bottom would still have abundant unaltered habitat available nearby. Overall, habitat conversion is unavoidable, but is not expected to have population-level negative effects, so the BOEM anticipates **minor** cumulative impacts.

Increased vessel activity may result from the projects described above, alongside any potential increase in commercial or recreational marine transportation in the region. Assuming all vessels follow standard regulations, there may be **minor** cumulative impacts from noise and **minor** or **negligible** cumulative impacts due to routine vessel discharge. Ongoing military use would generate both vessel traffic and other acoustic stressors and discharges related to military activities, but these are expected to be periodic, with **minor** cumulative impacts.

Seven different Fisheries Use and Management programs regulate commercial and recreational fisheries in and around the WDA in both state and federal waters. The baseline state of fish, invertebrate, and EFH resources described in Section 3.3.6.1 was shaped in part by ongoing fishing activities in the region, and fishing will continue to produce impacts including fish mortality, seafloor disturbance, and vessel use. The Proposed Action may contribute **minor** cumulative impacts alongside these activities, particularly during construction.

Global climate change, including the resulting temperature increases, sea level rise, and stronger storm systems would likely affect fish, invertebrate, and EFH resources regardless of the Proposed Action. Therefore, BOEM does not anticipate the Proposed Action would make any measurable contribution to those cumulative effects. Theoretically, the Proposed Action could ameliorate these effects, although its contribution would be negligible.

BOEM anticipates the cumulative impacts under Alternative B, C, D1, and D2 to be the same as the Proposed Action. BOEM anticipates the cumulative impacts under Alternative E to be the same as the Proposed Action; however, the reduction in the proposed Project footprint would potentially result in an overall reduction in cumulative impacts.

3.3.6.11. Incomplete or Unavailable Information for Finfish, Invertebrates, and Essential Fish Habitat

Currently unavailable information for finfish, invertebrates, and EFH include:

- Marine habitat use by Atlantic sturgeon;
- The amount of hard-bottom habitat impacted in the OECC (potential juvenile Atlantic cod HAPC);
- Impacts of current environmental and climate changes and human-related influences (i.e., commercial fishing) on potential fish community shifts regionally; and
- Large monopile pile driving acoustic impacts on juvenile and adult fish and invertebrates.

Although some information relevant to finfish, invertebrates, and EFH (data, reports, etc.) was not available at the time of publication, sufficient information exists to support the findings presented herein.

3.3.7. Marine Mammals

3.3.7.1. Description of the Affected Environment for Marine Mammals

This section provides information relevant to marine mammals that are found in the vicinity of the proposed Project area, which may be directly or indirectly affected by proposed-Project activities. This section focuses on those species and life stages that are likely to occur regularly or commonly in the WDA based on the area defined by Kenney and Vigness-Raposa (2010).

Regional Setting (Northwest Atlantic)

Thirty-eight species of marine mammals, including 6 mysticetes (baleen whales), 28 odontocetes (toothed whales, dolphins, and porpoise), and 4 seals, are known to inhabit the Northwest Atlantic OCS region (BOEM 2014a). Nineteen are regularly or commonly occurring in the region (Table 3.3.7-1). Among marine mammal species that may be found in the region, the ESA lists five as federally endangered: North Atlantic right whale (NARW), blue whale, fin whale, sei whale, and sperm whale (*Physeter macrocephalus*). Sightings and strandings data indicate that blue whales occur along the U.S. East Coast only occasionally (NMFS 1998; Kraus et al. 2016b). Although the blue whale may be an occasional visitor to the region, it is not considered further in this Draft EIS because it is extremely rare. Beaked whales can occur in relatively high numbers in the region, but generally occur offshore near the shelf edge (BOEM 2014a) and are not considered further in this Draft EIS. All marine mammals are listed under the MMPA. Thirty-three marine mammal species that are not federally listed under that ESA may be found in the region, including 2 baleen whale species, 27 toothed whale species, and 4 seal species.

Seasonal migration between foraging and nursery grounds determines the biogeography of marine mammals in the Northwest Atlantic. The availability and abundance of prey items, which is itself influenced by regional oceanographic conditions, determines these movement patterns. The mixing in the Gulf of Maine of cold, fresh Scotian Shelf water and warm, saltier slope water that enters the Gulf via the Northeast Channel forms the main water mass affecting the New England Shelf. Water temperatures at a depth of 112 feet (34 meters) near the northwest corner of the MA WEA from October 2009 to July 2010 varied between 35 and 75°F (2 and 24°C; Ullman and Codiga 2010b). These conditions affect zooplankton abundance and distribution.

Table 3.3.7-1: Marine Mammals Regularly or Commonly Occurring in the Region

Common Name	Scientific Name	ESA (MMPA) Status [a]	Relative Occurrence in Region [b]	Seasonal Occurrence in Region	Likely to Occur in Project Area [f]
Order Cetacea, Suborder Mysticeti (baleen whales), Family Balaenopteridae					
NARW [c]	*Eubalaena glacialis*	E(D)	Common	Year-round, peak winter-spring	X
Fin whale [c]	*Balaenoptera physalus*	E(D)	Common	Year-round, peak spring-summer	X
Sei whale [c]	*Balaenoptera borealis*	E(D)	Regular	Spring-summer	X
Minke whale [c]	*Balaenoptera acutorostrata acutorostrata*	(N)	Common	Year-round, peak spring-fall	X
Humpback whale (West Indies distinct population segment) [c]	*Megaptera novaeangliae*	(N)	Common	Year-round, peak spring-summer	X
Suborder Odontoceti (toothed whales and dolphins)					
Family Physeteridae					
Sperm whale [c]	*Physeter macrocephalus*	E(D)	Common	Year-round, peak summer-fall	X
Family Delphinidae					
Risso's dolphin	*Grampus griseus*	(N)	Common Offshore	Year-round, peak spring-fall	
Long-finned pilot whale	*Globicephala melas*	(S)	Common	Year-round, peak spring-summer	X
White-beaked dolphin	*Lagenorhynchus albirostris*	(N)	Regular	Spring	
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	(N)	Common	Year-round, peak spring-fall	X
Atlantic spotted dolphin	*Stenella frontalis*	(N)	Rare/ Regular [c]	Spring-fall [d]	
Striped dolphin	*Stenella coeruleoalba*	(N)	Rare/ Regular [c]	Year-round	
Short-beaked common dolphin	*Delphinus delphis*	(N)	Common	Year-round, peak summer-fall	X
Bottlenose dolphin (Western North Atlantic offshore stock)	*Tursiops truncatus*	(D)	Common	Year-round	X

Common Name	Scientific Name	ESA (MMPA) Status [a]	Relative Occurrence in Region [b]	Seasonal Occurrence in Region	Likely to Occur in Project Area [f]
Family Phocoenidae					
Harbor porpoise	*Phocoena phocoena*	(N)	Common	Year-round, peak fall-spring	X
Order Carnivora, Suborder Caniformia, Family Phocidae (earless seals)					
Harbor seal	*Phoca vitulina concolor*	(N)	Common	Year-round [e]	X
Gray seal	*Halichoerus grypus*	(N)	Common	Year-round [e]	X
Harp seal	*Pagophilus groenlandicus*	(N)	Common	Year-round [e]	X
Hooded seal	*Cystophora cristata*	(N)	Regular	Year-round [e]	X

[a] D = Depleted; E = Endangered; ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; N = Not Strategic; NARW = North Atlantic right whale; S = Strategic
[b] Based on occurrence within Rhode Island Ocean Special Area Management Plan Study Area (which includes the WDA and surrounding Project area): Common = greater than 100 records; Regular = 10–100 records; Rare = less than 10 records (Kenney and Vigness-Raposa 2010).
[c] NEFSC and SEFSC 2011a
[d] Based on Kraus et al. 2016b; BOEM 2014a. Region defined as the waters south of Martha's Vineyard and Nantucket and Nantucket Shoals.
[e] Based on Kenney and Vigness-Raposa 2010
[f] Palka et al. 2017

Project Area

Data regarding the occurrence of marine mammals in or near the proposed Project area were collected by vessel, aerial, and acoustic survey methods. A complete list of all marine mammals that may occur in the proposed Project area can be found in COP Table 6.7-1 (Volume III; Epsilon 2018a) and BOEM 2014a. Of the listed species identified in the region, only NARWs, fin whales, sei whales, and sperm whales are likely to occur within the proposed Project area (Table 3.3.7-1; NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015, 2016, 2017; Palka et al. 2017). Please refer to the BA for detailed information regarding these species (BOEM 2018b). Table 3.3.7-1 identifies the 11 non-listed species most likely to occur within the proposed Project area. Risso's dolphins (*Grampus griseus*) and white-beaked dolphins (*Lagenorhynchus albirostris*) are likely to occur in the nearby waters surrounding the proposed Project area (i.e., within 40 nautical miles from the WDA) in relatively high abundance (BOEM 2014a).

Marine mammals are highly migratory, and seasonal occurrences in the proposed Project area vary for each species. The BA includes distribution maps of the listed species in the Project area and details regarding their seasonal occurrence (BOEM 2018b). Seasonal distributions for humpback whales, minke whales, harbor porpoise, and three dolphin species in the proposed Project area are shown in Figures B.5-1 through B.5-4). The distribution maps present species occurrence in the proposed Project area using a combination of habitat-based density estimates (Roberts 2016a, 2016b) and sightings data overlaid as density dots (circles representing the number of animals sighted over the time period; Right Whale Consortium 2018). The density estimates and sightings data are the products of two separate databases, but the combination of these datasets provides a comprehensive assessment of distribution based on available data. Both databases include a compilation of datasets from various sources. Many of the same data sources are included in both databases, but not all. For example, the density estimates are based on data collected from 1992 to 2014, while the sightings data were collected from 1978 to 2017. The density estimates represent the number of animals predicted to occur per 100 km^2. The sightings data are an historical account of the number of whales that have been observed in a particular area, and they do not account for the presence (or absence) of whales in areas not surveyed. BOEM did not correct these sightings data for effort; they are represented as different color and density scales for each species, and thus should not be used to interpret the relative densities of whales.

The habitat within the proposed Project area provides foraging habitat and may play a role in the reproductive cycle for multiple species (Leiter et al. 2017; Stone et al. 2017). Stone et al. (2017) documented 27 sightings of cetaceans with their young, including humpback whales, fin, sei, minke, NARWs, pilot whales, and bottlenose and common dolphins. Humpback whales had the highest number of sightings with calves present (ten). Calves were present in all seasons from October 2011 through June 2015, but a majority of these observations were during spring and summer (81.5 percent). NARWs were observed engaging in mating/courtship behavior and foraging, and mothers with calves were sighted in recent surveys in the Deepwater WLA (Leiter et al. 2017; Stone et al. 2017). The BA provides detailed discussions regarding documented behaviors of listed species (BOEM 2018b). Results from these studies and others indicate that the habitat within the vicinity of the Project area has a higher ecological significance than previously known (Stone et al. 2017).

A total of 669 cetacean sightings, including 384 large whale sightings, were recorded within the Deepwater WLA and MA WEA during systematic line-transect aerial surveys between October 2011 and June 2015 (Kraus et al. 2016b; Stone et al. 2017; Table 3.3.7-2). The area encompassing the Deepwater WLA and MA WEA was also surveyed using aerial and acoustic surveys from 2010 through 2017 as part of the Atlantic Marine Assessment Program for Protected Species (Palka et al. 2017). These data are included in the abundance and sightings maps of humpback whales, minke whales, harbor porpoise, Atlantic white-sided dolphins, bottlenose dolphins, and short-beaked common dolphins by season (Figures B.5-1 through B.5-4).

Table 3.3.7-2: Summary of Species in the Deepwater WLA and MA WEA between October 2011 and June 2015

Common Name	Scientific Name	Number of Sightings/Densities	Season of Sightings	Acoustic Presence Detected
*NARW	*Eubalaena glacialis*	60 (annual average of 35 individuals)	Winter & Spring	Year-round
*Fin	*Balaenoptera physalus*	87	Summer	Year-round
*Sei	*Balaenoptera borealis*	25	Summer	NA
*Sperm	*Physeter macrocephalus*	4	Summer & Fall	NA
Humpback	*Megaptera novaeangliae*	82	Spring & Summer	Winter December through February
Minke	*Balaenoptera acutorostrata acutorostrata*	86	Spring & Summer	October and November, with a few in Winter
Short-beaked common dolphin	*Delphinus delphis*	high densities	Summer & Fall	
Bottlenose dolphin	*Tursiops truncatus*	moderate densities high densities	Spring & Summer Fall	
Harbor porpoise [a]	*Harbor porpoise*	moderate to high densities	Spring, Fall, & Winter	
Atlantic white-sided dolphin [a]	*Lagenorhynchus acutus*	historically in relatively high numbers moderate numbers	Spring Fall	

Source: Kraus et al. 2016b; Stone et al. 2017
* = ESA-listed species; NA = not available
[a] Historically from 1976 through 2018 according to Right Whale Consortium 2018 and as shown in Figures B.5-3 and B.5-4

Aspects of Resource Potentially Affected

Marine mammals utilize the coastal waters of the northwest Atlantic OCS and proposed Project area for a variety of biologically important functions, such as resting, foraging, mating, avoiding predators, and migration (Madsen et al. 2006; Weilgart 2007). The proposed-Project activities could possibly impact the behavior and hearing ability of marine mammals.

Current Condition and Trend

Past and current impacts on marine mammals involve a variety of anthropogenic impacts, including collisions with vessels (ship strikes), whaling/hunting, entanglement with fishing gear, anthropogenic noise, pollution, disturbance of marine and coastal environments, climate change, effects on benthic habitat, waste discharge, and accidental fuel leaks or spills. Many marine mammal migrations cover long distances, so these factors impact animals over very broad geographical scales.

Regional, pre-existing threats to marine mammals in the Project area include fisheries interactions, vessel traffic, ocean noise, and climate change. Due to the changing water temperatures, ocean currents, and increased acidity, climate change has the potential to impact marine mammals prey distribution and abundance. The BA provides a detailed discussion regarding these threats and other proposed Project-related threats to endangered whales (BOEM 2018b). Commercial fisheries occurring in the southeastern New England region include bottom trawl, midwater trawl, dredge, gillnet, longline, and pots and traps (COP; Epsilon 2018a). Targeted fisheries species include monkfish, scallop, surfclam/quahog, squid, mackerel, herring, and lobster among others. Commercial vessel traffic in the region is variable depending on location and vessel type. The commercial vessel types and relative density in the Project region during 2013 include cargo (low), passenger (high), tug-tow (high), and tanker (low) (COP; Volume III; Epsilon 2018a). Ambient noise measured within the WLA was between 76.4 and 78.3 dB re 1 μPa^2 per hertz (Hz), with sources including commercial port traffic, recreational boats, and scientific and naval sonar activity (Alpine Ocean Seismic Surveying Inc. 2017).

Table 3.3.7-3 presents the current status for cetaceans. Over the last several years, NARW distribution and patterns of habitat use have shifted, in some cases dramatically (Pettis et al. 2017). Elevated NARW mortalities have occurred since June 7, 2017. A total of 19 confirmed dead stranded whales, with an additional 5 live whale entanglements in Canada, have been documented to date (NOAA 2018e). Human interactions (e.g., fishery-related entanglements and vessel strikes) are the most likely cause of this unusual mortality event (UME). In addition to this recent UME, the reproductive output for the species has declined by 40 percent since 2010 (Kraus et al. 2016a). In 2018, no new NARW calves were documented in their calving grounds; this represented the first time since annual NOAA aerial surveys began in 1989. This combination of factors threatens the very survival of this species (Pettis et al. 2017). A more detailed discussion of the current status of the NARW is available in the BA (BOEM 2018b).

Data through 2015 indicated that the trend for the Gulf of Maine stock of the humpback whale, which is considered part of the West Indies Distinct Population Segments (DPS), was increasing. However, since January 2016, strandings of humpback whales in the Western North Atlantic have occurred at a higher than normal rate. This event has been declared a UME and may be related to larger-than-usual numbers of vessel collisions (NOAA 2018e). There have been 79 mortalities documented from Maine to Florida through July 31, 2018, as part of this event (NOAA 2018f), with 14 percent off of Massachusetts. Stranding location is not necessarily indicative of the location of injury or death, as floating carcasses can move with tide and currents. Of the whales examined, about 50 percent had evidence of either ship strike or entanglement (NOAA 2018f). Although the stock is currently characterized by an upward trend in abundance, the detected level of U.S. fishery-caused mortality and serious injury, which is likely biased low, is more than 10 percent of the calculated potential biological removal[11] (PBR); and, therefore, cannot be considered insignificant (Hayes et al. 2018). Since January 2017, elevated minke whale mortalities have occurred along the Atlantic coast from Maine through South Carolina, with 43 total strandings documented as of July 31, 2018 (including 13 strandings in Massachusetts; NOAA 2018g). These mortalities have been declared a UME.

Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (12 to 23 cubic centimeters per 100 cubic meters) in January through February to relatively high densities (greater than 55 cubic centimeters per 100 cubic meter) during May through August (NEFSC 2018). These trends are also present in one of the most abundant and widespread zooplankton species on the Northeast U.S. Shelf, *Calanus finmarchicus*, an important food source for many fish species and for NARWs. On average, *C. finmarchicus* has been the most abundant during the spring and summer (March through August), with the peak density in May through June along the Northeast U.S. Shelf (NEFSC 2018). Levels of zooplankton biovolume have been remarkably consistent over the past 20 years with some inter-annual variability. However, mean total density for *C. finmarchicus* along the Northeast U.S. Shelf varied greatly from year to year, commonly halving or doubling from one year to the next (NEFSC 2018). The BA discusses recent trends in the abundance and distribution of this important food source for NARWs (BOEM 2018b). This region also has a very diverse and abundant fish assemblage that includes prey species for marine mammals, including American Sand Lance (*Ammodytes americanus*), Atlantic Herring (*Clupea harengus)*, and Atlantic Mackerel (*Scomber scombrus*).

The U.S. population size of the Western North Atlantic stock of gray seals is estimated at 27,131 (Hayes et al. 2018). For the period 2011 to 2015, the total estimated human-caused mortality and serious injury to gray seals was 5,207 per year (Hayes et al. 2018). The Western North Atlantic (WNA) stocks of gray, hooded, harbor, and harp seals all experience human-caused mortalities each year (Table 3.3.7-3; Hayes et al. 2018, Waring et al. 2007). Mortalities caused by human interactions with seals may result from boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposures, harassment, shooting, and research. During 2011 to 2015, more gray and harp seal strandings were reported in Massachusetts than in any other state from Maine to North Carolina (Hayes et al. 2018). In this same region, hooded seal strandings during 2001 to 2005 were also higher in Massachusetts than in any other state. From Maine to North Carolina during 2011 to 2015, the most stranding mortalities were in Massachusetts (348 animals), which is the center of gray seal abundance in U.S. waters, and this species has the lowest overall stock abundance of the four seals that are found in the region (Hayes et al. 2018; Waring et al. 2007).

[11] Calculated potential biological removal is the maximum number of animals, not including in natural mortalities, which may disappear annually from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population level.

Table 3.3.7-3: Summary of Current Status for Cetaceans and Carnivora

Common Name	Scientific Name	Stock [a]	Population Estimate	Population Trend [a]	Average Annual Minimum Human-Caused Mortality Total = Fishery Entanglement (Vessel Strike) [b]	Stranding Mortalities in Massachusetts (or Specified Area) [b]	Reference
*NARW	*Eubalaena glacialis*	WNA	450	Decline from 2011-2015	5.36 = 4.55(0.81) from 2011-2015 19 mortalities during 2017-June 2018 [c]	9	Hayes et al. 2018
*Fin whale	*Balaenoptera physalus*	WNA	1,618	NA	2.65 = 1.05(1.6)	3	Hayes et al. 2018
*Sei whale	*Balaenoptera borealis*	Nova Scotia	357	NA	0.8	0	Hayes et al. 2017
*Sperm whale	*Physeter macrocephalus*	North Atlantic	2,288	NA	0.8 = 0.2(0.6)	3	Waring et al. 2015
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	823	Increasing through 2015 [d]	8.25 = 6.45(1.8)	19 [c]	Hayes et al. 2018
Minke whale	*Balaenoptera acutorostrata acutorostrata*	Canadian East Coast	2,591	NA	9.15 = 7.75(1.4)	11 [c]	Hayes et al. 2018
Risso's dolphin	*Grampus griseus*	WNA	12,619	NA	43	6	Hayes et al. 2018
Long-finned pilot whale	*Globicephala melas*	WNA	5,636	NA	38	13	Hayes et al. 2017
White-beaked dolphin	*Lagenorhynchus albirostris*	WNA	2,003	NA	0	2	Waring et al. 2007
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	WNA	48,819 [e]	NA	56	62	Hayes et al. 2018
Atlantic spotted dolphin	*Stenella frontalis*	WNA	44,715	NA	0	19 between New York and Florida	Waring et al. 2014
Striped dolphin	*Stenella coeruleoalba*	WNA	54,807	NA	0	13	Waring et al. 2014
Short-beaked common dolphin	*Delphinus delphis*	WNA	70,184	NA	409	441	Hayes et al. 2017
Bottlenose dolphin [f]	*Tursiops truncatus*	WNA offshore	77,532	NA	39.4	~1,650 between New York and Florida	Hayes et al. 2017

Common Name	Scientific Name	Stock [a]	Population Estimate	Population Trend [a]	Average Annual Minimum Human-Caused Mortality Total = Fishery Entanglement (Vessel Strike) [b]	Stranding Mortalities in Massachusetts (or Specified Area) [b]	Reference
Harbor Porpoise	*Phocoena phocoena*	Gulf of Maine/ Bay of Fundy	79,883	NA	307	207	Hayes et al. 2018
Gray seal	*Halichoerus grypus*	WNA	27,131	NA	5,207	348	Hayes et al. 2018
Hooded seal	*Cystophora cristata*	WNA	512,000	NA	368	421	Hayes et al. 2018
Harp seal	*Pagophilus groenlandicus*	WNA	7.4 million	NA	216,044	106	Hayes et al. 2018

*ESA-listed species
[a] NA = not available; NARW = North Atlantic right whale; WNA = Western North Atlantic
[b] Average annual mortalities and strandings based on the following date ranges for each reference: Hayes et al. 2018 = 2011 to 2015; Hayes et al. 2017 = 2010 to 2014; Waring et al. 2015 = 2009 to 2013; Waring et al. 2014 = 2008 to 2012; Waring et al. 2007 = 2001 to 2005
[c] Unusual Mortality Event (UME)
[d] However, since January 2016 strandings have increased in the WNA at a higher rate than normal
[e] Gulf of Maine population, not the entire WNA stock
[f] There was a UME for common bottlenose dolphin stocks in the WNA during 2013–2015 (Hayes et al. 2017).

The Western North Atlantic stock of harbor seals is estimated at 75,834 animals, with an estimated human-caused mortality and serious injury of 368 seals per year (Hayes et al. 2018). During 2011 to 2015 from Maine to North Carolina, the second highest number of harbor seal strandings (421 animals) was recorded off Massachusetts (Hayes et al. 2018). The current abundance estimate for hooded seals belonging to the Western North Atlantic stock is 512,000, with an estimated human-caused mortality and serious injury of 5,199 animals per year (Waring et al. 2007). Among strandings from Maine to North Carolina from 2001 to 2005, the highest number of hooded seals was recorded off Massachusetts (53 animals; Waring et al. 2007). The abundance estimate for the Western North Atlantic stock of harp seals is 7.4 million animals, with an estimated human-caused mortality and serious injury rate of 216,044 seals per year (Hayes et al. 2018). From 2011 to 2015 from Maine to North Carolina, the highest number of strandings (106 animals) was recorded off Massachusetts (Hayes et al. 2018). NMFS defines a strategic marine mammal stock as a declining stock that is experiencing a high level of human-caused mortality, and is likely to be listed under the ESA, or designated as depleted under the MMPA. None of these seal stocks are considered strategic.

3.3.7.2. Environmental Consequences

Relevant Design Parameters

The primary Project design parameters that would influence the magnitude of the impact on marine mammals include (see Appendix G for details on the design parameters and maximum-case scenario):

- *The WTG foundation type used.* The potential acoustic impacts on marine mammals differ among the WTG foundation types that Vineyard Wind would use: either 100 monopiles (34-foot-diameter [10.3-meter]) and up to two ESP jacket foundations (Scenario 1) or a combination of 90 monopiles and up to 12 jacket foundations (Scenario 2). The jacket-type foundation would have a higher acoustic impact and a greater risk of exposure than the monopile foundation because of the longer time required to install more piles (up to four 9.8-foot [3-meter] pin piles per jacket) (Pyć et al. 2018). Sound exposure levels are higher for marine mammals under Scenario 2 than under the Scenario 1 (Pyć et al. 2018).
- *Sound produced by pile driving.* To assess daily underwater sound produced by pile driving, each pile type is analyzed independently due to differences in source levels produced by the hammer power needed to drive each pile type, daily pile-driving duration for each foundation type, the main frequencies produced by each pile diameter, and impacts on each marine-mammal hearing group. Depending on the species' hearing differences and pile differences, the relative impacts on each hearing group vary considerably, warranting a separate analysis for each pile type.
- *Total days of pile driving.* At the installation rate of one monopile or jacket foundation per day, Vineyard Wind would need a total of 102 days of pile driving regardless of whether they use Scenario 1 or Scenario 2 (Pyć et al. 2018). At two monopiles and one jacket foundation installed per day, only 52 days of pile driving would be needed for Scenario 1 and 57 days of pile driving for Scenario 2. In terms of total days of pile driving, the maximum-case scenario would be 102 days of work (Pyć et al. 2018).
- *Vessels and ports.* Vineyard Wind would utilize a number of ports during proposed-Project activities. See Section 2.1.1, for more details.

Potential Variances in Impacts

Potentially variable aspects of the proposed-Project design include the OECC route, the WTG design selected (e.g., 8 MW, 10 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule. Although some variation is expected in the design parameters, any scenario within the PDE would likely lead to impacts similar to those under the maximum-case scenario.

3.3.7.3. Impacts of Alternative A (Proposed Action) on Marine Mammals

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Cetaceans rely heavily on acoustics for communication, foraging, mating, avoiding predators, and navigation (Madsen et al. 2006; Weilgart 2007). Proposed Action activities may negatively affect marine mammals if the sound frequencies produced overlap with the functional hearing range of the animal exposed (NSF and USGS 2011). Noise-producing Proposed-Action activities may negatively affect marine mammals during foraging, orientation, migration, response to predators, social interactions, or other activities (Southall et al. 2007). Noise exposure can interfere with these functions, with the potential to cause responses ranging from mild behavioral changes to physical injury. Marine mammals may also be affected by non-acoustic Proposed Action activities including vessel strike, accidental spills, and changes to benthic foraging habitat.

Construction and Installation of Offshore Components

Vineyard Wind submitted comprehensive acoustic modeling of underwater sound propagation and potential effects on marine species during piling installation for the Proposed Action (Pyć et al. 2018) that provided detailed information for the pile-driving analysis. Pyć et al. (2018) modeled Scenarios 1 and 2 over a construction period of May through December (excluding the months of January through April), when endangered NARWs are likely to be present in relatively high numbers.

For estimating marine mammal densities (animals/km^2) for modeling, Pyć et al. (2018) used the Duke University Marine Geospatial Ecological Laboratory model results (Roberts et al. 2016a) and an unpublished updated model for NARW densities (Roberts et al. 2016b) that incorporates more sighting data, including those from the Atlantic Marine Assessment Program for Protected Species (2010 to 2014). Pyć et al. (2018) calculated the density estimates for pinnipeds using Roberts et al. (2016a) density data. The model used the following NMFS (2018) threshold criteria for Level A harassment[12], permanent threshold shift (PTS) to marine mammals (see Table 3.3.7-4). These numbers are preliminary and may not reflect the actual take numbers authorized under the ESA and MMPA by NMFS.

Table 3.3.7-4: PTS Onset Acoustic Threshold Levels

Hearing Group	PTS Onset Thresholds to Evaluate Level A Harassment [a] (received level)	
	Impulsive	Non-impulsive
LFC	L_{pk}, flat 219 dB; L_{E24} 183 dB	L_{E24} 199 dB
MFC	L_{pk}, flat 230 dB; L_{E24} 185 dB	L_{E24} 198 dB
HFC	L_{pk}, flat 202 dB; L_{E24} 55 dB	L_{E24} 173 dB
PPW	L_{pk}, flat 218 dB; L_{E24} 85 dB	L_{E24} 201 dB

Source: Pyć et al. 2018; NMFS 2018a

µPa = micropascal; µPa^{2}s = micropascal squared second; dB = decibel; HFC = high frequency cetacean (harbor porpoise); L_{pk} flat = peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa; L_{E24} = cumulative sound exposure over a 24 hour period and has a reference value of 1 µPa^{2}s; LFC = low frequency cetacean (all the large whales except sperm whales); MFC = mid-frequency cetacean (all dolphins, pilot whales, and sperm whales); PPW = Pinnipeds in the water (all seals); PTS = permanent threshold shift

[a] Dual-metric acoustic thresholds for impulsive sounds. Use whichever results in the largest isopleth (mapped distance) for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Because of the complexity and variability of marine mammal behavioral responses to acoustic exposure, NMFS has not yet released technical guidance on behavioral threshold criteria (Level B harassment[13]; NMFS 2018a). NMFS currently uses a step function to assess behavioral impact (NOAA 2005 as cited in Pyć et al. 2018). Pyć et al. (2018) use the unweighted NOAA (2005), and the frequency-weighted Wood et al. (2012) criteria to estimate behavioral response to impulsive pile-driving sound (see Table 3.3.7-5).

Table 3.3.7-5: Behavioral Exposure Criteria

Marine Mammal Group	Probability of response to frequency-weighted SPL (dB re 1 µPa)				Unweighted (dB root mean square) [a]
	120	140	160	180	
Harbor porpoise (*Phocoena phocoena*)	50%	90%			160
Migrating mysticete whales	10%	50%	90%		160
All other species (and behaviors)		10%	50%	90%	160

Source: Adapted from Wood et al. 2012; Pyć et al. 2018

µPa = micropascal; dB = decibel; SPL = sound pressure level

Note: Probability of behavioral response frequency-weighted sound pressure level (SPL dB re 1 µPa); probabilities are not additive.

[a] Pyć et al. 2018

Pyć et al. (2018) modeled three levels of attenuation: 0 dB (no attenuation), 6 dB, and 12 dB. The 0 dB level was modeled as a reference point to evaluate the effectiveness of the proposed mitigation of sound reduction technology (e.g., Hydro-sound Damper, bubble curtains or similar). When comparing the two potential levels of attenuation (6 dB and 12 dB), 6 dB is the least effective modeled level and would be considered as the most impactful.

[12] Level A harassment "has the potential to injure a marine mammal or marine mammal stock in the wild" (NOAA 2017d).

[13] Level B harassment "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild" (NOAA 2017d).

Table 3.3.7-6 summarizes the numbers of marine mammals estimated to experience sound levels above threshold criteria for Level A and Level B harassment for the maximum-case scenario condition, Scenario 2 (up to 90 monopiles and up to 12 jacket foundation) with 6 dB attenuation (Pyć et al. 2018). The Pyć report integrates results from acoustic propagation models (which estimate the amplitude of sounds at a given location) and species density maps. Their report predicts the number of individual animals (for each species) that would be exposed to a given sound level at each part of the area of interest. Overall, the numbers of marine mammals potentially exposed to impacts, and may potentially receive Level A harassment, from pile driving are higher under Scenario 2 (Pyć et al. 2018; Table 3.3.7-6).

Table 3.3.7-6 also provides the number of marine mammals estimated to be exposed to Level B harassment with 6 dB attenuation (Pyć et al. 2018). Numbers for small cetaceans and seals are generally higher due to their relatively high abundance in the Proposed Action area.

Table 3.3.7-6: Numbers of Marine Mammals Estimated to Experience Sound Levels above Threshold Criteria for Scenario 2 (Two Piles Installed per Day with 6 dB Attenuation)

Common Name	Scientific Name	Injury (L_{pk})	Injury (L_E)	Behavior Maximum SPL ($L_{p,24hr}$)
*NARW	*Eubalaena glacialis*	0.02	1.39	11.75
*Fin Whale	*Balaenoptera physalus*	0.12	5.32	35.04
*Sei Whale	*Balaenoptera borealis*	0	0.21	1.44
Humpback Whale	*Megaptera novaeangliae*	0.02	7.05	19.96
Minke Whale	*Balaenoptera acutorostrata*	0.02	0.21	10.25
*Sperm Whale	*Physeter macrocephalus*	0	0	0
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	0.13	0	442.69
Bottlenose Dolphin	*Tursiops truncatus*	0	0	62.48
Pilot Whales	*Globicephala*	0	0	0
Risso's Dolphin	*Grampus griseus*	0	0	0.49
Short-beaked Dolphin	*Delphinus delphis*	0.27	0	540.25
Harbor Porpoise	*Phocoena phocoena*	6.14	0.25	181.70
Harbor Seal	*Phoca vitulina concolor*	0.78	0.70	132.62
Gray Seal	*Halichoerus grypus*	0.24	0.43	116.96
Harp Seal	*Pagophilus groenlandicus*	0.30	0.44	130.92

Note: Scenario 2 = 90 monopiles and up to 12 jacket foundations
* = ESA, listed species; L_E = cumulative sound exposure; L_{pk} = peak sound pressure; $L_{p,24hr}$ = sound pressure level over 24 hours; NARW = North Atlantic right whale

Pyć et al. (2018) also estimated the Level A and Level B acoustic threshold exposures as a percentage of each species' abundance for Scenarios 1 and 2. Estimated percentages are higher for Scenario 2 compared to Scenario 1 and is presented here as the maximum-case scenario (Pyć et al. 2018). Estimated population-level percentages for Level A and Level B exposure were less than 1 percent for all marine mammals except NARW and humpback whales for Level A and NARW, humpback whales, and Atlantic white-sided dolphin (see Table 3.3.7-7; Pyć et al. 2018).

Table 3.3.7-7: Estimated Exposure Threshold as a Percentage of Species' Abundance for Scenario 2 (Two Piles per Day with 6 dB Attenuation)

Species	Scientific Name	Scenario 2		
		Level A (L_{pk})	Level A (L_E)	Level B maximum SPL ($L_{p,24hr}$)
*NARW	*Eubalaena glacialis*	0.01	0.35	2.98
*Fin Whale	*Balaenoptera physalus*	0	0.09	0.61
*Sei Whale	*Balaenoptera borealis*	0	0.03	0.21
Humpback Whale	*Megaptera novaeangliae*	0	0.54	1.54
Minke Whale	*Balaenoptera acutorostrata*	0	0.01	0.38
*Sperm Whale	*Physeter macrocephalus*	0	0	0
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	0	0	1.19
Bottlenose Dolphin	*Tursiops truncatus*	0	0	0.06
Pilot Whales	*Globicephala*	0	0	0
Risso's Dolphin	*Grampus griseus*	0	0	0.01
Short-beaked Dolphin	*Delphinus delphis*	0	0	0.63

Species	Scientific Name	Scenario 2		
		Level A (L_{pk})	Level A (L_E)	Level B maximum SPL ($L_{p,24hr}$)
Harbor Porpoise	*Phocoena phocoena*	0.01	0	0.21
Harbor Seal	*Phoca vitulina concolor*	0	0	0.17
Gray Seal	*Halichoerus grypus*	0	0	0.43
Harp Seal	*Pagophilus groenlandicus*	0	0	0

Note: Scenario 2 = 90 monopiles and up to 12 jacket foundations
* = ESA, listed species; L_E = cumulative sound exposure; L_{pk} = peak sound pressure; $L_{p,24hr}$ = sound pressure level over 24 hours; NARW = North Atlantic right whale

Pyć et al. (2018) provides a radial distance to threshold criteria[14] for Level A harassment for installation of one 34-foot (10.3-meter) monopile and four 10-foot (3-meter) jacket piles for each hearing group with 6 dB attenuation, considered the most impactful scenario (see Table 3.3.7-8). Radial distances to Level A thresholds are greater for four jacket piles compared to one monopile for all hearing groups (see Table 3.3.7-8) (Pyć et al. 2018). When comparing all hearing groups, radii are the largest for the low-frequency hearing group (mysticetes), and range from 4.5 miles (7,253 meters) for the jacket foundation to 2.0 miles (3,191 meters) for the monopile foundation with 6 dB attenuation. Radial distance to thresholds for Level A harassment are moderate for seals in water (0.6 miles [977 meters]) and harbor porpoise (high-frequency hearing group; 0.4 miles [564 meters]) during installation of jacket piles. Pyć et al. (2018) assumed jacket foundation installation occurring for a maximum of 12 pile-driving days under Scenario 2 (up to 10 WTG and two ESP jacket foundations; 2 days each month from June through September and 1 day each month during May, and October through December) or two pile-driving days under Scenario 1 (two ESP jacket foundations; 1 day each month in July and August).

Table 3.3.7-8: Radial Distances (R95% in meters) to Sound Pressure Level for Level A and Level B Harassment Thresholds for Marine Mammals with 6 dB Attenuation

Foundation Type	Hearing Group	Level A Harassment (L_{pk})	Level A Harassment (L_{E24})	Level B Unweighted 160 dB (root mean square)	Level B Frequency-Weighted Mean 50% Probability of Response (L_{E24}) [b]
		6 dB	6 dB	6 dB	6 dB
34-foot (10.3-meter) diameter monopile	LFC	17	3,191	4,121	4,007
	MFC [a]	5	43		821
	HFC	119	71		22,140
	PPW	19	153		2,046
Four, 10-foot (3-meter) diameter jacket piles	LFC	4	7,253	3,220	3,302
	MFC [a]	1	71		1,406
	HFC	26	564		34,918
	PPW	5	977		2,400

Source: Pyć et al. 2018 and Wood et al. 2012
Note: Level A distances are the average of two measured positions. Level B ranges are calculated using the average maximum hammer energy at two modeling sites for marine mammal functional hearing groups estimated for each scenario foundation type.
μPa = micropascal; μPa^2s = micropascal squared second; dB = decibel; HFC = high frequency cetacean (harbor porpoise); LFC = low frequency cetacean (all the large whales except sperm whales); L_{pk} = peak sound pressure; L_{E24} = cumulative sound exposure over a 24 hour period and has a reference value of 1 μPa^2s; MFC = mid-frequency cetacean (all dolphins, pilot whales, and sperm whales); PPW = Pinnipeds in the water (all seals)
[a] The mysticetes found in the WDA during planned operations are likely foraging even if they are migrating (e.g., Leiter et al. 2017). The migrating mysticete category in Wood et al. (2012) was not used to select ranges used in the table.
[b] Wood et al. 2012

Vineyard Wind's self-imposed measures of utilizing soft start, Protected Species Observers, and passive acoustic monitoring would reduce the potential impacts to marine mammals. Vineyard Wind's self-imposed measures are described in detail in Pyć et al. 2018, Table 31. Based on the analysis, there is a **minor** to **moderate** risk of Level A and Level B harassment to marine mammals from pile driving due to the large radial distance to this threshold and maximum-case of 102 days that pile driving may occur. Therefore, BOEM considers impacts from pile driving to be

[14] The radial distance to threshold criteria is the radius of a circle centered around the source encompassing the sound at levels above threshold.

minor for NARW due to avoidance of peak seasons of occurrence and **moderate** for all other marine mammals. BOEM could further reduce potential impacts on marine mammals by implementing mitigation measures outlined in Appendix D, which could include long-term passive acoustic monitoring; daily, pre-construction PAM and visual surveys; and the sunrise and sunset prohibition on pile driving as well as requiring the use of noise reduction technologies during all pile-driving activities to achieve a required minimum attenuation (reduction) of 6 dB re 1 μPa (root mean square). These above measures would reduce noise impacts during construction and the likelihood of impacts to marine mammals, but would not result in a change to the significance level of impacts.

The isopleths for Level A harassment during installation of a jacket foundation for NARW, fin, sei, humpback, and minke whales (4.5 miles [7,253 meters]) is too large to monitor effectively by visual observation. Isopleths to injury thresholds during pile driving of monopile foundations are smaller than those for jacket piles, although the radial distance to the Level A harassment threshold for large whales is still too large to be effectively monitored using visual observation (3.3 miles [5,443 meters]; see Table 3.3.7-8) (Pyć et al. 2018). The maximum number of pile-driving days is 102, at the rate of one monopile installed per day (see Table 5.1-5 in BOEM 2018b; Pyć et al. 2018).

The traditional method of assessing Level B impacts on marine mammals is an unweighted 160 dB sound pressure level (SPL) (NOAA 2005 as cited in Pyć et al. 2018). However, the application of a step function that evaluates weighted exposures as a percentage of animals responding between each step between different threshold levels has gained recent acceptance (Wood et al. 2012; Nowacek et al. 2015). Analyses of both approaches to assess the consequences of sound exposure on marine mammals can produce very different results (Farmer et al. 2018). Since there is no NMFS guidance available on either single metric or probabilistic dose-response functions required to evaluate the impacts of sound exposure for marine mammals, BOEM has applied both approaches in this analysis. Maximum distances are presented using the hammer energy schedule for one 34-foot (10.3-meter) diameter monopile and four jacket piles, corresponding to the most conservative hammer and energy combination (see Table 3.3.7-8).

Using the unweighted criteria, radial distance to Level B harassment with 6 dB attenuation is lower for jacket piles (2 miles [3,220 meters]) compared to a 34-foot (10.3-meter) monopile (2.6 miles [4,121 meters]) for all marine mammals (see Table 3.3.7-8) (Pyć et al. 2018). Using the weighted criteria, radial distance to the Level B threshold is also lower for jacket piles for low-frequency cetaceans (2.1 miles [3,302 meters]) compared to a 34-foot (10.3-meter) monopile (2.5 miles [4,007 meters]). However, for all other hearing groups, radial distances are greater for jacket piles compared to a monopile foundation (see Table 3.3.7-8) (Pyć et al. 2018).Pile-driving noise has the potential to cause Level A and Level B harassment to marine mammals. Vineyard Wind would use sound-reducing technologies to minimize harmful impacts to marine mammals, but as discussed above, attenuation level may vary with local conditions. With a proposed target of 12 dB and maximum-case scenario of 6 dB attenuation, there is a **minor** to **moderate** risk of Level B harassment to marine mammals from pile driving due to the large radial distance to this threshold and the up-to-102 days that pile driving may occur. With the added requirement of 6 dB attenuation from BOEM to the supplementary NARW mitigation, impacts from pile driving would be **minor** for NARW due to avoidance of peak seasons of occurrence and **moderate** for all other marine mammals.

Increased vessel traffic may also impact marine mammals. Vessel noise is the human activity that generates the greatest amount of sound energy into the ocean (Weilgart 2007). Vessel noise may result in multiple impacts for marine mammals, including reduced communication, interference with predator/prey detection, and avoidance of habitat areas (Southall 2005). Ship engines and vessel hulls themselves emit broadband, continuous sound, generally ranging from 150 to 180 dB re 1 μPa per meter, at low frequencies below 1000 Hz (NSF and USGS 2011). The frequency range for vessel noise overlaps the hearing frequency range for all marine mammals.

Possible effects from vessel noise are variable and can depend on species, location, whale activity, novelty of the noise, vessel behavior, and habitat. Right whales are known to produce a variety of sounds with most of the energy below 1,000 Hz (Parks and Tyack 2005) overlapping with the energy of vessel noise. In a study investigating NARW reactions to shipping noise, tagged whales showed no response to playback of vessel noise and passing vessels approached the whales to within less than 1 nautical mile (Nowacek et al. 2004). This lack of response suggests that whales are unlikely to respond to the sounds of oncoming vessels even when they hear them, thereby increasing the risk of ship strike (Nowacek et al. 2004). This is particularly problematic for whales swimming below the surface where they are less likely to be observed by mariners.

Studies indicate noise from shipping increases stress hormone levels in NARWs (Rolland et al. 2012), and modeling suggests that their communication space has been reduced substantially by anthropogenic noise (Hatch et al. 2012). Authors also suggest that physiological stress may contribute to suppressed immunity and reduced reproductive rates and fecundity in NARWs (Hatch et al. 2012; Rolland et al. 2012). Similar impacts could occur for other marine mammal species. Other behavioral responses to Proposed Action-related noise could include animals avoiding the ensonified area, which may have been used as a forage, migratory, or socializing area.

Potential acoustic impacts from vessel noise during construction and installation activities would consist of vessel noise produced during vessel transit to and from ports, as well as, the vessel noise produced during the placement of scour protection, dredging, cable laying by jet plow, bathymetric surveys, and WTG and ESP installation.

According to the Navigation Risk Assessment (COP Appendix III-I; Epsilon 2018a), current vessel traffic in the Proposed Action area and surrounding waters is relatively high, and vessel traffic within the MA WEA and WDA is relatively moderate (see Section 3.4.7). The NRA for the Proposed Action area indicates that the maximum number of vessels in the WDA or OECC during construction would be 46 per day (with an average of 25 per day) (COP Appendix III-I; Epsilon 2018a). This volume of traffic would vary monthly depending on weather and Proposed Action activities. Over the course of the entire construction phase, the Proposed Action would generate an average of seven daily vessel trips between both the primary and secondary ports and the WDA or OECC. During the period of maximum activity, Proposed Action construction would generate an average of 18 construction vessel trips per day in or out of construction ports. In maximum conditions, this could theoretically include up to 46 trips in a single day—including up to 4 trips per day to or from secondary ports, with the remainder originating or terminating at the New Bedford MCT, compared to the current 25 daily vessel trips measured via AIS in 2011 (COP Appendix III-I; Epsilon 2018a). Vineyard Wind would be using MCT as the primary port for construction, with potential secondary ports located in Rhode Island, Massachusetts, Connecticut, and Canada. Vessels would deliver components from European ports. Any vessels transiting from Canada and Europe would follow the major navigation routes.

Results from studies on acoustic impacts from vessel noise on odontocetes indicate that small vessels at a speed of 5 knots in shallow coastal water can reduce the communication range for bottlenose dolphins within 164 feet (50 meters) of the vessel by 26 percent (Jensen et al. 2009). Pilot whales in a quieter, deep-water habitat could experience a 50-percent reduction in communication range from a similar size boat and speed (Jensen et al. 2009). Since lower frequencies propagate further away from the sound source compared to higher frequencies, low frequency cetaceans are at a greater risk of experiencing Level B harassment produced by vessel traffic. Potential behavioral impacts from Proposed Action-related vessel traffic noise is anticipated to be **moderate** for mysticetes because the frequency of sound emitted from vessels overlaps to a greater extent for this low-frequency hearing group compared to the other groups, and **minor** for all other marine mammals. BOEM could further reduce potential impacts on marine mammals by implementing mitigation measures outlined in Appendix D, which could include the requirement of AIS on all Proposed Action vessels, which would allow Vineyard Wind to monitor the number of vessels and traffic patterns for compliance with vessel speed requirements, and would decrease the potential for vessel strike for marine mammals. This measure would reduce potential impacts during construction and the likelihood of impacts to marine mammals but would not result in a change to the significance level of impacts.

Vineyard Wind would use vessels with ducted propeller thrusters during construction and installation activities. Of the 19 different Proposed Action vessel types listed in COP Table 4.2-1 (Volume I, Section 4.2.4; Epsilon 2018a) all except three—barge, floating crane, and smaller support vessels that use jet-drive propulsion—are described as having "blade propeller system/blade thrusters." Assuming sound sources for blade propeller system/blade thrusters are similar to those for ducted propellers, vessel noise may cause behavioral modification for some marine mammals. Sound-source levels for ducted propeller thrusters were modeled for a project offshore of Virginia (BOEM 2015) and measured during the installation of the Block Island Wind Farm transmission cable. For both projects, the sound-source level was 177 dB (root mean square) at 3 feet (1 meter). Ducted propeller thruster use may exceed threshold criteria for injury at a distance of 351 feet (107 meters) (BOEM 2014a). However, marine mammals would need to remain within that distance for a prolonged period to be impacted by PTS, which is extremely unlikely to occur. Distances to the threshold criteria for behavioral modification for marine mammals would be approximately 0.9 to 2 miles (1.4 to 3.2 kilometers).

The BA provides details regarding impacts on listed whale species (BOEM 2018b). The potential for any harassment of marine mammals from ducted propeller thruster use is considered **moderate** for listed whale species (low-frequency cetaceans: NARW, fin and sei whales) and **minor** for all other marine mammals.

Cable laying may also impact marine mammals. The timeframe for offshore export cable installation is still being developed in response to time-of-year considerations, especially those provided by the MA DMF. Additionally, the scheduling of the offshore export cable installation also considers ongoing construction planning and sequencing for the entire proposed Project, as well as refinements to the statistical weather modeling. At this point, it is likely that offshore export cable installation would occur in the period April through October. If offshore export cable installation occurs in April, it is possible that NARW would be feeding in the vicinity of the OECC. However, all appropriate mitigation measures would be implemented to minimize potential impacts to the whales, including the 1,640-foot (500-meter) setback (Vineyard Wind 2018c). Vineyard Wind may use several different methods to lay the offshore cables, but expects to install the majority of the export and inter-array cables using simultaneous lay and bury via jet plowing. However, other methods may be needed in areas of coarser or more consolidated sediment, rocky bottom, or other difficult conditions to ensure a proper burial depth. The cumulative sound exposure level over 24 hours (L_{E24}) during cable laying is expected to reach approximately 237 dB re 1 $\mu Pa^2 s$ at 1 meter (3.3 feet) (Brims 2015), which exceeds the NMFS threshold criteria for PTS from non-impulsive noise (L_{E24} 199 dB re 1 μPa^{2}s; Pyć et al. 2018). The radial distance to the threshold criteria for Level A or Level B harassment for marine mammals in the Proposed Action area is not known. The distance to the threshold for Level A harassment is expected to be relatively small and the distance to threshold for Level B harassment is expected to be in the range of other vessel noise. BOEM therefore anticipates **minor** impacts from cable laying noise.

Vineyard Wind may use helicopters to supplement crew transport and for Proposed Action support during both construction and operations (Epsilon 2018a). A study observing bowhead whales' (*Balaena mysticetus*) behavioral responses to helicopters indicated that their presence causes some behavioral changes, including short surfacing durations, abrupt dives, and percussive behavior (e.g., breach, tail slap; Patenaude et al. 2002). Of the 63 bowhead groups observed, 14 percent reacted to the helicopter, with the majority of the responses occurring when the helicopter was at altitudes of 492 feet (150 meters) and lateral distances of 820 feet (250 meters). Patenaude et al. (2002) included an analysis of the noise recorded at 9.8 and 59 feet (3 and 18 meters) depth that was generated by two aircrafts, a Bell 212 helicopter and a fixed-wing De Havilland Twin Otter. The helicopter was 7 to 17.5 dB louder than the fixed-wing aircraft, with a peak received level of approximately 126 dB re 1 mPa, and the sound levels for the helicopter were predictably and inversely related to altitude. The study suggests that the responses to the helicopter were acoustic rather than visual (Patenaude et al. 2002). While helicopter traffic may cause some behavioral changes for marine mammals, BOEM does not expect it to cause injury. Thus, the potential impacts from helicopter noise would be **minor** for all marine mammals**.**

Vessel strike is one of the primary causes of death to NARWs, with as many as 75 percent of known anthropogenic mortalities of NARWs likely resulting from collisions with large ships along the U.S. and Canadian eastern seaboard (Kite-Powell et al. 2007). Marine mammals are more vulnerable to vessel strike when they are within the draft of the vessel and when they are not detectable by visual observers. Some behaviors or conditions that make marine mammals undetectable include skim feeding or swimming just below the surface, weather conditions with poor visibility, and nighttime. Vessels operating at speeds exceeding 10 knots have been associated with the highest risk for vessel strikes of NARWs (Vanderlaan and Taggart 2007). Due to the relatively low densities of NARW in the Project area, concentrating vessel traffic into corridors would have a **negligible** impact on the potential for vessel strike. COP Table 4.2-1 (Volume I, Section 4.2.4; Epsilon (2018) summarizes vessel details including type/class, number of each type, length, and speed for each Proposed Action activity during construction. The maximum transit speeds of these vessels vary from 6 to 30 knots. Operational vessels within the WDA would usually be stationary or travelling at slow speeds, although transits between ports and the WDA may result in speeds ≥10-knots. For example, transits of heavy cargo vessels, deck carriers, and semi-submersible vessels (lengths ranging from 394 to 732 feet [120 to 223 meters]) used for overseas foundation transport have an operational speed of 13 to 18 knots; multi-role survey vessels or smaller support vessels (lengths from 43 to 367 feet [13 to 112 meters]) used for pre-installation surveys have operational speeds ranging from 18 to 22 knots; and crew transfer vessels (66 to 98 feet [20 to 30 meters]) used for crew transfer, refueling, or as a service boat, have operational speeds of 25 knots (COP Volume I, Table 4.2-1; Epsilon 2018a). Vineyard Wind's self-imposed measures are described in detail in Pyć et al. 2018, Table 31.

Study results indicate that for vessels travelling at greater than 14 knots, these measures may not be protective of whales located between 328 and 820 feet (100 and 250 meters) directly in the path of a large vessel. Kite-Powell et al. (2007) modeled the likelihood of a strike with a NARW where the ship is initially on a collision course with the whale. Model results suggest that oncoming vessels traveling at 15 knots or more are likely to strike more than half of NARWs located in or swimming into the vessels' path, even when they take evasive action (Kite-Powell et al. 2007). The model also suggests that the strike risk posed by a conventional ship moving at 20 to 25 knots can be reduced by 30 percent when slowing down to 12 or 13 knots, and by 40 percent at 10 knots. Whales are more likely to be safe from ship strikes if they detect and react to an oncoming vessel at a distance of 820 feet (250 meters) or more. Strike risk is considerable if the detection distance drops below 328 feet (100 meters).

These results suggest that for conventional ships at speeds in excess of 10 knots, encounters are virtually certain to result in ship strikes if the detection distance is 164 feet (50 meters) or less. When detection distance is around 328 feet (100 meters), there is no appreciable strike risk for ship speeds below 10 knots; the strike risk rises rapidly to between 50 and 80 percent at 15 knots, and exceeds 90 percent above 20 knots. For detection distance of 492 feet (150 meters), lethal strike risk is **negligible** below 15 knots, and reaches 60 to 80 percent at 25 knots. At a 656 foot- (200 meter-) detection distance, strike risk begins at 20 knots and stays below 40 percent even at 25 knots. Detection distances of 820 feet (250 meters) or above create very low ship strike risk from conventional vessels. In addition, Vanderlaan and Taggart (2007) estimated that the probability of a lethal injury given a ship strike increases from 21 percent at ship speeds of 8.6 knots to 50 percent at 11.8 knots and 79 percent at 15 knots. The BA provides additional details regarding impacts on listed whale species (BOEM 2018b). Due to the relatively moderate level of increase in vessel traffic and the size and operation speed of Proposed Action vessels, BOEM expects **moderate** impacts from vessel strikes for mysticetes and **minor** for all other marine mammals.

Elevated levels of turbidity may potentially impact fish prey species and the ability to forage for some marine mammals. Model results of simulations show that the use of the trailing suction hopper dredger for pre-cable installation dredging on the OECC has the potential to generate temporary turbidity plumes throughout the entire water column of TSS at 10 mg/L extending up to 9.9 miles (16 kilometers) and 750 mg/L extending up to 3.1 miles (5 kilometers) from the OECC centerline for 2 to 3 hours respectively, though this may be less extensive at varying locations along the route (COP, Volume III-A; Epsilon 2018a).

Relatively high TSS concentrations (>1,000 mg/L) are predicted at distances up to 3.1 miles (5 kilometers) from the OECC centerline in response to the relatively high loading of dumping and swift transport of the dumped sediments, but this high concentration would only persist for less than 2 hours. In general, excess TSS concentrations over 10 mg/L from dredging can extend several kilometers from the OECC centerline and may be present throughout the entire water column but are temporary and typically dissipate within about 6 hours (COP Volume III, Appendix III-A; Epsilon 2018a). Elevated turbidity levels would be short-term and temporary, and marine mammals reside often in turbid waters, so significant impacts from turbidity are not likely (Todd et al. 2015). BOEM anticipates **negligible** impacts on marine mammals from turbidity.

Sediment dispersal model results indicate that during inter-array cable-laying activities most of the mass settles out quickly and is not transported for long by the currents (COP, Volume III-A; Epsilon 2018a). The sediment plume is confined to the bottom 9.8 feet (3 meters) of the water column, which is only a fraction of the total water column in the WDA. Deposition greater than 0.04 inch (1 millimeter) is confined within 328 feet to 492 feet (100 meters to 150 meters) of the trench centerline for the typical and maximum-impact simulations respectively, and maximum deposition in both simulations is less than 0.2 inch (5 millimeters). Therefore, BOEM anticipates short-term and localized water quality impacts from inter-array cable installation and **negligible** impacts on marine mammals from turbidity.

Benthic soft-bottom communities affected by anchoring of vessels, installation of WTG and ESP foundations, inter-array and OECC cables, and scour protection could take some time to recover. Impacts on soft-bottom habitat may negatively affect foraging habitat and food availability for seals. However, the footprint of impacted soft-bottom habitat (394 acres [1.6 km^2]) is a very small percentage (0.5 percent) of the available habitat in the WDA. BOEM anticipates **minor** impacts from benthic habitat modification for marine mammals.

Marine mammals have the potential to be entangled in anchor lines, towlines, and submarine cables. However, the only anchor lines deployed during the Proposed Action would be associated with cable installation. Steel anchor cables used on construction barges are typically 2 to 3 inches (5 to 7 centimeters) in diameter. These cables are usually under tension while deployed, eliminating the potential for entanglement. Similarly, towlines for cable installation are expected to be under constant tension. Thus, BOEM anticipates **negligible** impacts on marine mammals from entanglement.

Other potential additional mitigation options mentioned in Appendix D include adaptive management of construction activities, long-term ecological monitoring, a central fund for regional monitoring of population impacts, and periodic cleanup of fishing gear trapped on WTG foundations and other offshore Project elements.

Construction and Installation of Onshore Project Components

BOEM does not expect construction and installation of onshore Proposed Action components to affect marine mammals; therefore, impacts would be **negligible**.

Operations and Maintenance of Offshore Components

In general, reported sound levels of operational wind turbines is low (Madsen et al. 2006). According to measurements at the Block Island Wind Farm, low-frequency noise generated by WTGs reaches ambient levels at 164 feet (50 meters; Miller and Potty 2017). Sound pressure level measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 65.6 feet (14 and 20 meters) from the WTGs (Tougaard and Henrikson 2009). Although sound pressure levels may be different in the local conditions of the WDA, if sound levels at the WDA are similar, operational noise could be slightly higher than ambient, which ranged from 95 to greater than 104 dB re 11 µPa at the Deepwater WLA and MA WEA from 2011 to 2015 (Kraus et al. 2016b). Based on the results from both Tougaard and Henriksen (2009) and Kraus et al. (2016b), the operational sounds generated by WTGs associated with the Proposed Action are expected to be similar to the ambient sounds found within the Deepwater WLA and MA WEA (Pyć et al. 2018). Thus, noise impacts on marine mammals from operational WTGs would be **negligible**.

The current literature suggests that cetaceans can sense the geomagnetic field and use it to navigate during migrations (Normandeau et al. 2011). It is not clear whether they use the geomagnetic field solely or in addition to other regional cues. It is also not known which components of the geomagnetic field cetaceans are sensing (i.e., the horizontal or vertical component, field intensity or inclination angle). Nor is it known what effects the perturbations in the geomagnetic field by EMF within the vicinity of buried power cables may have on these animals. No evidence of magnetic sensitivity has been reported for seals (Normandeau et al. 2011).

Marine mammals appear to have a detection threshold for magnetic intensity gradients (i.e., changes in magnetic field levels with distance) of 0.1 percent of the earth's magnetic field or about 0.05 microtesla (μT) (Kirschvink 1990), and are thus likely to be very sensitive to minor changes in magnetic fields (Walker et al. 2003). There is a potential for animals to react to local variations of the geomagnetic field caused by power cable EMF. Depending on the magnitude and persistence of the confounding magnetic field, such an effect could cause a trivial temporary change in swim direction or a detour during the animal's migration (Gill et al. 2005). Such an effect to marine mammals is more likely to occur with DC cables than with AC cables (Normandeau et al. 2011). However, because AC cables have been proposed for the project, and because the WDA and OECC are extremely small areas within the coastal waters used by migrating marine mammals, BOEM anticipates little to no effect on migratory behavior.

Both OECC and inter-array cable arrays are AC, and Vineyard Wind would bury these cables at a depth of 5 to 8 feet (1.5 to 2.5 meters). Modeled and measured magnetic field levels from various existing submarine power cables indicate that AC cables buried to a depth of 3 feet (1 meter) would emit field intensities less than 0.05 μT up to 82 feet (25 meters) above the cable, and 79 feet (24 meters) along the seafloor. Comparison of these results with marine mammals' sensitivity levels suggests that potential impacts from submarine cables would be **negligible** to **minor**.

Vineyard Wind estimates the total annual number of vessel round trips during operations and maintenance would be between 401 and 887, equating to an average of 1 to 3 vessel trips per day (COP Volume I, Table 4.2-1; Epsilon 2018a). Operations and maintenance vessels range in size from 66 to 98 feet (20 to 30 meters) to 394 to 732 feet (120 to 223 meters) with operational speeds from 10 to 30 knots. Potential impacts from vessel noise on marine mammals are the same as those described for the construction and installation activities and may cause Level B harassment. BOEM anticipates **minor** impacts on marine mammals from Proposed Action-related vessel traffic noise.

Due to the moderate level of increase in vessel traffic, and the size and operational speed of Proposed Action vessels, BOEM anticipates **moderate** impacts on the large whale species—NARW, humpback, and minke whales—from vessel strikes and **negligible** to **minor** impacts on all other marine mammal species.

Once operational, there are data to suggest that seals (Russell et al. 2014) and harbor porpoise (Scheidat et al. 2011) may be attracted to the Proposed Action infrastructure. In a tagging study of grey and harbor seals in the North Sea, Russell et al. (2014) suggested the seals used the associated wind energy structures for foraging. The directed movements showed that animals could effectively navigate to and between structures. Studies of harbor porpoise activity within operational wind facilities showed that the porpoises' acoustic activity was significantly higher inside the wind energy facility compared to the reference areas, indicating an increase in the occurrence of porpoises in the area. The reasons for the apparent attraction to the wind energy facility area are not clear (Scheidat et al. 2011). The authors suggest two possible reasons: (1) an increase in food availability inside the wind energy facility from the reef effect and/or (2) the absence of vessels in an otherwise heavily trafficked part of the North Sea (i.e., a sheltering effect). Since seals and harbor porpoise occur in the WDA, it is likely that these species would be attracted to the forage items including shellfish and other fish species and shelter provided in the WDA.

BOEM expects the hard bottom associated with the scour protection and the WTGs to increase forage items for seals, leading to an overall **minor beneficial** impact from the gain in forage habitat. BOEM anticipates **negligible** impacts on all other marine mammals from the change from soft bottom to hard bottom. The effects of increased forage and shelter would have a **minor beneficial** impact on seals and harbor porpoise.

Other species of marine mammals would be more likely to avoid the WDA. It is possible that the presence of the WTGs and/or operation noise could cause marine mammals to avoid the WDA. This would be a potential habitat loss of 75,614 acres (306 km^2), which when compared to the available surrounding coastal waters is relatively small. An avoidance of the WDA may also cause some animals to be at an increased level of risk to interactions with potentially high vessel traffic including fisheries vessels, and also fisheries gear. The effects of avoidance of the WDA would likely be a **minor** impact, but the increased risk of vessel traffic in areas surrounding the WDA would be a **moderate** impact.

NMFS has determined that the gear associated with sink gill net and lobster pots would have the potential to affect marine mammals (NOAA 2018m). In the WDA, of these two gear types, sink gill net is most likely to occur within the proposed Project area as shown in Table 3.4.5-4. BOEM has determined that the potential for displacement of fixed gear from the WDA is low due to the gear able to be deployed in a fixed location. There is the potential that in the short-term sink gillnet effort could shift into the WDA if catch it higher around wind turbine foundations. However, this is considered a temporary effect as fishing effort would eventually depress any short-term increases in fish biomass (Roach et al. 2018). This impact is anticipated to be short term (1 to 2 years) and would have negligible if any impacts to marine mammals.

Operations and Maintenance of Onshore Project Components

Operations and maintenance of onshore Proposed Action components would not affect marine mammals; therefore, impacts would be **negligible**.

Decommissioning

Decommissioning impacts include underwater noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jet, and vacuum pump. Sound pressure levels are not available for these types of equipment, but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 µPa (Pangerc et al. 2016). Vineyard Wind would return the sediments previously removed from the inner space of the pile to the depression left when the pile is removed. In addition, Vineyard Wind would likely use a vacuum pump and diver or ROV-assisted hoses to minimize sediment disturbance and turbidity. Vineyard Wind may abandon the offshore export cables in place to minimize environmental impact; in which case there would be no impacts from their decommissioning. If required, Vineyard Wind would remove the cables from their embedded position in the seabed. Where necessary, Vineyard Wind would jet plow the cable trench to remove the sandy sediments covering the cables, and reel the cables onto barges. Risks from removing the cables would be short-term, localized to the Proposed Action area, and be similar to those experienced during cable installation. Although some of the decommissioning activities (e.g., acoustic impacts and increased levels of turbidity) may cause marine mammals, including listed species, to avoid or leave the Proposed Action area, this disturbance would be short term and temporary. Details regarding potential impacts on listed whale species can be found in the BA (BOEM 2018b). BOEM anticipates **minor** impacts on marine mammals during decommissioning.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities are described in Section 2.3. Rowe et al. (2018) present results from an oil spill model assessing the trajectory and weathering of oil following a catastrophic release of all oil contents from the topple of an ESP (the only Proposed Action component containing more than 250 barrels of oil) located closest to shore within the WDA. In the unlikely event of an accidental oil spill, oil may negatively impact marine mammals within 20 to 50 miles (32 to 80 kilometers) of the spill. BOEM expects the negative impacts to be sublethal. Vineyard Wind would have an Oil Spill Response Plan in place that would decrease potential impacts from spills. Therefore, BOEM anticipates **minor** impacts on marine mammals from accidental oil (or other chemicals, in *de minimis* amounts) spills.

Conclusion

Based on the analysis above, BOEM anticipates the following levels of potential impacts on marine mammals from construction, operations and maintenance, and decommissioning of the Proposed Action:

- Vineyard Wind's self-imposed measures to reduce impacts for all marine mammals plus the supplementary NARW measures would minimize harmful impacts to marine mammals. Impacts from pile driving would be **minor** for NARW due to avoidance of peak seasons of occurrence and **moderate** for all other marine mammals.
- M**oderate** impacts from vessel noise for the mysticete whale species and **minor** for all other marine mammals. **Minor** impacts from High Resolution Geophysical (HRG) survey noise for all marine mammals.
- M**oderate** impacts from vessel strike for the mysticete whale species and **minor** for all other marine mammals.
- N**egligible** to **minor** impacts for all marine mammals from turbidity during OECC cable laying, EMF, vessel noise during decommissioning, and accidental oil spills.
- **Negligible** impacts from turbidity during inter-array cable laying, benthic habitat modification, WTG noise, and entanglement.
- **Minor** impacts from loss of soft-bottom and associated forage habitat for seals. However, the hard bottom associated with the scour protection and the WTGs are expected to increase forage items for seals. The overall impact would be a **minor beneficial** gain in forage habitat for seals. BOEM anticipates **negligible** impacts due to the change from soft bottom to hard bottom for all other marine mammals.
- The effects of avoidance of the WDA would likely be a **minor** impact, but the increased risk of vessel traffic in areas surrounding the WDA would be a **moderate** impact.

Vineyard Wind has committed to protective measures that would reduce potential impacts on marine mammals (COP Volume III, Table 4.2-1; Epsilon 2018a). While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on marine mammals by imposing mitigation measures outlined in Chapter 2 and Appendix D. Long-term passive acoustic monitoring; daily, pre-construction PAM and visual surveys; and the sunrise and sunset prohibition on pile driving would reduce the likelihood of impacts to marine mammals but would remain as **minor** for NARW and **moderate** for all other marine mammals. The requirement of AIS on all Proposed Action vessels would allow Vineyard Wind to monitor the number of vessels and traffic patterns for compliance with vessel speed requirements, and would decrease the potential for vessel strike for marine mammals, but are still expected to result in **moderate** for the mysticete whale species and **minor** for all other marine mammals. Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

3.3.7.4. Impacts of Alternatives B and C on Marine Mammals

Incremental Contribution of Alternatives B and C

Direct and Indirect Effects of Routine Activities

Alternative B would narrow the PDE to only include the Covell's Beach landfall. Alternative C would entail moving the six northern-most WTG locations to the southern portion of the WDA.

Construction and Installation

BOEM does not expect the selection of the landfall location under Alternative B to have any measurable effect on marine mammals. Alternative C would not significantly change the potential impacts during construction and installation because the number of turbines remains the same, and the southern portion of the WDA does not include areas with higher densities of marine mammals. Thus, potential impacts on marine mammals during construction and installation under Alternatives B and C are expected to be the same as under the Proposed Action: **minor** for NARW and **moderate** for all other marine mammals from pile driving; **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals; **minor** from turbidity during OECC cable laying; and **negligible** from inter-array cable laying, benthic habitat modification, WTG noise, and entanglement.

Operations and Maintenance

Potential impacts on marine mammals during operations and maintenance under Alternatives B and C are the same as those under the Proposed Action: **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals; negligible to **minor** from EMF; and **negligible** from benthic habitat modification and WTG noise.

Decommissioning

Potential impacts on marine mammals during decommissioning under Alternatives B and C are the same as those under the Proposed Action: **moderate** for the mysticete whale species from vessel noise and vessel strike and **minor** for all other marine mammals.

Direct and Indirect Effects of Non-Routine Activities

Potential impacts on marine mammals from non-routine or low-probability activities under Alternatives B and C are the same as those under the Proposed Action; therefore, BOEM expects **minor** impacts from accidental oil spills.

Conclusion

BOEM does not anticipate potential impacts on marine mammals during construction and installation, operations and maintenance, and decommissioning under Alternatives B and C to be measurably different than under the Proposed Action: **negligible** to **moderate**. Mitigation measures identified above would also be applicable to these alternatives.

3.3.7.5. Impacts of Alternatives D1 and D2 on Marine Mammals

Incremental Contribution of Alternatives D1 and D2

Direct and Indirect Effects of Routine Activities

Construction and Installation

Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. The total acreage of the WDA could increase by 22 percent (16,603 acres [67 km^2]) to achieve wider spacing between WTGs.[15] Alternative D2 would align WTGs in an east-west orientation with a 1 nautical mile spacing

[15] As noted in Chapter 2, if stakeholders achieve consensus on implementing the regional transit lane to the south of the WDA, WTG placements for Alternative D1 would need to be placed south of the lane, thus increasing the footprint required for this alternative.

between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed-gear fishing vessels.

HRG surveys would be performed as part of pre-construction Project activities for Alternatives D1 and D2. BOEM believes that the risk of Level A harassment occurring in any listed species from HRG surveys in discountable because the PTS distances are small and have a discountable chance of exposing listed species to levels of sound causing ear injury. Depending on equipment used, distances to Level A threshold are estimated to be a maximum of 26 meters for mysticetes and 1 meter for sperm whales (BOEM 2018b), and 96 meters for non-listed odontocetes and 35 meters for seals (BOEM 2014a). Distance to Level B threshold is approximately 10 to 502 meters for baleen whales and 10 to 1,585 meters for sperm whales depending on the suite of equipment used during any particular survey and the largest potential disturbance time is likely to be no longer than 24 seconds (BOEM 2018b). The distance to Level B threshold for non-listed odontocetes and seals ranges from 16 to 689 meters (BOEM 2014a). Because the exposure to Level A harassment is very small and Level B is small very brief and temporary, impacts to marine mammals from HRG noise under Alternative D1 and D2 would be **minor**.

All other potential impacts on marine mammals under Alternatives D1 and D2 compared to the Proposed Action are not expected to be measurably different. Because the radius of noise would be the same, potential impacts would still be **minor** for NARW and **moderate** for all other marine mammals from pile driving; **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals; **minor** from turbidity during OECC cable laying; and **negligible** from inter-array cable laying, benthic habitat modification, WTG noise, and entanglement.

Operations and Maintenance

During operations and maintenance, Alternatives D1 and D2 would increase the area with inter-array cables compared to the Proposed Action. BOEM anticipates this difference to increase the potential for EMF and corresponding effects on marine mammals' navigation and the amount of survey work done. Since the level of potential impacts from EMF on marine mammals is not well studied, BOEM does not know the extent of any additional impacts, but is not likely to be major. BOEM anticipates all other potential impacts on marine mammals during operations and maintenance under Alternatives D1 and D2 to be **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals; **negligible** to **minor** from EMF; and **negligible** from benthic habitat modification and WTG noise.

Decommissioning

If Vineyard Wind leaves cables in place during decommissioning, no change in potential impacts on marine mammals are expected from Alternatives D1 and D2 compared to the Proposed Action. If Vineyard Wind removes cables, the disturbance to the bottom habitat and resulting negative impacts on potential forage items would be greater than under Alternatives D1 and D2 compared to the Proposed Action. BOEM anticipates potential impacts on marine mammals during decommissioning to be **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals.

Direct and Indirect Effects of Non-Routine Activities

BOEM does not anticipate any measurable difference in potential impacts on marine mammals from non-routine activities under Alternatives D1 and D2 compared to the Proposed Action. BOEM expects impacts to be **minor** from accidental oil spills.

Conclusion

Alternatives D1 and D2 would involve an increase in inter-array cabling and larger WDA footprint during construction and installation, operations and maintenance, and decommissioning; however, BOEM anticipates the potential impacts overall not to be significantly different than under the Proposed Action: **negligible** to **moderate.** Mitigation measures identified above would also be applicable to these alternatives.

3.3.7.6. Impacts of Alternative E on Marine Mammals

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and Installation

Under Alternative E, there would be a 16 percent reduction of the number of WTGs. This reduction would translate into a reduction in pile-driving days, vessel traffic, duration of acoustic impacts, and fewer impacts on water quality and the benthic environment. However, potential impacts on marine mammals from construction and installation of 84 WTGs are still expected to be **minor** for NARW and **moderate** for all other marine mammals from pile driving; **moderate** for the listed mysticete whale species and **minor** for all other marine mammals from vessel noise and vessel strike; **minor** from turbidity during OECC cable laying; and **negligible** from turbidity inter-array cable laying, benthic habitat modification, WTG noise, and entanglement.

Operations and Maintenance

Under Alternative E, BOEM anticipates potential impacts on marine mammals during operations and maintenance to be **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals; **negligible** to **minor** from EMF; and **negligible** from benthic habitat modification and WTG noise.

Decommissioning

BOEM anticipates potential impacts on marine mammals during decommissioning to be **moderate** for the mysticete whale species from vessel noise and vessel strike, and **minor** for all other marine mammals.

Direct and Indirect Effects of Non-Routine Activities

BOEM does not anticipate any measurable difference in potential impacts on marine mammals from non-routine activities under Alternative E compared to the Proposed Action. BOEM expects impacts to be **minor** from accidental oil spills.

Conclusion

Alternative E would involve a decrease in the potential impacts on marine mammals during construction and installation, operations and maintenance, and decommissioning; however, BOEM anticipates the potential impacts overall not to be significantly different than under the Proposed Action: **negligible** to **moderate.** Mitigation measures identified above would also be applicable to this alternative.

3.3.7.7. Impacts of Alternative F (No Action Alternative) on Marine Mammals

Under Alternative F, there would be no potential EMF-related impacts on navigation, injury, or behavioral modification due to pile driving, and no increased potential for vessel strike.

3.3.7.8. Comparison of Alternatives for Marine Mammals

When comparing Alternatives A through E, BOEM anticipates Alternative E to have the lowest potential impacts on marine mammals, and potential impacts under Alternatives A through D2 would be very similar for marine mammals, with insignificant or non-measurable differences between them. However, out of all of the alternatives, Alternative F, the No Action Alternative, would have the lowest level of impacts on marine mammals in the proposed Project area.

3.3.7.9. Cumulative Impacts

As described in Appendix C, BOEM considered cumulative impacts on marine mammals for the waters encompassing the Scotian Shelf LME, Northeast Shelf LME, and Southeast Shelf LME (see Appendix C, Figure C.1-8).

Cumulative impacts on marine mammals within this geographic range could include effects vessel traffic, entanglement in fisheries gear, noise, pollution, climate change, habitat disturbance, waste discharge, and accidental fuel/oil spills. Appendix C lists the types of actions that BOEM has identified as potentially contributing to cumulative impacts when combined with impacts from the Proposed Action over the geography and time scale described above.

Cumulative impacts on marine mammals include potential effects from the following specific activities:

- Eight potential site assessment projects on offshore renewable leases from Virginia to Massachusetts.
- Offshore wind energy projects from North Carolina to Maine as described in Appendix C include Atlantic City Wind and CVOW (both Tier 1 projects, totaling six potential additional WTGs) and South Fork Wind (Tier 2 project totaling 15 potential additional WTGs). Other leases held by developers as well as projects specified in Appendix C under Tiers 3, 4, and 5 may contain future development activities, some of which currently have unknown design and scope. Currently available information, as presented in Appendix C, suggests that the four Tier 3 projects (Skipjack Wind, U.S. Wind, Revolution Wind, and BSW) could represent up 232 additional WTGs. Although BOEM does not consider the four Tier 3 projects reasonably foreseeable, the potential impacts associated with them would be similar to the Proposed Action if these projects move forward. However, the extent of these effects would ultimately depend on project-specific information that is unknown at this time.
- Four tidal projects proposed on the U.S. East Coast.
- Eight marine mineral requests and active leases from New Jersey to Florida.
- Eight HRG survey permits under review from Delaware to Florida.
- Seven existing, approved, and proposed liquefied natural gas terminals along the U.S. East Coast from Massachusetts to Florida.
- Current military use that includes acoustic stressors (e.g., sonar, explosives, air guns, noise from vessels, equipment, and aircraft).

Indirect impacts of the Proposed Action could occur from modifications to Vineyard Haven port exposing marine mammals to acoustic impacts. At the time of preparation of this Draft EIS, information was lacking to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port. However, potential indirect impacts associated with this port are expected to be **minor** to **moderate** depending on the type and duration of noise. In addition, the MCT upgrades associated with the offshore wind energy industry may include potential impacts to marine mammals. Impacts are expected to be **negligible** to **minor**, but would also depend on the type and duration of noise. Additional potential upgrades to ports to support the offshore wind energy industry could contribute to cumulative impacts.

All projects and actions described above include increased vessel traffic, with potential exposure to vessel noise and increased risk of vessel strike. Marine transportation (e.g., from fisheries use, recreational use, and military use) occurs throughout marine mammals' range. BOEM anticipates the cumulative impacts of vessel traffic to be **moderate** because of the potential lethal impacts of vessel strike.

Underwater noise associated with pile driving, air guns used for military practice, vessel traffic, and seismic surveys for oil and gas development may cause injury or behavior disturbance to marine mammals. Because of the prevalence of vessel noise and the potential behavioral responses vessel noise and other sources of noise may illicit, the cumulative effects of underwater noise associated with the Proposed Action in combination with other past, present, and reasonably foreseeable actions range from **minor** to **moderate** depending on the type and duration of the noise. If multiple additional projects or actions, particularly offshore wind energy projects, come to fruition and result in overlapping construction schedules, cumulative impacts would be expected to be more severe (**moderate** to **major**) than if construction activities occurred isolated in time and space.

Many of the project types and actions would cause disturbance or loss to benthic foraging habitat from placement of structures, dredging, mining, or resettled sediment from seafloor disturbance. Some project types, including wind and oil and gas development, may convert benthic habitat from soft- to hard-bottom substrate. Because habitat disturbance would be localized and temporary, BOEM anticipates the cumulative effects of habitat disturbance would be **minor**.

The risk of pollution, including spills and leaks of oil, liquefied natural gas, chemicals, fuel, and waste discharge is ubiquitous throughout marine mammals' range. Due to limited sources of potential pollution from routine Project activities, BOEM anticipates the cumulative effects of pollution to be **minor**.

BOEM anticipates the Proposed Action plus cumulative actions area to have **negligible** impact on marine mammals from all onshore activities and components, so there would be no cumulative impacts when combined with any of the identified onshore developments (see Appendix C).

BOEM anticipates the cumulative impacts under Alternatives B, D1, D2, and E to be the same as under the Proposed Action: **negligible** to **moderate**. However, the reduction in the Project footprint under Alternative E would potentially result in an overall reduction in cumulative impacts.

3.3.7.10. Incomplete or Unavailable Information for Marine Mammals

Substantial data gaps exist between the interaction of marine mammals and dynamic cables. These gaps remain partly owing to difficulties in evaluating impacts at population scale around these deployments (Taormina et al. 2018).

However, BOEM used the best available information when developing this section and sufficient information exists to support the findings presented herein.

3.3.8. Sea Turtles

Five ESA-listed species of sea turtles may occur in the U.S. Northwest Atlantic Ocean: leatherback (*Dermochelys coriacea*), loggerhead (Northwest Atlantic Ocean DPS, *Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), green (North Atlantic DPS, *Chelonia mydas*), and hawksbill (*Eretmochelys imbricata*). Among these species, four sea turtles are likely to occur in the WDA, OECC, and surrounding waters: leatherback, loggerhead (Northwest Atlantic Ocean DPS), Kemp's ridley, and green (North Atlantic DPS) sea turtles. Hawksbill sea turtles are rare in Massachusetts, and not likely to occur in the area; therefore, this Draft EIS does not consider them further.

These species are highly migratory and occur in the coastal waters of the northeast United States in the summer and fall. In general, sea turtles migrate from southern wintering grounds to northern summer feeding grounds, including the Project area. The BA for Construction of the Vineyard Wind Offshore Wind Project (BOEM 2018b) contains details regarding specific migratory behavior and seasonal distribution for each species, as well as additional details regarding the potential impacts on these species. The sections below provide a summary of the information presented in the BA (BOEM 2018b).

3.3.8.1. Description of the Affected Environment for Sea Turtles

The proposed Project area assessed for the four listed sea turtles is the area ensonified during pile driving, vessel transit to and from ports that will support proposed Project activities, and the OECC area from the WDA to the south shore of Cape Cod (Barnstable or West Yarmouth). The combination of sightings, strandings, and bycatch data provides the best available information on sea turtle distribution in the proposed Project area. This section summarizes data from the most current sightings surveys of the MA WEA (including the WDA; Kraus et al. 2016b), NMFS Sea Turtle Stranding and Salvage Network (NMFS 2018b), most recent available density estimates (Pyć et al. 2018), and historic regional data (Kenney and Vigness-Raposa 2010).

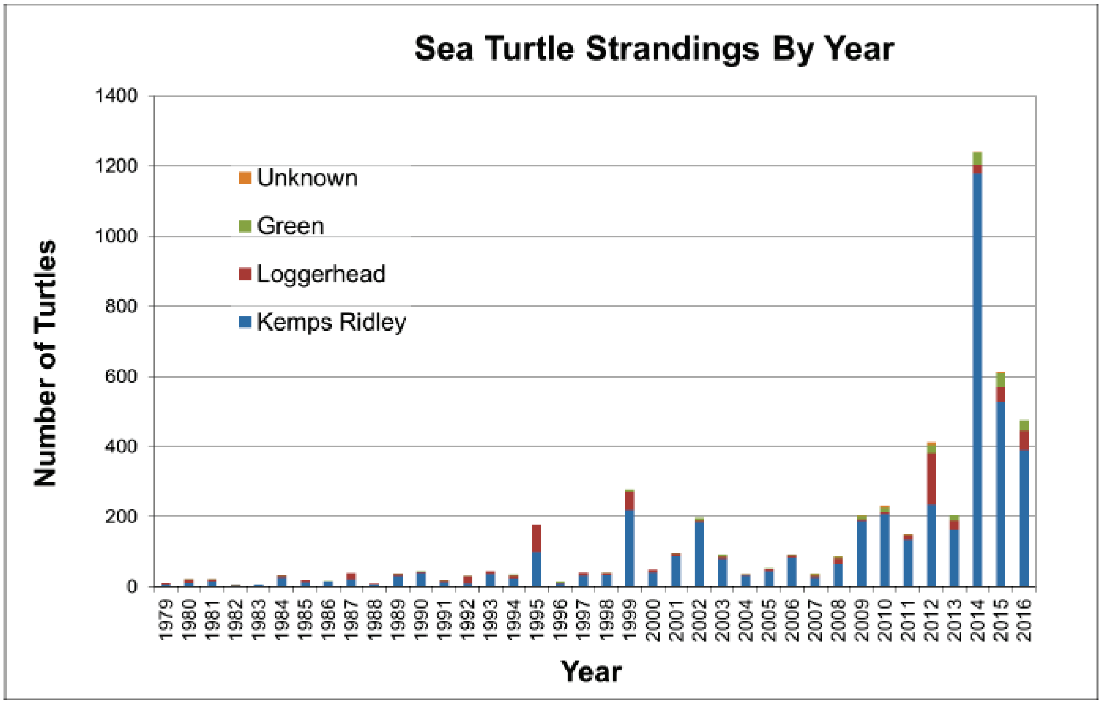
Regional Setting

Table 3.3.8-1 summarizes sea turtle occurrence in southern New England coastal waters off Rhode Island and Massachusetts. Prey items vary with species, and the Vineyard Wind BA (BOEM 2018b) contains foraging information. Current threats to sea turtles include entanglement in fisheries gear and vessel strikes. In addition, loggerhead, Kemp's ridley, and green sea turtles are susceptible to cold stunning, or the hypothermic reaction that occurs when sea turtles are exposed to prolonged cold-water temperatures, causing a decreased heart rate, decreased circulation, and lethargy, followed by shock, pneumonia, and possibly death. The Wellfleet Bay Wildlife Sanctuary strandings data are shown in Figure 3.3.8-1. Strandings over the past 3 years have occurred from November through January, with peak periods depending on year (WBWS 2018). For example, in 2014 the peak stranding period was mid- to late November, in 2015 most strandings occurred during mid- to late December, and in 2016, strandings occurred primarily from November through December (WBWS 2018).

Table 3.3.8-1: Summary of Sea Turtles Likely to Occur in the Coastal Waters off Rhode Island and Massachusetts

Common Name	Scientific Name	DPS/Population	ESA Status (Massachusetts ESA Status)	Relative Occurrence in the WDA and Surrounding Waters [a]
Leatherback	*Dermochelys coriacea*	Atlantic	E (E)	Common [b]
Loggerhead	*Caretta caretta*	Northwest Atlantic DPS	T (T)	Common [b]
Kemp's ridley	*Lepidochelys kempii*	NA	E (E)	Regular [b]
Green	*Chelonia mydas*	North Atlantic DPS	T (T)	Rare [b]

Source: Adapted from COP Volume III (Epsilon 2018a); Kenney and Vigness-Raposa 2010
DPS = distinct population segments; E = Endangered; ESA = Endangered Species Act; T = Threatened; WDA = Wind Development Area; NA = not applicable
[a] Common > 100 turtles; Regular = 10 to 100 turtles; Rare < 10 turtles. Although historical sightings records suggest rare occurrence of Kemp's ridley sea turtles, the most recent (2007–2017) stranding records indicate regular occurrence in the area.
[b] Wellfleet Bay Wildlife Sanctuary strandings data also indicate same relative occurrence as Kenney and Vigness-Raposa 2010. Data not available for leatherback sea turtles since they are not susceptible to cold stunning. Kemp's ridley strandings have been more common in recent years.



Source: WBWS 2018

Figure 3.3.8-1: Sea Turtle Strandings by Year on Cape Cod from 1979 through 2016

Northeast Fisheries Observer Program statistical area 537 encompasses the waters from the southern shores of Martha's Vineyard and Nantucket south (including the proposed Project area) to the OCS shelf waters off New York (NMFS 2018b). NMFS bycatch data in this area indicated that a total of 31 turtles (4 leatherback, 2 green, 20 loggerhead, and 5 unidentified hard-shelled turtles) were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2017 (NMFS 2018b). These data under represent the actual number of bycaught turtles due to the limited observer coverage for each fishery. The turtles were caught from June through December, with the majority in July (18 of 31) and August (5 of 31). In area 538, which includes the waters from the south shore of Cape Cod to the southern shores of Martha's Vineyard and Nantucket (and the proposed Project OECC area), one loggerhead turtle was incidentally caught in August of 2014 (NMFS 2018b).

Project Area

Kraus et al. (2016b) sighted three species of sea turtles in the MA WEA from October 2011 through June 2015: leatherback, loggerhead, and Kemp's ridley. Leatherback (161 sightings) and loggerhead sea turtles (87 sightings) were the most commonly sighted species occurring mostly during summer and fall, with a few sightings of both species in the spring (Kraus et al. 2016b). Kraus et al. (2016b) sighted a total of six Kemp's ridley sea turtles: one in August and five in September. Over their study period, Kraus et al. (2016b) observed 30 unidentifiable sea turtles. Because of their high submergence rate, sea turtles are difficult to spot during surveys, and their numbers in the MA WEA are likely to be an underestimate. There were no sightings of any species of sea turtle during the winter season. Although Kraus et al. (2016b) did not observe green sea turtles during the surveys, stranding records indicate the presence of green sea turtles in the area. Please refer to Appendix B for the sightings per unit effort (SPUE) for loggerhead, leatherback, Kemp's ridley, and unidentified sea turtles in the Project area (see Figures B.5-5 through B.5-8). Additional information on sea turtle occurrence in the proposed Project area is available in the Vineyard Wind BA (BOEM 2018b).

Density estimates based on the most recent sightings data are not available for all sea turtles in the WDA. Although density estimates for the Project area are limited, Pyć et al. (2018) summarized seasonal estimates of sea turtle densities using data from the U.S. Navy Operating Area Density Estimate database (see Table 3.3.8-2). A detailed discussion of density estimates can be found in the BA for Construction of the Vineyard Wind Offshore Wind Project (BOEM 2018b). These estimates suggest that loggerhead sea turtles are the most likely species of sea turtle found in the proposed Project area, and their densities would be highest during summer (see Table 3.3.8-2; Pyć et al., 2018). Details on data handling to develop these estimates are available in Pyć et al. (2018).

Table 3.3.8-2: Sea Turtle Density Estimates for the Project Area

Common Name	Scientific Name	Density [a]			
		Spring	Summer	Fall	Winter
Leatherback Sea Turtle	*Dermochelys coriacea*	0.0274	0	0.0274	0.0274
Loggerhead Sea Turtle	*Caretta caretta*	0.1117	0.1192	0.1111	0.1111
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	0.0105	0.0105	0.0105	0.0105

Source: Pyć et al. 2018
[a] Animals/100 km^2 (38.6 square miles)

Aspects of Resource Potentially Affected

While in the coastal waters in and near the proposed Project area, sea turtles may be found swimming, foraging, migrating, diving at depth for extended periods of time, and possibly engaged in extended rest periods on the ocean bottom. All sea turtle species are susceptible to the effects of vessel traffic, with potential impacts including behavioral modification from vessel noise and vessel strike. Other potential acoustic impacts could include behavioral modification during proposed Project construction, including potential injury during pile-driving activities. Benthic forage prey for loggerheads, green, and Kemp's ridley sea turtles (including crustaceans, mollusks, and vegetation) could be impacted by proposed Project activities that would affect the seafloor. Sea turtles navigate using the earth's magnetic field, and EMF emitted from proposed Project cables could potentially impact this ability (Normandeau et al. 2011). A detailed effects analysis for sea turtles was completed and is available in the Vineyard Wind BA (BOEM 2018b), and summarized in Section 3.3.8.3. There are no nesting beaches or other critical habitats in the proposed Project area; therefore, potential impacts associated with onshore project components are not evaluated in this section.

Current Condition and Trend

Sea turtles are wide-ranging and long-lived, making population estimates difficult, and methods vary depending on species (TEWG 2007; NMFS and USFWS 2013; NMFS and USFWS 2015). Since sea turtles have large ranges and highly migratory behaviors, the current condition and trend of sea turtles are affected by factors outside of the proposed Project area. For details on nesting habits for the four sea turtle species, see BOEM 2014a and the Vineyard Wind BA (BOEM 2018b).

- Leatherback:
  - The population estimate (total number of adults) in the Atlantic is 34,000 to 94,000 (NMFS and USFWS 2013; TEWG 2007).
  - Aside from the western Caribbean, nesting trends at all other Atlantic nesting sites are generally stable or increasing (NMFS and USFWS 2013; TEWG 2007).
- Loggerhead:
  - Regional abundance estimate in the Northwest Atlantic Continental Shelf in 2010 was approximately 588,000 individuals (NEFSC and SEFSC 2011b).
  - The three largest nesting subpopulations responsible for most of the production in the western North Atlantic (Peninsular Florida, Northern United States, and Quintana Roo, Mexico) have all been declining since at least the late 1990s, thus indicating a downward trend for this population (TEWG 2009).
- Kemp's ridley:
  - The population was severely decimated in 1985, due to intensive egg collection and fishery bycatch, with only 702 nests counted during the entire year (NMFS and USFWS 2015; Bevan et al. 2016). Recent models indicate a persistent reduction in survival and/or recruitment to the nesting population suggesting that the population is not recovering (NMFS and USFWS 2015).
  - Evaluations of hypothesized causes of the nesting setback, including the Deepwater Horizon oil spill in 2010, have been inconclusive, and experts suggest that various natural and anthropogenic causes could have contributed to the nesting setback either separately or synergistically (Caillouet et al. 2018).
- North Atlantic DPS of green sea turtles:
  - The primary nesting beaches are Costa Rica, Mexico, United States (Florida), and Cuba. According to NMFS and USFWS (2014), nesting trends are generally increasing for this DPS.

3.3.8.2. Environmental Consequences

Relevant Design Parameters

The primary Project design parameters that would influence the magnitude of the impact on sea turtles include (see Appendix G for details on the design parameters and maximum-case scenario):

- The WTG foundation type used. The potential acoustic impacts on sea turtles differ among the WTG foundation types that Vineyard Wind would use: either Scenario 1 (100 monopiles and two ESP jacket foundations) or Scenario 2 (a combination of up to 90 monopiles and 12 jacket foundations). The jacket-type foundation would have a higher acoustic impact than the monopile foundation due to the increased risk of exposure because of the longer time required to install more piles (up to four 9.8-foot [3-meter] pin piles per jacket) (Pyć et al. 2018).
- The monopile diameter. The potential acoustic impacts on sea turtles differ among the WTG monopile diameters that may be used. Vineyard Wind would use either 34-foot (10.3-meter) or 25-foot (7.5-meter) diameter monopiles. The acoustic modeling (Pyć et al. 2018) assessed two scenarios: the impacts associated with a monopile diameter of 34 feet (10.3 meters) and a monopile diameter of 30 feet (9 meters).
- The number of WTGs installed. The overall potential acoustic impacts on sea turtles differ among scenarios based on the total number of WTGs installed. Vineyard Wind would use either 80 10-MW turbines or 100 8-MW turbines. Although the potential acoustic impacts of installing a single 10-MW turbine (34-foot [10.3-meter] diameter monopile) are higher than installing a single 8-MW turbine (25-foot [7.5-meter] diameter monopile), the overall impacts of using the larger turbines are expected to be lower due to the total duration of pile driving that would be required to install fewer piles (Pyć et al. 2018). (This assumes that Vineyard Wind would install the same number of jacket foundations under both scenarios.)
- The number of ESPs. Vineyard Wind would use either one approximately 800 MW ESP or two 400 MW ESPs. Impacts would be higher if Vineyard Wind used two ESPs due to the overall installation time required (1 day per ESP). (This assumes that Vineyard Wind would use the same foundation type under both scenarios.)

Potential Variances in Impacts

Aspects of the proposed-Project design include the OECC, the WTG design selected (e.g., 8 MW, 10 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule, which will be determined based on site assessment data, engineering requirements, and other factors. Although some variation is expected in the design parameters, the impact assessment in this section analyzes the maximum-case scenario.

3.3.8.3. Impacts of Alternative A (Proposed Action) on Sea Turtles

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Construction and Installation

Acoustic exposure modeling was conducted for sea turtles for pile driving of the two foundation types (monopile and jacket piles) under two possible design scenarios (a combination of monopile and jacket foundations and monopiles only) and three levels of attenuation (0 dB, 6 dB, and 12 dB), using the most recent available sightings data (see Table 3.3.8-3; Pyć et al. 2018). The 0 dB level was modeled as a reference point to evaluate the effectiveness of the proposed sound reduction technology (e.g., Hydro-sound Damper, bubble curtains or similar). Although sound reduction would aim for 12 dB, BOEM considers 6 dB the maximum-case scenario in this Draft EIS. The BA provides for a detailed discussion of the threshold criteria used for deriving sea turtle density estimates for the WDA.

When comparing threshold criteria between foundation types, the maximum radial distance to Level A threshold for sea turtles would be largest during 34-foot (10.3–meter) monopile installation at 2,536.1 feet (773 meters), or an area of 470 acres (1.9 km^2). The radial distance to Level A threshold during jacket installation would be 1,738.8 feet (530 meters), or an area of 222 acres (0.9 km^2) and would occur for 12 days for 14 hours per day (Table 3.3.8-3; Pyć et al. 2018). The largest distance to Level B threshold would occur during monopile installation at 7,805 feet (2,379 meters) or 5,832 acres (23.6 km^2). Level B harassment would reach 1,944 m from the pile during jacket installation with an area of 2,941 acres (11.9 km^2) (Table 3.3.8-3; Pyć et al. 2018).

Table 3.3.8-3: Mean Radial Distance (R95% in meters) to Threshold Criteria for Sea Turtles during Impact Hammering with 6 dB Attenuation System [a,b]

Foundation/Hammer Type	Level A Harassment 210 dB L_E (Popper et al. 2014)	Level A Harassment Unweighted 180 dB SPL (NMFS 2016)	Level B Harassment Unweighted 166 dB SPL (NMFS 2016)
10.3-meter monopole/IHC S-4000 hammer	477	773	2,739
Jacket (four 3-meter piles)/ IHC S-2500 hammer	530	243	1,944

Source: Pyć et al. 2018
dB = decibel; L_E = cumulative sound exposures; SPL = sound pressure level
[a] Mean of two measured positions within the WDA
[b] The R95% for a given sound level is the radial distance centered at a pile-driving location, encompassing 95 percent of the largest distances within the sound pressure levels above a given threshold.

The cumulative sound exposure level is the dominant threshold (Table 3.3.8-3). The maximum-case scenario is defined by the highest number of adult (number of juveniles is not available) sea turtles predicted to exceed Level A threshold criteria with 6 dB attenuation. Scenario 1 with two piles installed per day had the highest number of sea turtles estimated to be exposed to Level A harassment, and thus is considered the maximum-case scenario. Table 3.3.8-4 provides the exposure estimates for Level A and Level B harassment for the sea turtles.

Table 3.3.8-4: Estimated Number of Sea Turtles Exposed to Level A and Level B Harassment for Scenario 1 with Two Piles per day Using 6 dB of Attenuation [a]

Common Name	Scientific Name	Level A Harassment (Popper et al. 2014) PK (L_{pk})	Level A Harassment (NMFS 2016) SPL (L_p)	Level B Harassment (NMFS 2016) SPL (L_p)
Kemp’s Ridley	*Lepidochelys kempii*	0.01	0.03	0.18
Leatherback	*Dermochelys coriacea*	0.01	0.04	0.24
Loggerhead	*Caretta caretta*	0.09	0.33	1.96

Source: Pyć et al. 2018
L_p = sound pressure; L_{pk} = peak sound level; PK = peak; SPL = sound pressure level
[a] Evaluated for NMFS Level A and Level B harassment and Popper et al. (2014) Level A harassment.

Kraus et al. (2016b) indicate higher density (0.8725 animals per 24,710 acres [100 km^2] in the fall and 0.63 animals per 24,710 acres [100 km^2] in the summer) compared to densities estimated in the acoustic model in the fall (0.0274 animals per 24,710 acres [100 km^2]) and summer (0 animals per 24,710 acres [100 km^2]) (Pyć et al. 2018). Thus, the exposure of leatherback turtles to pile driving noise could be greater than that estimated in the acoustic model.

SPUE data indicate that loggerhead, leatherback, and unidentified sea turtles are most susceptible to impacts from pile driving during the fall, when expected abundance in the WDA are relatively moderate to high (September through November) (see Appendix B; Figures B.5-5 through B.5-8; Right Whale Consortium 2018). Assuming the model predictions are accurate, and considering that sea turtles would exhibit an avoidance response before receiving the 24-hour exposures in Table 3.3.8-3, BOEM anticipates **minor** impacts on sea turtles from pile driving**.** There have been no documented sea turtle mortalities associated with pile driving. Based on the low densities of sea turtles in the proposed Project area, soft-starts to allow turtles to leave the area before injurious levels are received, and the implementation of exclusion zones, mortal injury would not be expected.

The frequency range for vessel noise (10 to 1000 Hz) (MMS 2007) overlaps with sea turtles’ known hearing range (less than 1000 Hz with maximum sensitivity between 200 to 700 Hz; Bartol et al. 1999) and would therefore be audible. Sea turtles may respond to vessel approach and/or noise with a startle response and a temporary stress response (NSF and USGS 2011). Samuel et al. (2005) indicated that vessel noise can have an effect on sea turtle behavior, especially their submergence patterns. BOEM anticipates that the potential effects of noise from construction and installation vessels would elicit brief responses to the passing vessel resulting in **minor** impacts to sea turtles.

Propeller and collision injuries from boats and ships are common in sea turtles. Additional information on sea turtle vessel strikes and potential for injury is included in the Vineyard Wind BA (BOEM 2018b). Construction and installation vessels would range in size from 66 to 98 feet (20 to 30 meters) to 394 to 732 feet (120 to 223 meters), with operational speeds from 10 to 25 knots. Over the course of the entire construction phase, an average of 25 vessels would be present in the WDA or OECC; the Proposed Action would generate an average of seven daily vessel trips between both the primary and secondary ports and the WDA or OECC. During the period of maximum activity, an average of 46 construction vessels would be present in the WDA or OECC, and Proposed Action construction would generate an average of 18 construction vessel trips per day in or out of construction ports. In maximum conditions, this could theoretically include up to 46 trips in a single day, including up to 4 trips per day to or from secondary ports, with the remainder originating or terminating at the New Bedford MCT, compared to the current of 25 daily vessels trips in the WDA, as measured by AIS (COP Appendix III-I; Epsilon 2018a).

Table 4.2-1 of the COP (Volume 1; Epsilon 2018a) summarizes vessel details including type/class, number of each type, length, and speed for each proposed Project activity during construction. The speed of these vessels varies from 6 to 30 knots maximum transit speed. Operational speeds are generally lower than transit speeds, but several would exceed the 10-knots NMFS speed restriction that has been developed for NARW (50 CFR 224.105).

Sea turtles are likely to be most susceptible to vessel collision in coastal waters, where they forage, when vessels transit from ports. Vessel speed may exceed 10 knots during such transits, and those vessels travelling at greater than 10 knots would pose the greatest threat to sea turtles. The increase in vessel round trips during construction and installation is likely to increase the relative risk of vessel strike for sea turtles. However, the vessel strike avoidance measures that Pyć et al. (2018) outlines are designed to minimize the potential of vessel strikes for sea turtles by reducing vessel speed and maintaining a distance of 49.2 feet (15 meters) or greater from sighted turtles. BOEM anticipates the potential effects of vessel strike on sea turtles due to construction and installation vessels to be **minor**. While the significance level of impacts would remain the same, BOEM could further reduce potential impacts on sea turtles with the requirement of AIS on all proposed-Project vessels, which would allow Vineyard Wind to monitor the number of vessels and traffic patterns for compliance with vessel speed requirements, and would decrease the potential for vessel strikes against sea turtles.

Proposed Action activities known to disturb the seafloor bottom and near-bottom, such as scour protection, pile driving, and cable laying, may directly affect sea turtle foraging habitat and associated prey. Please refer to Tables 3.3.5-1 and Table 3.3.5-2 showing the maximum areas of impacts predicted from proposed-Project construction activities.

Sea turtles in the WDA would likely be foraging, since the benthic community in the WDA includes several prey items including amphipods and other crustaceans, crabs, gastropods, and bivalves (BOEM 2014a). Construction and installation would affect a small percentage of the available foraging habitat, and recolonization and recovery to pre-construction species assemblages is expected within up to 2 to 4 years (Van Dalfsen and Essink 2001), but may be as rapid as 100 days (Dernie et al. 2003b) given the similarity of nearby habitat and species (see Section 3.3.5 for benthic recovery processes). Because impacts to foraging habitat are mostly temporary and localized, BOEM anticipates impact of the Proposed Action activities associated with bottom disturbance on sea turtles to be **minor**.

As previously discussed in Section 3.3.5, the proposed Project would result in a conversion of soft-bottom habitat to hard-bottom due to scour protection over the life of the proposed Project (see Section 3.3.5, Tables 3.3.5-1 and Table 3.3.5-2). The reef effect is usually considered a beneficial impact, associated with higher densities and biomass of fish and decapod crustaceans (Taormina et al. 2018), providing a potential increase in available forage items and shelter for sea turtles compared to the surrounding soft-bottoms. This conversion would be a beneficial impact for sea turtles via habitat creation.

BOEM anticipates benthic disturbance and increased levels of turbidity during dredging, plowing, piling, and anchoring (see Section 3.2.2, Section 3.3.5, and BOEM 2018b). Water quality impacts from inter-array and OECC cable installation are therefore short-term and localized. Due to the relatively small area impacted by habitat disturbance and resettled sediment, BOEM anticipates impacts on prey and foraging success for sea turtles would be **negligible**.

BOEM expects organisms including polychaetes, oligochaetes, nematodes, nudibranchs, gastropods, and crabs to be present on or near the towers as growth of fouling organisms develops, and could provide forage for sea turtles. In the maximum-case scenario, the total affected area within the WDA would be approximately 0.2 percent of bottom habitat. Given the relatively small area impacted, BOEM anticipates **minor** impacts on sea turtles.

In addition, the fall pipe technique used for placement of scour protection may include the use of an ROV. Data for underwater sound levels from ROVs are limited and highly variable. Estimates from one study indicated levels with thrusters off were greater than 130 dB, and levels with all thrusters on were greater than 160 dB (Roundtree et al. 2002). BOEM does not expect these noise levels to cause injury but could cause temporary behavioral modification to sea turtles, with impacts anticipated to be **minor.**

BOEM could further reduce potential impacts on sea turtles by imposing mitigation measures outlined in Chapter 2 and Appendix D. Impacts on sea turtles could be reduced through adaptive management or near-term refinement of exclusion zones based on field measurements of noise reduction systems, and long-term refinements of other pile-driving monitoring protocols based on monthly and/or annual monitoring results. Daily pre-construction visual surveys and the sunrise and sunset prohibition on pile driving would reduce the likelihood of impacts to sea turtles. Monitoring for charter and recreational fishing gear around WTG foundations would decrease ingestion by and entanglement of gear for sea turtles.

The requirement of AIS on all Proposed Action vessels would allow Vineyard Wind to monitor the number of vessels and traffic patterns for compliance with vessel speed requirements, and would decrease the potential for vessel strike for sea turtles. Potential mitigation measures also include the following monitoring initiatives:

- Regional Monitoring Initiative for Protected Species consisting of central funding of long-term regional monitoring of population level impacts; and
- Ecological Monitoring, or long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations, including the movement of and habitat use of protected species (Appendix D).

Operations and Maintenance

Sea turtles are known to possess geomagnetic sensitivity (but not electro sensitivity) that is used for orientation, navigation, and migration (Lohmann et al. 1997). Multiple studies have demonstrated magneto sensitivity and behavioral responses to field intensities ranging from 0.0047 to 4000 μT for loggerhead turtles, and 29.3 to 200 μT for green turtles (Normandeau et al. 2011). While other sea turtle species have not been studied, anatomical, life history, and behavioral similarities suggest that they could be responsive at similar threshold levels.

Both the OECC and inter-array systems are AC cables and Vineyard Wind would bury all cables at a depth of 5 to 8 feet (1.5 to 2.5 meters). Modeled and measured magnetic field levels from various existing undersea power cable results indicate that AC cables buried to a depth of 3.2 feet (1 meter) would emit field intensities less than 0.05 μT to 82 feet (25 meters) above the cable, and 79 feet (24 meters) along the seafloor. Comparison of these results with sensitivity levels for sea turtles suggests that turtles are capable of sensing magnetic fields from undersea cables (Normandeau et al. 2011).

Juvenile and adult sea turtles may detect the EMF over relatively small areas near cables (e.g., when resting on the bottom or foraging on benthic organisms near cables or concrete mattresses). There are no data on impacts to sea turtles from EMFs generated by underwater cables. However, any potential impacts from AC cables on turtle navigation or orientation would likely be undetectable under natural conditions, and thus would be insignificant (Normandeau et al. 2011). The potential impacts on sea turtles exposed to EMFs from cables installed under the Proposed Action would be **negligible**.

The BA provides a detailed discussion on the continuous underwater noise produced from the operation of wind turbines. Due to the relatively low sound levels as described in the BA (BOEM 2018b), BOEM anticipates impacts on sea turtles from operational WTG noise would be **negligible**.

Vineyard Wind estimates the total annual number of vessel round trips during operations and maintenance to be between 401 and 887, equating to an average of 1 to 3 vessel trips per day (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2018a). Operations and maintenance vessels range in size from 66 to 98 feet (20 to 30 meters) to 394 to 732 feet (120 to 223 meters) with operational speeds from 10 to 25 knots. The frequency range for vessel noise overlaps with sea turtles' known hearing range and would therefore be audible. However, Hazel et al. (2007) suggest that sea turtles' ability to detect approaching small boats is primarily vision-dependent, not acoustic. Sea turtles may respond to vessel approach and/or noise with a startle response (diving or swimming away) and a temporary stress response (NSF and USGS 2011). BOEM anticipates the potential effects of noise from construction and installation vessels on disturbance of sea turtles to be localized, short-term, and therefore **minor**.

Sea turtles are likely to be most susceptible to vessel collision when they are at the surface, or where they occur in high numbers that overlap with high levels of vessel traffic. The increase in vessel round trips during operations and maintenance is likely to increase the relative risk of vessel strike for sea turtles, especially with those vessels travelling at a speed greater than 10 knots. Considering the relatively small increase in vessel traffic and low densities of sea turtles in the proposed Project area, BOEM anticipates the potential effects of vessel strike on sea turtles due to operations and maintenance vessels to be **minor**.

The potential displacement of vessels outside of the proposed Project area could result in a higher number of vessels using transit corridors outside of the WDA but a lower number inside of the WDA. Based on the relatively uniform distribution and low densities of sea turtles in the proposed Project area (see Table 3.3.8-2), the risk of vessel strikes would not increase as a result of this displacement. BOEM anticipates other potential impacts including negative effects to water quality from routine vessel discharges and marine debris to be **negligible** for sea turtles due to anticipated compliance with regulatory measures to control discharges and accidental spills.

There is a potential for displacement of fishing activity from the proposed Project area, which could result in consequences to sea turtles. Fisheries that may interact with turtles in the proposed Project area include bottom trawl, sink gillnet, and sea scallop dredge. There would be no expected increases in the amount of gear or fishing effort based on current quotas. However, fishing effort may be re-allocated or displaced within and surrounding the WDA. Due to relatively low and uniform densities of sea turtles in the proposed Project area and surrounding areas in which displacement is expected to occur, the current rate of sea turtle interactions with fishing gear would not be expected to change. Although relatively higher densities of leatherback sea turtles have been reported seasonally to the northeast of the WDA, it is not expected that fishing effort would be displaced to that area. Therefore, BOEM anticipates any indirect impacts resulting from displacement of fishing effort would be **negligible**.

Indirect impacts of the Proposed Action could occur from modifications to Vineyard Haven port exposing sea turtles to acoustic impacts. At the time of preparation of publication, information was lacking to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port. However, BOEM expects potential indirect impacts associated with this port to be **minor** to **moderate** depending on the type and duration of noise.

Decommissioning

Decommissioning is expected to have similar levels of vessel traffic as construction and installation; however, pile driving is not part of the decommissioning process; therefore, noise is not expected to be a primary impact producing factor during decommissioning.

Decommissioning impacts would include noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jets, and vacuum pumps. Sound pressure levels are not available for these types of equipment, but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 μPa; Pangerc et al. 2016). In addition, Vineyard Wind proposes HRG and ROV surveys for site clearance activities. According to BOEM (2014b), there would be little or no Level A harassment resulting from non-airgun HRG surveys. The most likely and extensive effects of HRG surveys on sea turtles would be behavioral responses. The removal of subsea power cables could represent another source of potential impacts on sea turtles during decommissioning (see Chapter 2). If subsea cables are not left in place, the risks from removing the cables would be short-term, localized to the Proposed Action area, and similar to those experienced during cable installation. Impacts from habitat disturbance and resettled sediments would be **negligible** for sea turtles.

Although some of the decommissioning activities (e.g. acoustic impacts and increased levels of turbidity) may cause sea turtles to avoid or leave the Proposed Action area, this disturbance would be short term and temporary. BOEM anticipates potential impacts on sea turtles during decommissioning to be **minor**.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities are described in Section 2.3. Rowe et al. (2018) present results from an oil spill model assessing the trajectory and weathering of oil following a catastrophic release of all oil contents from the topple of an ESP (the only Proposed Action component containing more than 250 barrels of oil) located closest to shore within the WDA. In the unlikely event of an accidental oil spill, oil may negatively impact marine mammals within 20 to 50 miles (32 to 80 kilometers) of the spill. The BA contains details on the oil spill model (BOEM 2018b).

In the unlikely event of an accidental oil spill, sea turtles may be exposed to oil if they occur within 20 to 50 miles (32 to 80 kilometers) of the spill. BOEM expects the potential impacts of exposure to be sublethal. Vineyard Wind would have an Oil Spill Response Plan in place that would decrease potential impacts from spills. Therefore, due to the unlikelihood of an oil spill, the sublethal level of impact, and the implementation of an Oil Spill Response Plan, potential negative impacts on sea turtles from accidental oil (or other chemical) spills are considered **minor.**

Conclusion

Based on the analysis above, BOEM anticipates the following levels of potential impacts on sea turtles from construction, operations, maintenance, and decommissioning of the Proposed Action:

- **Minor** impacts from pile driving;
- **Minor** impacts from vessel noise;
- **Minor** impacts from vessel strike;
- **Minor** impacts due to loss of foraging habitat;
- **Minor** impacts from accidental oil spills;
- **Negligible** to **minor** impacts for HRG noise; and
- **Negligible** impacts from turbidity during inter-array cable laying, EMF, WTG noise, and fisheries interactions.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.3.8.4. Impacts of Alternative B on Sea Turtles

Alternative B would narrow the PDE to only include the Covell's Beach landfall. The cable route to Covell's Beach is a more direct route than the eastern OECC, and thus may require fewer days of cable-laying activity. However, BOEM expects any decrease in activity to be insignificant to sea turtles and the change in landfall location is not expected to have any measurable effect on sea turtles. BOEM anticipates potential impacts on sea turtles during construction and installation under Alternative B to be the same as the Proposed Action, **minor**.

During operations and maintenance as well as during decommissioning, BOEM anticipates potential impacts on sea turtles under Alternative B to be the same as under the Proposed Action. Thus, BOEM anticipates the impacts would be **minor**. Direct and indirect effects of non-routine activities as well as cumulative effects to sea turtles are also anticipated to be the same as the Proposed Action, **minor**. Mitigation measures identified above would also be applicable to this alternative.

3.3.8.5. Impacts of Alternative C on Sea Turtles

BOEM does not expect relocation of the six northern-most WTG locations to the southern portion of the WDA to significantly change the potential impacts during construction and installation because the total number of WTGs would remain the same, and the southern portion of the WDA does not include areas with higher densities of sea turtles. BOEM anticipates potential impacts on sea turtles under Alternative C to be **minor**.

During operations and maintenance as well as decommissioning activities, BOEM anticipates potential impacts on sea turtles under Alternative C to be the same as those under the Proposed Action. Thus, BOEM anticipates the impacts would be **minor**. Direct and indirect effects of non-routine activities as well as cumulative effects to sea turtles are also anticipated to be the same as the Proposed Action, **minor**. Mitigation measures identified above would also be applicable to this alternative.

3.3.8.6. Impacts of Alternatives D1 and D2 on Sea Turtles

Incremental Contribution of Alternatives D1 and D2

Direct and Indirect Effects of Routine Activities

Construction and Installation

Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. The total acreage of the WDA could increase by 22 percent (16,603 acres [67 km^2]) to achieve wider spacing between WTGs.[16] Alternative D2 would align WTGs in an east-west orientation with a 1 nautical mile spacing between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed gear fishing vessels.

HRG surveys would be performed as part of pre-construction Project activities for Alternatives D1 and D2 due to the increase in total acreage of the WDA. The additional survey work would be required to addresses changes in WTG placements and inter-array cable locations. Such additional pre-construction surveys of bottom bathymetry using HRG and geological surveys could result in acoustic impacts. The non-airgun HRG surveys would use only electromechanical sources such as boomer, sparker, and chirp sub-bottom profilers; side-scan sonar; and multibeam depth sounders. Acoustic signals from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles. The boomer has an operating frequency range of 200 Hz to 16 kHz and could be audible to sea turtles; however, it has very short pulse lengths (120, 150, or 180 microseconds) and a very low source level, with a 180 dB radius of less than 5 meters (16 feet) (BOEM 2014b). Because the exposure to Level A harassment is very small and Level B is small, very brief, and temporary, BOEM anticipates **minor** impacts on sea turtles from HRG noise. Thus, BOEM anticipates potential impacts on sea turtles under Alternative D2 would be **minor**.

Although the potential disturbance of forage habitat would be greater, that area would represent a relatively small proportion of the available forage habitat in the region. Thus, BOEM does not anticipate potential impacts on sea turtles under Alternatives D1 and D2, compared to the Proposed Action to be measurably different and would be **minor**.

[16] As noted in Chapter 2, if stakeholders achieve consensus on implementing the regional transit lane to the south of the WDA, WTG placements for Alternative D1 would need to be placed south of the lane, thus increasing the footprint required for this alternative.

Operations and Maintenance

During operations and maintenance, Alternatives D1 and D2 would increase the area with inter-array cables compared to the Proposed Action. BOEM expects this difference to increase the potential for EMF and effects on sea turtle navigation. Since the level of potential impacts from EMF on juvenile sea turtles is not well studied, BOEM does not know the extent of any additional impacts, but it is not likely to be **major**. Although there would be an increase in cables and EMF, BOEM anticipates potential impacts on sea turtles during operations and maintenance under Alternatives D1 and D2 to be **negligible**.

Decommissioning

If Vineyard Wind leaves cables in place during decommissioning, no change in potential impacts on sea turtles are expected under Alternatives D1 and D2 compared to the Proposed Action. If Vineyard Wind removes cables, the resulting disturbance to bottom habitat and potential forage items would be greater due to longer inter-array cables under Alternatives D1 and D2 compared to the Proposed Action. Even with this increase, BOEM anticipates potential impacts on sea turtles during decommissioning would be **minor** since this area represents a relatively small proportion of available foraging habitat in the region.

Direct and Indirect Effects of Non-Routine Activities

BOEM expects no measurable difference in potential impacts on sea turtles during non-routine activities under Alternatives D1 and D2 compared to the Proposed Action. Thus, BOEM anticipates impacts to be **minor**.

Conclusion

Although Alternatives D1 and D2 would involve an increase in inter-array cabling and potential loss of benthic foraging area, potential impacts on sea turtles during construction and installation, operations and maintenance, and decommissioning under Alternatives D1 and D2 are not expected to be measurably different than the Proposed Action. BOEM also anticipates the cumulative impacts under Alternatives D1 and D2 to be the same as under the Proposed Action, **minor**. Mitigation measures identified above would also be applicable to these alternatives.

3.3.8.7. Impacts of Alternative E on Sea Turtles

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and Installation

Under Alternative E, there would be a 16 percent reduction of the number of WTGs. This reduction would translate into a reduction in pile driving days, vessel traffic, duration of acoustic impacts and fewer impacts on water quality and the benthic environment. The maximum footprint of the WTG and ESP foundations and associated scour protection would be approximately 45 acres (0.2 km^2), which is an 8-acre (32,375-m^2) reduction (7.0 percent) in comparison to the Proposed Action. In actuality, the maximum footprint would likely be slightly smaller, since there would be a reduced amount of inter-array cabling and presumably a reduction in the necessary amount of cable protection within the WDA. Alternative E would likely result in a reduced construction and installation footprint given the fewer WTGs to be installed; therefore requiring less use of jack-up vessels and other impactful equipment. However, BOEM anticipates potential impacts on sea turtles from construction and installation of 84 WTGs would be **minor**.

Operations and Maintenance

Under Alternative E, a reduction in potential impacts from vessel traffic is expected. Thus, BOEM anticipates potential impacts on sea turtles from operations and maintenance of 84 WTGs would be **minor.**

Decommissioning

Under Alternative E, a reduction in vessel traffic, duration of acoustic impacts, and fewer impacts on water quality and the benthic environment are expected. BOEM anticipates potential impacts on sea turtles from decommissioning 84 WTGs would be **minor.**

Direct and Indirect Effects of Non-Routine Activities

BOEM expects potential impacts from non-routine activities under Alternative E to be reduced, but not likely measurably different than the Proposed Action. Thus, BOEM anticipates impacts would be **minor**.

Conclusion

Although Alternative E would involve a decrease in potential impacts on sea turtles during construction and installation, operations and maintenance, and decommissioning, BOEM anticipates the potential impacts overall not to be significantly different than under and would be **minor**. Mitigation measures identified above would also be applicable to this alternative.

3.3.8.8. Impacts of Alternative F (No Action Alternative) on Sea Turtles

Under Alternative F, there would not be any potential for EMF-related impacts on navigation, injury, or behavioral modification due to pile driving, no changes to benthic foraging habitat, and no increased potential for vessel strike.

3.3.8.9. Comparison of Alternatives for Sea Turtles

When comparing Alternatives A through E, BOEM expects Alternative E to have the lowest potential impact on sea turtles, and potential impacts under the Proposed Action and Alternatives B through D2 would be very similar for sea turtles, with differences between them not measurable.

3.3.8.10. Cumulative Impacts

As described in Appendix C, BOEM considered cumulative impacts on sea turtles for the waters encompassing the Northeast Shelf LME, Southeast Shelf LME, the Caribbean Sea, and the Gulf of Mexico (Appendix C, Figure C.1-9). Cumulative impacts on sea turtles within this geographic range could include effects from vessel traffic, entanglement in fisheries gear, noise, pollution, climate change, effects on benthic habitat, waste discharge, accidental fuel/oil spills, beach nourishment, sand and mineral mining, coastal armoring, and other disturbance to marine and coastal habitats. Appendix C contains a listing of ten types of actions that BOEM has identified as potentially contributing to cumulative impacts when combined with impacts from the Proposed Action over the geography and time scale described above.

Cumulative impacts on sea turtles include potential effects from the following:

- Eight potential site assessment projects on offshore renewable leases from Virginia to Massachusetts.
- Offshore wind energy projects from North Carolina to Maine as described in Appendix C include Atlantic City Wind and CVOW (both Tier 1 projects, totaling six potential additional WTGs) and South Fork Wind (Tier 2 project, totaling 15 potential additional WTGs). Other leases held by developers as well as projects specified in Appendix C under Tiers 3, 4, and 5 may contain future development activities, some of which currently have unknown design and scope. Currently available information, as presented in Appendix C, suggests that the four Tier 3 projects (Skipjack Wind, U.S. Wind, Revolution Wind, and BSW) could represent up 232 additional WTGs. Although BOEM does not consider the four Tier 3 projects reasonably foreseeable, the potential impacts associated with them would be similar to the Proposed Action if these projects move forward. However, the extent of these effects would ultimately depend on project-specific information that is unknown at this time.
- Four tidal projects proposed on the U.S. East Coast.
- Eight marine mineral requests and active leases from New Jersey to Florida.
- Eight HRG survey permits under review from Delaware to Florida.
- Seven existing, approved, and proposed liquefied natural gas terminals along the U.S. East Coast from Massachusetts to Florida.
- Current military use that includes acoustic stressors (e.g., sonar, explosives, air guns, noise from vessels, equipment and aircraft).
- Loss of nesting beaches due to climate change from North Carolina to Texas, as well as the U.S. Virgin Islands and Puerto Rico.

The MCT upgrades associated with the offshore wind energy industry may include potential impacts to sea turtles. However, BOEM expects **negligible** to **minor** impacts because sea turtles are not typically found in the vicinity of the New Bedford port, and impacts would also depend on the type and duration of noise. Additional potential upgrades to ports to support the offshore wind energy industry could contribute to cumulative impacts.

All projects and actions described above include increased vessel traffic, with the potential for exposure to vessel noise and the risk for vessel strike. Marine transportation (e.g., from fisheries use, recreational use, and military use) occurs throughout sea turtles' range. BOEM anticipates the cumulative impacts of vessel traffic to be **moderate**.

Underwater noise associated with pile driving, air guns used for military practice, vessel traffic, and seismic surveys may cause injury or behavior disturbance to sea turtles. Because of the prevalence of vessel noise and the potential behavioral responses vessel noise and other sources of noise may illicit, the cumulative effects of underwater noise associated with the Proposed Action in combination with other past, present, and reasonably foreseeable actions range from **minor** to **moderate** depending on the type and duration of the noise. If multiple additional projects or actions, particularly offshore wind energy projects, come to fruition and result in overlapping construction schedules, cumulative impacts would be expected to be more severe (**moderate** to **major**) than if construction activities occurred isolated in time and space.

Many of the project types and actions would cause disturbance or loss to benthic foraging habitat from placement of structures, dredging, mining, or resettled sediment from seafloor disturbance. Some project types, including wind and oil and gas development, may convert benthic habitat from soft- to hard-bottom substrate. Since habitat disturbance would be localized and temporary, BOEM anticipates the cumulative effects of habitat disturbance would be **minor**.

The risk of pollution, including spills and leaks of oil, liquefied natural gas, chemicals, fuel, and waste discharge, is ubiquitous throughout sea turtles' range. Due to limited sources of potential pollution from routine project activities, BOEM anticipates the cumulative effects of pollution to be **minor**.

Rising sea level associated with climate change will negatively affect sea turtles through loss of nesting beaches in the southern portion of their range (i.e., North Carolina to Texas and U.S. Virgin Islands, and Puerto Rico). However, since the proposed Project area does not impact any nesting beaches, no cumulative impacts are expected.

BOEM anticipates the Proposed Action plus cumulative actions area to have **negligible** impact on sea turtles from all onshore activities and components, so there would be no cumulative impacts when combined with any of the identified onshore developments (see Appendix C).

BOEM anticipates the cumulative impacts under Alternatives B, D1, D2, and E to be the same as under the Proposed Action: **negligible** to **moderate**. However, the reduction in the Project footprint under Alternative E would potentially result in an overall reduction in cumulative impacts.

3.3.8.11. Incomplete or Unavailable Information for Sea Turtles

The effects of EMF to juvenile loggerhead, leatherback, Kemp's ridley, and green sea turtles, both foraging and migrating, are not well understood. However, BOEM used the best available information when developing this section and sufficient information exists to support the findings presented herein.

3.4. SOCIOECONOMIC AND CULTURAL RESOURCES

3.4.1. Demographics, Employment, and Economics

This section discusses demographics, employment, and other economic conditions. The study area for this section includes the Commonwealth of Massachusetts, the states of Rhode Island and Connecticut, and the following counties:

- Massachusetts: Barnstable, Bristol, Dukes, and Nantucket
- Rhode Island (proposed Project construction activities at potential ports only): Providence (Port of Providence [ProvPort]) and Washington (Port of Davisville/Quonset Point)
- Connecticut (proposed Project construction activities at potential ports only): Fairfield (Port of Bridgeport) and New London (Port of New London/Groton)

Related sections include Sections 3.4.2, 3.4.4, and 3.4.5.

3.4.1.1. Description of the Affected Environment for Demographics, Employment, and Economics

Regional Setting

Proposed Project facilities and associated port activities would be located primarily within coastal Massachusetts, Connecticut, and Rhode Island. Appendix F.1 provides detailed demographic information for the study area.

Study Area

Barnstable, Dukes, and Nantucket Counties

The population of Barnstable County declined by 3.4 percent from 2000 to 2016, while the population of Dukes and Nantucket Counties grew. Dukes and Nantucket Counties have the smallest population of any counties in

Massachusetts. The population of Barnstable and Dukes Counties are older, on average, than the population of surrounding counties and Massachusetts as a whole, while Nantucket County's age distribution is similar to the statewide profile (U.S. Census Bureau 2012b and U.S. Census Bureau 2018a).

Barnstable, Dukes, and Nantucket Counties are notable for their high proportion of seasonal housing. In Massachusetts as a whole, 4 percent of housing units are seasonally occupied, as compared to 38 percent of homes in Barnstable County, 60 percent of homes in Dukes County, and 61 percent of homes in Nantucket County (U.S. Census Bureau 2018a). Towns in Barnstable County experience significant seasonal population growth. During the peak tourist season from June through August, the population of Cape Cod grows by "an equivalent [of] 68,856 full time residents" (COP Volume III, Section 7.1.1.1.1; Epsilon 2018a), equivalent to approximately 32 percent of Barnstable County's 2016 population. In addition, "seasonal population continues to grow even as the number of Cape Cod's year-round residents decreased" (COP Volume III, Section 7.1.1.1.1; Epsilon 2018a). Unemployment rates in the three county area are higher than in Massachusetts as a whole. In 2017, unemployment was 4.4 percent in Nantucket County, 4.7 percent in Barnstable County, and 4.9 percent in Dukes County, as opposed to 3.7 percent in Massachusetts (COP Volume III, Section 7.1.1.1; Epsilon 2018a).

The industries that employ residents reflect the importance of tourism to these counties. A greater proportion of residents work in entertainment, recreation, accommodation, and food service (11 to 12 percent) than in Massachusetts as a whole (9 percent). In addition, 14 percent of employed Barnstable and Nantucket County residents hold jobs in retail trade, as compared to 11 percent statewide, and 9 to 17 percent of residents in the three counties hold jobs in construction as opposed to 5 percent statewide (U.S. Census Bureau 2018b).

The NOAA tracks economic activity dependent upon the ocean in its "Ocean Economy" data, which generally include commercial fishing and seafood processing, marine construction, commercial shipping and cargo handling facilities, ship and boat building, marine minerals, harbor and port authorities, passenger transportation, boat dealers, and tourism and recreation, amongst others. Table 3.4.1-1 reports these data in terms of gross domestic product (GDP) and employment. In Dukes, Barnstable, and Nantucket counties, tourism and recreation accounted for 96, 87, and over 99 percent of the overall Ocean Economy GDP (NOAA 2018a). This category includes recreational and charter fishing, as well as commercial ferry services based in Hyannis Harbor and Woods Hole, which provide service to Nantucket, Martha's Vineyard, and other locations. The Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority generated nearly $104 million in revenues in 2016 with almost 2,466,800 passenger trips, while Hy-Line Cruises' ferry service between Hyannis, Martha's Vineyard, and Nantucket had approximately 713,400 passenger trips (Steamship Authority 2016, 2018).

Vineyard Wind has stated that the proposed Project would establish an operations and maintenance facility at Vineyard Haven on Martha's Vineyard (Dukes County, Massachusetts).

Table 3.4.1-1: 2015 Ocean Economy Data for Study Area Counties

County	Ocean Economy GDP (Employment Data) – All Ocean Sectors (2015 USD) [a]	Total County GDP (Coastal Economy - Employment Data) – Total, All Industries (2015 USD) [b]	Ocean Economy GDP, as Percent of Total County GDP (%)	Total Ocean Economy Employment, including Self-Employed Individuals [c]
Barnstable, MA	$994,981,000	$9,160,917,267	11%	17,089
Bristol, MA	$689,939,000	$23,006,034,218	3%	6,888
Dukes, MA	$123,682,000	$903,724,682	14%	1,834
Nantucket, MA	$125,175,000	$823,871,218	15%	1,616
Providence, RI	$683,484,000	$36,208,200,559	2%	15,501
Washington, RI	$850,286,000	$5,515,374,746	15%	10,820
Fairfield, CT	$1,338,278,000	$88,240,524,152	2%	18,679
New London, CT	$2,192,435,000	$15,379,530,768	14%	17,764

GDP = gross domestic product; USD = U.S. dollars
[a] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies; All Ocean Sectors (NOAA 2018a)
[b] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2018b)
[c] Total employment calculated as All Ocean Sectors Employment (NOAA 2018a) plus All Ocean Sectors Self-Employed Workers (NOAA 2018c).

Bristol County, Massachusetts

Bristol County is more densely populated than Massachusetts as a whole, and had lower per capita income and housing values. As shown in Table F.1-4 in Appendix F.1, manufacturing and wholesale trade jobs account for more than 20 percent of the county's at-place employment, compared to 11 percent statewide (U.S. Census Bureau 2018b). In 2015, Ocean Economy activities accounted for 3 percent of Bristol County's GDP, and employed approximately 6,888 individuals, including self-employed individuals (see Table 3.4.1-1). Commercial fishing, aquaculture, and seafood processing accounted for 63 percent of Bristol County's total Ocean Economy value (NOAA 2018a). The unemployment rate in Bristol County was 4.7 percent in 2017 (COP Volume III, Section 7.1.1.1; Epsilon 2018a).

The Port of New Bedford, a full-service port with well-established fishing and cargo handling industries, is the highest-grossing commercial fishing port in the United States (Sasaki et al. 2016; New Bedford Port Authority 2018). The Port of New Bedford generated 36,578 jobs in 2015 (COP Volume III, Section 7.1.1.2; Epsilon 2018a). Section 3.4.5 provides additional information about the commercial fishing industry. Vineyard Wind has signed a lease to use the MCT at the Port of New Bedford, a facility developed by the port specifically to support the construction of offshore wind facilities, to support proposed Project construction. The Port will also likely support maintenance and operations activities given its infrastructure to stage offshore wind components.

Depending on demands and activities at the MCT, the proposed Project may conduct staging activities in other areas at the Port of New Bedford, at the ports of Montaup or Brayton Point, both in Bristol County, or at other ports in Rhode Island or Connecticut (see below). The Montaup and Brayton Point ports are both at the site of decommissioned power plants. The recent history of industrial activity in these locations suggests the presence of a skilled workforce consistent with proposed Project needs.

Providence and Washington Counties, Rhode Island

The City of Providence is the state capital and largest city in Rhode Island, and has approximately 60 percent of the state's population. As shown in Tables F.1-2 and F.1-3 in Appendix F.1, housing values, per capita income, and unemployment are higher than the state average (U.S. Census Bureau 2018a).

The ProvPort is a privately owned marine terminal that has generated approximately $164 million in economic output for Providence and $211 million for the State of Rhode Island since 1994 (COP Volume III, Section 7.1.1.2.1; Epsilon 2018a). In 2015, Ocean Economy activities accounted for 2 percent of the county's GDP (see Table 3.4.1-1), more than 84 percent of which was associated with tourism and recreation (NOAA 2018a).

Washington County contains only 12 percent of the state's population. Median per capita income and housing values are higher than the statewide figures, while unemployment rates and home vacancy rates are lower. A higher proportion of homes are seasonally occupied (17 percent) than in the state as a whole (4 percent) (U.S. Census Bureau 2018a).

The Port of Davisville in Washington County, known locally as Quonset Point, is home to more than 200 companies and nearly 11,000 workers (COP Volume III, Section 7.1.1.2.2; Epsilon 2018a). In 2015, Ocean Economy activities accounted for nearly 15 percent of the Washington County's total GDP (see Table 3.4.1-1). Washington County also contains Port Judith, a center of the Rhode Island fishing industry, and has a diverse Ocean Economy; tourism and recreation accounted for 32 percent of the county's total Ocean Economy value, while the "living resources" sector (commercial fishing, aquaculture, seafood processing, and markets) accounted for 9 percent of the Ocean Economy value (NOAA 2018a).

Statewide, Rhode Island has a diverse Ocean Economy. The primary sectors in the total Ocean Economy value of $2.58 million in 2015 were tourism and recreation (60.7 percent), ship building (22.1 percent), marine transportation (11.5 percent), and living resources (3.4 percent). Recreational fishing is important to the Ocean Economy tourism and recreation sectors, approaching the commercial fishing industry in economic value. Statewide, the commercial seafood industry produced 4,831 jobs and sales of $347 million, while the recreational fishing industry resulted in 3,354 jobs and sales of $332 million (NOAA 2015).

Fairfield and New London Counties, Connecticut

Fairfield County in southeastern Connecticut is the state's most populous county. Its largest city is Bridgeport, which contains the Port of Bridgeport, one of three deep-water ports in Connecticut (COP Volume III, Section 7.7.1.3.1; Epsilon 2018a). Fairfield County's per capita income and housing values were substantially higher than the statewide average, and as shown in Table 3.4.1-1 the Ocean Economy accounted for 2 percent of Fairfield County's GDP in 2015 (NOAA 2018a).

New London County is in southeastern Connecticut and contains the Port of New London/Groton, another deep-water port. New London County's economy is heavily influenced by tourism: 24 percent of the jobs located within New London County are in the accommodation and food services sectors, compared to 10 percent statewide (U.S. Census Bureau 2018b). As shown in Table 3.4.1-1, the Ocean Economy accounted for 14 percent of New London County's total GDP in 2015 (NOAA 2018a), while 13 percent of regional employment is attributed to the region's military and shipbuilding sectors, including the U.S. Naval Submarine Base in Groton and General Dynamics Electric Boat (Volume III, Section 7.1.1.3.2; Epsilon 2018a).

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the following aspects of the region's population and economy (Section 3.4.2 addresses impacts on environmental justice communities, Section 3.4.4 discusses recreation and tourism activities and facilities, and Section 3.4.5 discusses commercial fisheries):

- Jobs: The Project would provide temporary jobs during construction and decommissioning, and long-term jobs during operations and maintenance.
- Port activity: The Project would generate economic activity at ports used for the Project. The most intensive activity would occur during construction and decommissioning.
- Direct and indirect impacts on local and regional businesses: Development, construction, and operations and maintenance would require purchase of materials and services. Spending by employees and suppliers would contribute to economic activity.
- Revenues for federal, state, and local governments: Payment of personal income taxes, sales taxes, property taxes, corporate taxes, and payroll taxes would contribute to the regional economy. In addition, Vineyard Wind is negotiating HCAs with Barnstable and Yarmouth that would stipulate payments from Vineyard Wind to the local towns.

Condition and Trend

While median income, housing values, and employment rates vary, the mainland study area generally displays strong and diverse economic activity. Barnstable, Dukes, and Nantucket Counties are highly dependent on tourism and visitors, and have a high proportion of seasonally occupied homes. The economies of Martha's Vineyard and Nantucket are less diverse than the mainland jurisdictions.

As discussed in Section 3.4.4.3, BOEM anticipates Dukes, Barnstable, and Nantucket counties to continue to be heavily dependent on tourism and recreation, which accounts for 96, 87, and 99 percent of the overall Ocean Economy GDP of those respective counties. In Bristol, Providence, and Fairfield counties, with more diverse economies, ocean economy sectors would continue to be more diverse, with a higher proportion of shipping and commercial fishing, while also constituting a smaller proportion of the local economy. BOEM does not anticipate any substantial changes to the distribution of economic sectors in the study area over the Project's proposed lifetime.

3.4.1.2. Environmental Consequences

Relevant Project Design Parameters

Proposed-Project design parameters that would influence the magnitude of impact on the study area's demographic, employment, or economic characteristics include the following elements of the maximum-case scenario (as described in Appendix G):

- Overall size of project (approximately 800 MW) and number and position of WTGs;
- The extent to which Vineyard Wind hires local residents and obtains supplies and services from local vendors;
- The port(s) selected to support construction, installation, and decommissioning in addition to the MCT;
- The port(s) selected to support operations and maintenance in addition to Vineyard Haven Harbor and the MCT; and
- The design parameters that could impact commercial fishing and recreation and tourism (see Section 3.4.4.2) since direct impacts on these activities could lead to impacts on employment and economic activity. Section 3.4.5 discusses economic activity related to commercial and for-hire fishing in detail.

Potential Variances in Impacts

The proposed Project's beneficial impacts on employment and the economy are highly dependent on assumptions regarding how many workers and what percent of the construction materials, as well as construction and maintenance activities, can be locally sourced. A 2017 report estimated that during the initial implementation of offshore wind projects along the U.S. northeast coast, a base level of 35 percent of jobs, with a high probability of up to 55 percent of jobs, would be sourced from within the United States (BVG 2017). The proportion of jobs filled within the United

States would increase as the offshore wind energy industry grows, due to growth of a supply chain and supporting industries along the east coast, as well as a growing number of local operations and maintenance jobs for established wind facilities. By 2030 and continuing through 2056, approximately 65 to 75 percent of jobs associated with offshore wind are projected to be within the United States. Overseas manufacturers of components and specialized ships for installation of foundations and WTGs based overseas would fill jobs outside of the United States (BVG 2017). As an example of the mix of local, national, and foreign job creation, for the 5-turbine Block Island Wind Farm, turbine blade manufacturing occurred in Denmark, generator and nacelle manufacturing occurred in France, tower component manufacturing occurred in Spain, and foundation manufacturing occurred in Louisiana (Gould and Cresswell 2017).

In the COP, Vineyard Wind provided a University of Massachusetts at Dartmouth (UMass) study with its anticipated range of spending statewide and in southeastern Massachusetts to allow formulation of estimated economic contribution (Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a).[17] The analysis includes a base and high scenario; the high scenario assumes that a larger proportion of employees, vendors, and supplies come from Massachusetts. The impact assessment in Section 3.4.1.3 below evaluates the impacts of the "base" scenario, as a conservative measure, because the supply chain is not fully developed. Vineyard Wind provided no estimates of jobs or spending that the Proposed Action would generate outside of Massachusetts.

3.4.1.3. Impacts of Alternative A (Proposed Action) on Demographics, Employment, and Economics

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with construction, operations and maintenance, and decommissioning of the Proposed Action.

Direct and Indirect Effects of Routine Activities

Direct effects on demographics, employment, and economics include population gain or loss due to the Proposed Action; housing needs for Proposed Action workforce; job creation; tax revenues, payroll, and other Proposed Action expenditures; and other funds provided by Vineyard Wind in connection with the Proposed Action. Indirect effects include economic activity generated within the study area through spending by Proposed Action employees or vendors, or by governments, based upon income received from Vineyard Wind in connection with the Proposed Action.[18] Indirect economic effects may occur in the recreation, tourism, and the commercial fishing sectors. Sections 3.4.4 and 3.4.5 discuss impacts of the Proposed Action on these resources.

Construction and Installation

Table 3.4.1-2 summarizes Vineyard Wind's estimate of the Proposed Action's contributions to employment and economic activity within Massachusetts and a five-county area in southeastern Massachusetts during construction and installation. Based on this information, Borges et al. (2017a) estimated that at least 85 percent of direct job creation and 63 percent of indirect/induced job creation would be jobs located within southeastern Massachusetts, as opposed to jobs created at manufacturing facilities outside Massachusetts. Some of the local jobs would be filled by workers who move to the region to work on the Proposed Action, and who may leave when construction of the Proposed Action is complete. Vineyard Wind's base estimate for expenditures on materials and supplies within Massachusetts is $177 million, 60 percent of which they anticipate to be from suppliers within southeastern Massachusetts (Borges et al. 2017a).

The construction-phase jobs include jobs during the pre-construction stage, which is currently underway, for site assessment, design, environmental review, and permitting. For Massachusetts, these total 126 direct, 27 indirect, and 121 induced jobs, respectively. The Proposed Action would generate 119 pre-construction jobs and 952 construction jobs in southeastern Massachusetts.

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[17] As described in Section 3.1.1 of Borges et al. (2017a, available in COP Appendix III-L [Epsilon 2018a]), the base and high economic impact scenarios reflect different levels of spending by Vineyard Wind in Massachusetts and southeast Massachusetts.

[18] As defined in the economic contribution study: "Indirect impacts result from the suppliers of the wind farm purchasing goods and services as a result of the direct spending on the project. Because these impacts measure interactions among businesses, they are often referred to as supply-chain impacts. Induced impacts result from the spending of employees directly involved in the development, construction, and operations of the wind farm, as well as the spending of employees of the wind farm's suppliers within the region. These induced effects are often referred to as consumption-driven impacts." (Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a)

Table 3.4.1-2: Vineyard Wind's Projected Jobs and Expenditures during Preconstruction, Construction, and Installation (Base Estimate)

Scenario		Massachusetts Statewide	Southeastern Massachusetts
Jobs (FTE) [a]	Direct	1,100	1,071
	Indirect	373	215
	Induced	898	666
Direct Labor Income (thousands)		$114,858,283	$91,502
Direct Expenditures other than payroll (thousands) [b]		$177,363	$104,850

Source: Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a

[a] One FTE (full-time equivalent) job is the equivalent of one person working full time for 1 year (2,080 hours). Thus, two half-time employees would equal one FTE. Only those jobs that Vineyard Wind would perform in the designated area are included. Borges et al. (2017a) considers a local worker one who moves to the region to work on the Proposed Action and then moves on when the Proposed Action is over.

[b] Amount to be spent procuring materials and services from suppliers in the designated area to support the development and construction of the wind facility

Vineyard Wind projects that construction jobs would be filled primarily by local labor, although experienced workers from the Gulf of Mexico region (with experience in offshore oil or gas structures) or Europe would fill some supervisory and technical positions. Vineyard Wind would stage construction and installation of offshore components from the MCT (Epsilon 2018a).

A recently completed Massachusetts workforce assessment provides projections of possible statewide job creation from construction of multiple offshore wind projects totaling 1,600 MW (twice the Proposed Action's approximately 800 MW facility), using the Jobs and Economic Development Impact method developed by the National Renewable Energy Laboratory (NREL) (BCC et al. 2018). The assessment provides a low estimate, which assumes that no major components are manufactured within Massachusetts, and a high estimate, which assumes that a small amount of secondary foundation parts are sourced locally. The NREL study estimated that construction of 1,600 MW of offshore wind power would generate 2,279 to 3,171 direct employees, 2,315 to 3,618 indirect employees, and 2,284 to 3,063 induced employees (as measured in full-time equivalents). Vineyard Wind's Proposed Action would represent half of the 1,600 MW capacity included in the NREL study.

Other available studies neither support nor conflict with Vineyard Wind's estimates of job and economic activity generation in southeast Massachusetts, as opposed to elsewhere in Massachusetts. If the proportion of jobs in southeast Massachusetts is as high as estimated, the four counties included in the study area (Bristol, Barnstable, Dukes, and Nantucket counties) have a sufficient workforce to meet the Proposed Action's needs, although workers with specific skills and experience may need to relocate to southeastern Massachusetts (see Appendix F.1) and, as noted in the Massachusetts Workforce Assessment, training would be needed (BCC et al. 2018). Vineyard Wind's base estimate of 1,952 jobs created in southeastern Massachusetts during construction would represent 0.6 percent of the 2016 employed population of 335,873 in these four counties (see Appendix F.1). The 952 local construction-related jobs anticipated by Vineyard Wind would represent 5.7 percent of at least 16,800 study-area residents in the construction sector in 2016.[19] This increased demand could result in a temporary, irretrievable loss of workers available for other construction projects, leading to an influx of workers from other areas or deferral of development projects. Likewise, while some WTG components would be unique to WTGs, the demand for more general construction-related supplies and services to support the Proposed Action could result in a temporary loss of available services and supplies for other development projects. Chapter 6 discusses irreversible and irretrievable commitments of resources in greater detail.

Vineyard Wind estimated that job compensation (including benefits) would average between $88,000 and $96,000 for the construction phase, with occupations including engineers, construction managers, trade workers, and construction technicians (Borges et al. 2017a). A study from the New York Workforce Development Institute provided estimates of salaries for jobs in the wind energy industry that concur with Vineyard Wind's projections. Anticipated salaries range from $43,000 to $96,000 for trade workers and technicians, $65,000 to $73,000 for ships' crew and officers, and $64,000 to $150,000 for managers and engineers (Gould and Cresswell 2017).

Sufficient housing exists to meet the demands of workers who relocate to work on the Proposed Action. With more than 400,000 dwellings in the four most-local counties, and a vacancy rate for non-seasonal housing ranging from 6 percent in Barnstable County to 17 percent in Nantucket County, housing would be available for workers moving to

[19] Statewide, 5 percent of employed residents worked in the construction industry in 2016, while in the four most local counties, 7 to 17 percent of employed residents worked in construction. Using 5 percent as a more conservative estimate, at least 16,793 employed residents worked in the construction industry (see Appendix F.1).

the area to take construction jobs and would not displace tourism rentals. With an estimated 23,000 vacant housing units in the four most local counties in 2016, workers relocating to southeastern Massachusetts would be unlikely to cause housing shortages or increased housing prices (see Appendix F.1). The large number of seasonally vacant housing units in Barnstable, Dukes, and Nantucket counties could also provide temporary housing, depending on location and the time of year when construction occurs.

Table 3.4.1-3 summarizes estimated state and local tax revenues that would result from development, construction, and the first year of operations and maintenance of the Proposed Action.

Table 3.4.1-3: Projected Tax Revenues, Development, Construction, and First Year Operations and Maintenance (Base Case)

Type of Tax	Estimated Revenue (thousands)
Personal income taxes	$4,133
Other personal taxes	$547
Payroll taxes [a]	$67
Sales taxes	$3,019
Property taxes	$5,178
Corporate income taxes	$1,231
Fees and other taxes	$500
Total	$14,674

Source: Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a
[a] Includes both employee and employer paid payroll taxes

Construction and installation of the Proposed Action would diversify and generate jobs and revenues in the study area's "ocean economy" sector (see Section 3.4.1.1). In particular, the Proposed Action would require workers for tug and other vessel charters, dockage, fueling, inspection/repairs, provisioning, and crew work (Borges et al. 2017a). These jobs within the ocean economy sector would be concentrated in Bristol County (site of the MCT), but could also be created in counties with other port facilities described in Section 3.4.1.1. At the time of preparation of this Draft EIS, insufficient information was available to perform a detailed indirect assessment of the employment and economic impacts of modifications to the Vineyard Haven port. In general, these activities would generate additional jobs and revenues not included in Table 3.4.1-3 or the previous discussion.

As noted in Sections 3.4.4.3 and Section 3.4.5, construction and installation of the Proposed Action may have **minor** impacts on recreation, tourism, and commercial fisheries in the study area, with **moderate** impacts possible if Vineyard Wind selects the New Hampshire Avenue landfall site, due to the potential effects on activities that depend upon fishing and marine navigation in Lewis Bay. BOEM could reduce potential impacts on recreation, tourism, and commercial fisheries in and around Lewis Bay to **minor** by requiring use of the OECC routing mitigation measure (avoidance of the navigation channel or burial at a depth sufficient to allow dredging) as a condition of COP approval (see Section 2.2.1). These direct impacts on recreation and tourism and commercial fishing would have **minor** indirect economic impacts.

Overall, BOEM anticipates construction of the Proposed Action to have a **negligible** impact on demographics and, considering the short duration of construction and the job and revenue generation described above, a **minor beneficial** impact on employment and economics. Potential beneficial impacts on employment and economics would increase (but would remain **minor**, based on the definitions in Section 3.1) if the local hiring plan mitigation measure outlined in Section 2.2.1 became a condition of COP approval.

Operations and Maintenance

Table 3.4.1-4 summarizes Vineyard Wind's estimates of the job and economic impacts of Proposed Action operations and maintenance. Direct jobs would last for the operational life of the Proposed Action, up to 30 years after construction and installation. Ninety percent of the direct jobs would be located at the Operations and Maintenance Facilities at Vineyard Haven (Borges et al. 2017a), an approximate 1 percent increase in existing employment in Dukes County (see Table F.1-2 in Appendix F.1). Operations and maintenance occupations would consist of wind technicians, plant managers, water transportation workers, and engineers. Average annual compensation for these direct jobs, including benefits, would be approximately $99,000 (Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a). Indirect and induced jobs would also be located in southeastern Massachusetts and other portions of the state. Vineyard Wind would use the MCT for repair and maintenance of Proposed Action components and vehicles.

Table 3.4.1-4: Jobs and Economic Impacts during Operations and Maintenance (Base Case)

		Massachusetts Statewide	Southeastern Massachusetts
Jobs (FTE) [a]	Direct	80	80
	Indirect and Induced	89	89
	Total	169	169
Annual labor income (thousands)	Direct	$8,151	$8,151
	Indirect and Induced	$6,356	$4,047
	Total	$14,507	$12,198
Annual expenditures (thousands) [b]	Direct	$5,215	$4,606
	Indirect and Induced	$6,199	$5,079
	Total	$11,414	$9,684
Annual added economic value (thousands) [c]	Direct	$3,846	$2,388
	Indirect and Induced	$9,937	$6,469
	Total	$13,783	$8,857

Source: Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a

[a] One FTE (full-time equivalent) job is the equivalent of one person working full time for 1 year (2,080 hours). Thus, two half-time employees would equal one FTE. Only those jobs performed in the designated area are included in Borges et al. (2017a). Borges et al. (2017a) considers a local worker one who moves to the region to work on the Proposed Action and then moves on when the Proposed Action is over.

[b] Amount to be spent procuring materials and services from suppliers in the designated area to support the operations and maintenance of the offshore wind facility, excluding labor costs

[c] Economic value generated by operations and maintenance of the Proposed Action, excluding direct expenditures

Vineyard Wind has proposed the following additional investments upon negotiation of a Power Purchase Agreement (COP Appendix III-Q; Epsilon 2018a):

- HCAs: Pursuant to the HCA between Vineyard Wind and the Town of Barnstable, Vineyard Wind would provide $16 million to the town if the Covell's Beach cable landfall site and OECR is selected, or $6 million if the New Hampshire Avenue cable landfall site and OECR is selected (Town of Barnstable 2018b). HCAs for the Town of Yarmouth and other communities where onshore facilities are proposed (such as Tisbury, the planned location of the Operations and Maintenance Facilities at Vineyard Haven) have not been executed, but would likely include additional payments during the operations and maintenance period;
- Windward Workforce Program: $2 million one-time payment to support programs that recruit and train residents of Massachusetts, especially southeast Massachusetts, for jobs in the offshore wind industry, in partnership with high schools, community colleges, and other organizations;
- Offshore Wind Industry Accelerator Fund: an up-to $10 million one-time payment to attract investments in ports, manufacturing facilities, and technology development for offshore wind; and
- Resiliency and Affordability Fund: $1 million annually for 15 years to promote and support low-income ratepayers, clean energy projects, and coastal energy resiliency in Bristol, Dukes, Nantucket, and Barnstable counties.

Vineyard Wind's estimates of the Proposed Action's economic contributions estimate that the Windward Workforce Program, Offshore Wind Industry Accelerator Fund, and the first year of the HCAs would result in 53 direct and 125 indirect jobs during the first year that the funds are implemented (Borges et al. 2017a, available in COP Appendix III-L; Epsilon 2018a).

A joint research study of the University of Connecticut and Lawrence Berkeley National Laboratory found no net effects from WTGs on property values in Massachusetts (Atkinson-Palombo and Hoen 2014). Specifically, the study found no evidence of a "'scenic vista stigma,' the possible concern that homes might be devalued because of the view of a wind facility" (Atkinson-Palombo and Hoen 2014). This research, combined with the limited visibility of the Proposed Action from any residence (see Section 3.4.4.3) indicates that operation of the Proposed Action would have negligible impacts on property values.

Overall, operations and maintenance of the Proposed Action would have a **minor beneficial** impact on employment and economics.

Decommissioning

Decommissioning would result in a temporary increase in employment during the removal of the wind facility improvements. The nature and magnitude of these impacts would be similar to the impacts described for construction. Upon completion of decommissioning, the jobs and economic activity generated by operations and maintenance would cease, and the Proposed Action would no longer produce the employment and other revenues listed in Table 3.4.1-4.

The temporary employment increase during decommissioning would result in a **minor beneficial** impact on employment and economics in the study area, compared to the operations and maintenance phase, but **negligible** impacts compared to overall employment in the study area.

The Proposed Action's economic contributions at the end of decommissioning would be the same as pre-construction: none. Completion of decommissioning would result in a loss of the decommissioning workforce and associated taxes and revenues, as compared to the operations and maintenance phase, but would not constitute a change compared to existing conditions (as documented in Section 3.4.1.1).

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities would generally require intense, temporary activity to address emergency or urgent conditions. Economic impacts could include the cost to local and state government agencies of emergency response efforts; the benefit to businesses and workers who provide repairs and remediation; and impacts from disruption of business activities in the immediate vicinity of the non-routine activity. Overall, BOEM anticipates the net impacts on employment or economics to be **negligible.**

Conclusion

Based on the analysis above, construction and operations and maintenance of the Proposed Action would have overall **minor beneficial** impacts on employment and economic activity in the study area due to the anticipated creation of jobs, expenditures on local businesses, generation of tax revenues, and provision of grant funds that would result from the Proposed Action. Decommissioning of the Proposed Action would also have **minor beneficial** impacts on employment and economics due to the construction activity necessary to remove the wind facility structures and equipment. Upon completion of decommissioning, the jobs and economic activity generated by operations and maintenance would cease, and the Proposed Action would no longer produce the employment and other revenues listed in Table 3.4.1-4. While the beneficial impacts rating would remain the same, BOEM could further mitigate potential impacts of construction, operations and maintenance, and decommissioning by requiring Vineyard Wind to prepare and implement a Local Hiring Plan to ensure that estimated direct hiring of southeastern Massachusetts residents is achieved or exceeded (see Section 2.2.1; also see the Base Case in COP Appendix III-L; Epsilon 2018a).

Construction of the Proposed Action would have **minor** impacts on tourism, recreation, and commercial fishing, as stated in Sections 3.4.4 and 3.4.5, and would therefore have **minor** impacts on the businesses associated with those activities. These impacts do not change the overall **minor beneficial** impact of the Proposed Action on employment and economic activity.

The Proposed Action would have **negligible** impacts on demographics within the study area. While it is likely that some workers would relocate to the area due to the Proposed Action, the volume of workers needed compared to the current population is such that the change would be **negligible**.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.1.4. Impacts of Alternatives B, C, and D on Demographics, Employment, and Economics

The impacts of Alternatives B, C, and D (including Alternatives D1 and D2) on demographics, employment, and economics, excluding commercial fisheries and for-hire recreational fishing and recreation and tourism, would be the same as the Proposed Action:

- **Negligible** impacts on demographics in all Project phases;
- **Minor beneficial** impact on employment and economics during construction and installation, operation and maintenance, and decommissioning; and
- **Negligible** impacts associated with non-routine activities.

3.4.1.5. Impacts of Alternative E on Demographics, Employment and Economics

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and installation of Alternative E would include no more than 84 WTGs, each of which would likely have a generation capacity of approximately 9.5 MW, compared to the 100 WTGs (each with up to 8-MW capacity) in the

Proposed Action. Vineyard Wind's economic analysis did not estimate the employment and economic requirements and outputs for Alternative E.

Construction and Installation

For purposes of this analysis, BOEM assumes that manufacture and installation of up to 84 WTGs requires approximately the same labor inputs (person-hours) as construction of up to 100 WTGs, and increased direct expenditures. Due to economies of scale, BOEM assumes that increased direct expenditures are not proportional to the increase in output; therefore, Alternative E would require the same construction workforce and labor spending, but would generate reduced total direct expenses and lower tax revenues, compared to the Proposed Action. Nonetheless, construction of Alternative E would have **negligible** impacts on demographics and **minor beneficial** impacts on employment and economics.

Operations and Maintenance

For this analysis, BOEM assumes that operations and maintenance of Alternative E would generate fewer jobs and reduced labor spending, but similar direct expenditures and economic value added, compared to the Proposed Action. The reduced number of WTGs would likely facilitate navigation through the WDA, reducing potential economic impacts on commercial fishing businesses that navigate through the WDA and also providing a marginal reduction of impact on recreational boating. As a result, operations and maintenance of Alternative E would have **negligible** impacts on demographics and **minor beneficial** impacts on employment and economics.

Decommissioning

Compared to the Proposed Action, Alternative E would require a similar decommissioning workforce and labor spending, but would generate lower total direct expenses and lower tax revenues. Nonetheless, the economic and employment impacts of decommissioning of Alternative E would be similar to the impacts of construction and installation of Alternative E: **negligible** impact on demographics and **minor beneficial** impact on employment and economics.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities associated with Alternative E would be the same as the Proposed Action: **negligible**.

Conclusion

Based on the analysis above, Alternative E would generate a similar number of jobs and a similar amount of labor spending as the Proposed Action, but would generate lower direct spending and economic benefits compared to the Proposed Action. Alternative E would generate **minor beneficial** employment and economic inputs for the study area, although these benefits would be lower than for the Proposed Action. Construction of Alternative E would also have **minor**, negative impacts on businesses that conduct commercial fishing and recreational boating in the WDA, although these impacts would be less than those associated with the Proposed Action.

3.4.1.6. Impacts of Alternative F (No Action Alternative) on Demographics, Employment, and Economics

As discussed above and in Section 3.4.4.3, BOEM anticipates Dukes, Barnstable, and Nantucket counties to continue to be heavily dependent on tourism and recreation. If BOEM does not approve the proposed Project (either the Proposed Action or an alternative that involves construction of WTGs in the WDA), the resulting beneficial economic and demographic effects would not occur in the region. There would be no temporary jobs created during construction or decommissioning or long-term jobs during operations and maintenance. No economic activity would be generated at ports used for the proposed Project or for local or regional businesses. There would be no tax revenues created for federal, state, or local governments, and Vineyard Wind would not make HCA to the towns of Barnstable and Yarmouth. No impacts on local economies from effects on recreation, tourism, or commercial fishing would occur.

3.4.1.7. Comparison of Alternatives for Demographics, Employment, and Economics

The Proposed Action and Alternatives B through D (including D1 and D2) would have **negligible** impacts on demographics and a **minor beneficial** employment and economic impact. Alternative E would still have **negligible** impacts on demographics and **minor, beneficial** employment and economic impacts, but would have marginally lower impacts on employment and economics, compared to the Proposed Action, due to lower total direct expenses and tax revenues.

As discussed in Section 3.4.1.2, the analysis of impacts is based on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.1.3 through 3.4.1.5.

3.4.1.8. Cumulative Impacts

The analysis area for cumulative impacts on demographics, employment, and economic characteristics includes the counties where proposed onshore infrastructure and potential port cities are located as well as counties in closest proximity to the WDA (Barnstable, Bristol, Dukes, and Nantucket counties, Massachusetts; Providence and Washington counties, Rhode Island; and Fairfield and New London counties, Connecticut) (see Appendix C, Figure C.1-10). These counties are the most likely to experience beneficial or negative economic impacts from the Proposed Action.

Projects with the potential to generate cumulative impacts (as described in Appendix C) include the following reasonably foreseeable activities:

- Site characterization and site assessment activities for nearby offshore WLA projects;
- Construction and operation and maintenance of nearby offshore wind energy projects, including the proposed South Fork project, that may use the same ports and have similarly located areas of economic influence; and
- Onshore developments including residential, commercial, and industrial developments spurred by population growth in the region and onshore solar, transmission, gas pipeline, communications tower, and wind projects.

Cumulatively, the existing and proposed reasonably foreseeable activities associated with onshore and offshore wind energy projects would establish a market on the east coast for wind energy-related suppliers, manufacturers, and other support industries (see the estimates in Section 3.4.1.2). The projects closest to the Proposed Action—those offshore of Massachusetts, Rhode Island, Connecticut, and New York—would provide a regional market and ongoing demand for workers skilled in the professions and trades needed for construction, installation, maintenance, and repair of wind facilities. In addition to growth in the offshore wind energy sector, ongoing commercial development in the economic study area counties will continue to have a beneficial impact on local economies.

Due to the relatively large scale of the proposed approximately 800 MW project, the Proposed Action, when combined with past, present, and future projects, would make a **moderate beneficial** contribution to the cumulative economic and employment impacts, helping to create a viable wind energy industry on the east coast of the United States, when combined with the past, present and reasonably foreseeable future activities. Of the four Tier 3 projects outlined in Appendix C, two of them, BSW and Revolution Wind, would likely have the greatest contribution to beneficial cumulative economic effects if they came to fruition based on their size (totaling up to approximately 185 WTGs) and proximity to the Proposed Action.

BOEM anticipates the cumulative impacts on demographics, employment, and economics under Alternatives B, C, D1, D2, and E, when combined with past, present, and future projects, to be the same as the Proposed Action: **moderate beneficial** impacts.

3.4.1.9. Incomplete or Unavailable Information for Demographics, Employment, and Economics

Vineyard Wind's economic analysis did not estimate the employment and economic requirements and outputs for any alternative other than the Proposed Action. BOEM estimated or assumed changes in jobs, expenditures, and economic outputs for demographic, employment, and economic impacts for Alternatives B through E. This provided sufficient information for the evaluation of demographics, employment, and economics.

3.4.2. Environmental Justice

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Subsection 1-101).

EO 12898 directs federal agencies to actively scrutinize the following issues with respect to environmental justice as part of the NEPA process (CEQ 1997):

- The racial and economic composition of affected communities;
- Health-related issues that may amplify project effects to minority or low-income individuals; and
- Public participation strategies, including community or tribal participation in the NEPA process.

According to USEPA guidance, environmental justice analyses must address minority populations (i.e., residents who are non-white, or who are white but have Hispanic ethnicity) when they comprise over 50 percent of an affected area. Environmental justice analyses must also address affected areas where minority or low-income populations are "meaningfully greater" than the minority percentage in the "reference population"—the population of a larger area of the general population, often an entire state (USEPA 2016). Low-income populations are those that fall within the annual statistical poverty thresholds from the U.S. Department of Commerce, Bureau of the Census Population Reports, Series P-60 on Income and Poverty (USEPA 2016).

The Commonwealth of Massachusetts identifies an environmental justice "community" as one or more U.S. Census block groups that meet one or more of the following criteria (Commonwealth of Massachusetts 2017):

- 25 percent of households within the census block group have a median annual household income at or below 65 percent of the statewide median income for Massachusetts; or
- 25 percent or more of the residents are minority; or
- 25 percent or more of the residents have English Isolation.[20]

CEQ and USEPA guidance do not define "meaningfully greater" in terms of a specific percentage or other quantitative measure. Similarly, the states of Rhode Island and Connecticut do not provide specific thresholds. Accordingly, for affected areas in Massachusetts, this Draft EIS uses the Massachusetts criteria defined above, which is more stringent than the federal criteria and therefore would meet the federal criteria. For all other areas, this Draft EIS defines an environmental justice community as one or more block groups that meet USEPA's "50 percent" criterion for race, or that USEPA's EJSCREEN tool (USEPA 2017) identifies as being in the 80th or higher percentile for minority and/or low-income status.

3.4.2.1. Description of the Affected Environment for Environmental Justice

Regional Setting

Table 3.4.2-1 summarizes information about minority and poverty status (as a proxy for low-income status) in reference populations for the proposed Project's environmental justice impacts. This includes the Commonwealth of Massachusetts and states of Rhode Island and Connecticut, as well as counties potentially impacted by proposed Project activities.

Table 3.4.2-1: State-Level Minority and Low-Income Status (Reference Populations)

Jurisdiction	Minority Population Percentage	Percentage of Population in Poverty
Commonwealth of Massachusetts	18.7%	10.5%
Barnstable County	9.8%	7.6%
Bristol County	10.8%	10.7%
Dukes County	9.9%	7.6%
Nantucket County	14.4%	6.4%
State of Rhode Island	15.9%	12.8%
Providence County	21.6%	15.8%
Washington County	6.5%	9.8%
State of Connecticut	19.7%	9.8%
Fairfield County	21.1%	8.6%
New London County	16.4%	9.3%

Source: Vineyard Wind 2018b

Project Area

Environmental justice communities that meet both USEPA and statewide criteria do occur in counties where the proposed Project facilities would be located, as well as in or near the communities where impacts associated with construction and installation, operations and maintenance, and decommissioning activities may occur. Appendix F.2 provides maps of environmental justice communities in these areas. The environmental justice communities in Massachusetts counties screened are most commonly clustered around larger cities and towns, and occur in Hyannis, New Bedford, and Fall River. Environmental justice communities are present on Nantucket near the communities of Cisco, Nantucket, and near the airport and on Martha's Vineyard in Vineyard Haven and near Aquinnah. Additional environmental justice communities occur in Cape Cod and scattered throughout southeastern Massachusetts. Outside of

[20] Indicates households defined by the U.S. Census as being English Language Isolated or that do not include an adult who speaks only English or English very well (Commonwealth of Massachusetts 2017).

Massachusetts, environmental justice communities are most commonly found clustered around Providence and Newport, Rhode Island, and around New London, Connecticut.

Aspects of Resource Potentially Affected

Impacts on environmental justice communities typically occur as a result of impacts on other resources, such as socioeconomics, recreation and tourism (including visual resources), or air quality. Potentially affected environmental justice communities could include minority (including Native American tribes), low-income, and/or linguistically isolated populations. The Wampanoag Tribe of Gay Head (Aquinnah) considers the Gay Head Cliffs, including certain unencumbered views from the cliffs, as important cosmological and ceremonial cultural resources. Consultation with this tribe pursuant to Section 106 of the National Historic Preservation Act (NHPA) (see Section 3.4.3) is ongoing to determine the significance of and to assess potential effects to this resource.

Condition and Trend

Table 3.4.2-2 summarizes trends for non-white populations and the percentage of residents with household incomes below the federally defined poverty line in the counties studied in Massachusetts, Connecticut, and, Rhode Island.[21] The non-white population percentage and percentage of population living under the poverty level have generally increased since 2000 in nearly all study area jurisdictions.

Table 3.4.2-2: State-level Minority and Low-Income Status

Jurisdiction	Non-White Population Percentage			Percentage of Population in Poverty		
	2000	2010	2016	2000	2010	2017
Commonwealth of Massachusetts	15.5%	19.6%	20.6%	9.3%	10.5%	10.5%
Barnstable County	5.8%	7.3%	7.6%	6.9%	7.2%	7.6%
Bristol County	9.0%	11.6%	13.6%	10.0%	11.3%	10.7%
Dukes County	9.3%	12.4%	11.9%	7.3%	8.6%	7.6%
Nantucket County	12.2%	12.4%	14.7%	7.5%	7.2%	6.4%
State of Rhode Island	15.0%	18.6%	19.0%	11.9%	12.2%	12.8%
Providence County	21.6%	26.6%	26.7%	15.5%	15.4%	15.8%
Washington County	5.2%	6.2%	6.8%	7.3%	7.4%	9.8%
State of Connecticut	18.4%	22.4%	22.9%	7.9%	9.2%	9.8%
Fairfield County	20.7%	25.2%	26.2%	6.9%	8.0%	8.6%
New London County	13.0%	17.8%	18.6%	6.4%	7.2%	9.3%

Sources: U.S. Census Bureau 2007a, 2007b, 2010, 2012, 2018; Vineyard Wind 2018b

3.4.2.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of environmental justice impacts include the following elements of the maximum case (as described in Appendix G):

- The onshore cable landfall site chosen and the selected OECR;
- The time of year during which construction occurs. Tourism and recreational activities in the study area are focused on the summer months (May through September), especially from June through August. Onshore construction would take place from September through May, with the installation of cables continuing through June 15 with permission from the towns of Barnstable or Yarmouth (COP Volume I, Section 4.1; Epsilon 2018a); and
- The ports chosen for construction support in addition to the MCT, and the improvements needed at those additional ports due to the proposed Project.

Potential Variances in Impacts

Relevant aspects of the proposed-Project design subject to variation include the OECRs and the construction schedule. Below is a summary of the potential variances in impacts:

[21] Available census data for 2000 and 2010 do not distinguish between white and non-white Hispanic individuals. The percentage of the population with incomes below the federal poverty level ("Percentage of Population in Poverty") is therefore used as a proxy to illustrate trends relevant to environmental justice.

- OECRs: The environmental justice characteristics of the communities traversed by each OECR vary. The majority of the route for the Covell's Beach landfall site would pass through or be adjacent to communities that meet low income and/or minority environmental justice criteria (see Section 3.4.2.1 and Appendix F.2, Figure F.2-3), whereas only a small segment of the route for the New Hampshire Avenue landfall site would be adjacent to a low-income community (and no portion of the route would be adjacent to or within a minority community). In addition, the New Hampshire Avenue landfall would involve the cable traversing Lewis Bay, which commercial fisheries heavily use.
- Time of year of construction: As stated above, Vineyard Wind has scheduled onshore construction to take place after Labor Day and before Memorial Day, outside of the busiest tourist season on Cape Cod, Martha's Vineyard, and Nantucket. If the construction schedule were to shift such that construction of the cable landfalls and OECRs occurred during the tourist season, the proposed Project would have substantially larger impacts on land use, employment and economics, and recreation and tourism—impacts that could disproportionately affect environmental justice communities.

3.4.2.3. Impacts of Alternative A (Proposed Action) on Environmental Justice

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Effects on environmental justice communities are typically indirect and would occur when the Proposed Action's direct adverse effects on other resources, such as air quality (see Section 3.2.1), water quality (see Section 3.2.2), employment and economics (see Section 3.4.1), recreation and tourism (see Section 3.4.4), commercial fishing (see Section 3.4.5), or navigation (see Section 3.4.7), are felt disproportionately within environmental justice communities, due either to the location of these communities in relation to the Proposed Action or to their higher vulnerability to impacts.

Construction and Installation of Offshore Components

During construction and installation, residents and businesses within environmental justice communities would experience temporary inconveniences and restrictions on marine activities due to increased marine traffic and the presence of offshore construction areas in the WDA and near the OECC. Sections 3.4.4 and 3.4.5 conclude that construction and installation would have **moderate** impacts on recreational boating and commercial fishing, both of which contribute to employment and income. Section 3.4.7 concludes that construction and installation of the Proposed Action would have a **moderate** impact on marine navigation in the WDA and harbors that support offshore construction. The temporary impacts on commercial or recreational boating would impact all local boaters, and would not have disproportionate impacts on residents or businesses within the areas identified as environmental justice communities; however, the impact may be of greater magnitude for individuals who fish for subsistence, including members of Native American tribes (see Section 3.4.3) or members of environmental justice communities who depend on commercial fishing jobs (including seafood processing and packing industries) for their livelihood.

The average annual wage for workers employed in fishing in Massachusetts in 2015 was $66,932, and in seafood processing was $58,103; the average for all workers statewide was $66,713 (NOAA 2018h, 2018b, 2018c). Fishing industries generally provided wages and income higher than the tourist and recreation components of the ocean economy (Borges et al. 2017b). Commercial fishing is within the "living resource" sector of NOAA's Coastal Economy index (see Section 3.4.5.1), and includes fishing, seafood processing, seafood markets, aquaculture, and fish hatcheries (NOAA 2018h). Table 3.4.2-3 shows the 2015 average wage for living resource industry employees in southeastern Massachusetts, Rhode Island, and Suffolk County, New York (the counties within the environmental justice study area, as well as those containing the commercial fishing ports most exposed to the MA WEA, as listed in Table 3.4.5-3 in Section 3.4.5) was higher than the average wage for all workers statewide; however, most workers within this industry sector are self-employed. Income data for self-employed workers are not available, but average gross receipts for self-employed workers suggests that their average income is less than the average wage in most counties.

The average wage or income also obscures the range of income levels, which include higher income workers (ship's captains and managers), as well as lower-level or unskilled workers who earn substantially less than the average wage, including self-employed individuals. Many of these lower level workers in the living resource sector likely qualify as low-income, and would thus be vulnerable to temporary disruptions to commercial fishing during construction of the Proposed Action. Based on the potential impacts on subsistence fishing and commercial fishing, the Proposed Action would have a **moderate** disproportionate adverse impact on environmental justice communities, specifically low-income residents involved in the commercial fishing industry.

Table 3.4.2-3: Employment and Wages for Ocean Economy Living Resource Industries (2015)

County	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
	Number	Average Wage [a]	Number	Average Gross Receipts [b]	Total Employment	Average Wage
Massachusetts						
Barnstable	178	$34,174	787	$50,360	95,001	$44,219
Bristol	1,103	$106,539	767	$105,001	218,672	$45,891
Dukes	55	$42,527	99	$38,051	8,431	$45,660
Nantucket	11	$25,818	58	$41,276	6,858	$51,286
Rhode Island						
Providence	35	$26,629	109	$26,532	277,158	$51,807
Washington	240	$59,988	499	$84,904	52,005	$43,938
New York						
Suffolk	391	$28,243	689	$49,846	634,939	$54,612
Total	2,013	$75,803	3,008	$68,462	1,293,064	$51,267

Sources: NOAA 2018h, 2018i, 2018j
[a] Average wage calculated as total wages divided by total number of employees.
[b] Average gross receipts calculated as total gross receipts divided by number of self-employed workers.

Fabrication and staging at the MCT, which is within and surrounded by environmental justice communities, would support offshore construction (see Appendix F.2, Figure F.2-7). As described in Section 3.4.4.2, the intended purpose of the MCT is to support the wind energy industry. The city's Waterfront Framework Plan details goals for expansion, consolidation, and improvement of facilities to support commercial fishing, shipping, and recreational boating at the MCT and along the New Bedford Waterfront, providing for the full range of port users in addition to wind energy (Sasaki 2016). Therefore, use of the MCT and nearby industrial sites to support the Proposed Action would not displace or adversely affect residents or existing businesses. Other industrial and commercial sites with less intense uses, as well as major roads, separate urban residential neighborhoods from the MCT (Sasaki 2016). The New Bedford Waterfront Framework Plan recommends adaptive reuse of brick mill buildings south of the MCT for lower-intensity uses that would buffer the residential neighborhood to the south from the heavy industry of the port.

To support construction of the Proposed Action, Vineyard Wind may use the ports of Providence, New London-Groton, and Bridgeport, which are also in historic city centers within environmental justice communities (see Appendix F.2, Figures F.2-8 through F.2-11). The Quonset-Davisville Port is within a developing commerce/industrial park with less extensive nearby economic justice communities. As with the MCT, use of these ports for construction and installation of the Proposed Action would be similar to existing and designated activities at these ports. The Proposed Action would not result in the development of new facilities at or outside of any port, although improvements to existing facilities would occur by the facility owners; however, as described in Section 3.4.5.3, vessel traffic associated with construction and installation of the Proposed Action would have a **moderate** impact on commercial fishery and for-hire recreational fishing, due to increased vessel traffic near these ports, and potential displacement from these ports and docks. Accordingly, construction of the offshore components of the Proposed Action would have a **moderate** impact on environmental justice communities near the MCT and the Ports of Providence, New London-Groton, Bridgeport, and Quonset-Davisville.

The Brayton Point and Montaup sites are not adjacent to environmental justice communities (see Appendix F.2, Figure F.2-8), and are not currently used as ports. Use of either or both of these sites to support construction of the Proposed Action (which would be dependent on independent improvements to those sites) would impact neighborhoods closer to the sites, but would not have a disproportionate impact on environmental justice communities. Therefore, construction of the offshore components of the Proposed Action would have a **negligible** impact on environmental justice communities near the Brayton Point and Montaup sites.

Selection of the New Hampshire Avenue landfall site would exacerbate the **moderate** impacts on fishing and navigation since this option would require construction of the OECC cable through Lewis Bay. As described in Sections 3.4.4 and 3.4.5, commercial fishing, recreational, and ferry vessels heavily use Lewis Bay. Construction of the OECC through this area would temporarily disrupt these activities and could lead to loss of revenue if commercial vessels are unable to enter or exit as needed. These economic impacts could disproportionately impact members of environmental justice communities whose low-income status makes them more vulnerable to changes in economic conditions. The New Hampshire Avenue landfall site option for the Proposed Action could therefore have potentially **major** impacts on low-income residents in the commercial fishing industry.

Based on the above, installation and construction of the Proposed Action offshore components would have a **moderate** impact on environmental justice communities, particularly low-income commercial fishing, with the potential for **major** impacts on low-income residents of commercial fishing communities if the New Hampshire Avenue landfall site is selected. BOEM requiring the OECC routing mitigation measure outlined in Chapter 2 (avoidance of the navigation channel or burial at a depth sufficient to allow dredging) as a condition of COP approval would reduce potential impacts on low-income residents in the commercial fishing industry in and around Lewis Bay to **moderate**.

Overall, BOEM anticipates the potential impacts of the Proposed Action on low-income residents in the study area would be reduced to **minor** if the local hiring plan mitigation measure outlined in Chapter 2 became a condition of COP approval.

Construction and Installation of Onshore Project Components

As shown in Appendix F2, Figure F.2-3, the substation is in an area that meets the criteria for both low-income and minority status. A majority of the route for the Covell's Beach landfall site would pass through or adjacent to communities that meet low income and/or minority environmental justice criteria. Aside from the area near the substation, a small segment of the route for the New Hampshire Avenue landfall site would pass adjacent to a low-income community.

Construction of the OECR would temporarily disturb neighboring land uses through construction noise, vibration and dust, and delays in travel along the impacted roads. Environmental justice and non-environmental justice communities would equally experience these effects, and access to neighborhoods would be maintained. The location of the proposed substation adjacent to an existing substation, within an existing industrial area (i.e., Barnstable Municipal Airport), would avoid displacement of homes or businesses. Accordingly, BOEM anticipates onshore construction of the Proposed Action would have **negligible** impacts on environmental justice communities.

Operations and Maintenance of Offshore Components

Operations and maintenance of the WDA and OECC components of the Proposed Action would involve periodic vessel activity from the MCT and Operations and Maintenance Facilities in Vineyard Haven. Use of these facilities for their designated purposes would not disproportionately impact environmental justice communities; therefore, impacts would be **negligible**.

The WTG and ESP structures may have a **minor** beneficial impact on recreational fishing by providing habitat for target species (see Section 3.4.5). As a result, members of environmental justice communities who rely on offshore fishing for subsistence may also experience minor benefits. The Proposed Action would have a **moderate** impact on commercial fishing during operations (see Section 3.4.5); this would result in a **moderate** impact on environmental justice communities due to the vulnerability of low-income members of the commercial fishing industry to economic impacts on that industry.

As described in Section 3.4.1, selection of the New Hampshire Avenue landfall site and installation of the OECC across Lewis Bay's designated navigation channel would hinder future channel dredging. As described in Sections 3.4.4 and 3.4.5, commercial fishing, recreational, and ferry vessels heavily use Lewis Bay. The prevention of channel maintenance dredging through Lewis Bay area would permanently disrupt these activities and could lead to loss of revenue if commercial vessels are unable to enter or exit the bay as needed. These economic impacts could disproportionately impact members of environmental justice communities whose low-income status makes them more vulnerable to changes in economic conditions. The New Hampshire Avenue landfall site option for the Proposed Action could therefore have potentially **moderate** to **major** adverse impacts on environmental justice communities.

The Proposed Action would be partially visible in clear conditions from Gay Head cliffs on Martha's Vineyard. From this location, the closest visible WTG is 24 miles (39 kilometers) away (see simulation in COP Appendix III-H.a; Epsilon 2018a). BOEM would make a determination of the impacts of this view on the Aquinnah (an environmental justice community) after completion of Section 106 consultation.

Operations and Maintenance of Onshore Project Components

During operation, cable landfall sites and onshore cables would be underground and primarily within roads and utility ROWs, while the substation would operate within an industrial area. As a result, operations and occasional maintenance or repair operations would have **negligible** impacts and would not result in disproportionate or greater impacts on environmental justice communities.

The Operations and Maintenance Facilities in Vineyard Haven Harbor would contribute positively to employment opportunities and economic activity within or near environmental justice communities (see Section 3.4.1.3) and would have no disproportionate or adverse impacts on low income or minority populations. However, BOEM anticipates impacts on environmental justice communities would be **negligible**.

Decommissioning

Impacts during decommissioning would be similar to those during the construction phase. As with the construction phase, the temporary impacts of decommissioning on commercial or recreational boating would not disproportionately impact environmental justice communities; however, the impact of disruptions to offshore areas (due to safety zones and the presence of disassembly activities) may be of greater magnitude for individuals who fish for subsistence, including members of Native American tribes (see Section 3.4.3) or members of environmental justice communities who depend on commercial fishing jobs (including seafood processing and packing industries) for their livelihood, including those who rely on Lewis Bay. As a result, BOEM anticipates decommissioning of the Proposed Action would have **moderate** impacts unless the New Hampshire Avenue landfall site were used, in which case the impacts would be **major**.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. Spills from maintenance or repair vessels or activities requiring repair of WTGs, equipment, or cables, would generally require intense, temporary activity associated with oil spill response (see COP Appendix 1-A; Epsilon 2018a) or to address emergency conditions. The presence of onshore construction equipment, as well as the unexpectedly frequent vessel activity in Vineyard Haven Harbor or New Bedford Harbor, and in offshore locations above the OECC or near individual WTGs, could temporarily prevent or deter subsistence or commercial fishing or for-hire recreational fishing, or tourist activities near the site of a given non-routine event. The impacts of non-routine activities on environmental justice would be **minor**.

Conclusion

Environmental justice communities could disproportionately experience the Proposed Action's direct adverse effects on other resources, such as air quality, water quality, employment and economics, recreation and tourism, commercial fishing, or navigation, due either to the location of these communities in relation to the Proposed Action or to their higher vulnerability to impacts. Based on the analysis above, construction, operations, and decommissioning of the Proposed Action would have a **negligible** impact on environmental justice communities, with the following exceptions:

- Construction, operation, and decommissioning of the Proposed Action would have **moderate** adverse impacts on environmental justice communities due to the impact on commercial fishing, unless the New Hampshire Avenue landfall site were used, in which case the impacts would be **major**, due to the hindrance of dredging and associated disruption of marine businesses (particularly commercial fishing) that depend on access to Lewis Bay.
- Construction and decommissioning would have temporary, **moderate** adverse impacts on subsistence fishing.
- Construction of the Proposed Action using the New Hampshire Avenue landfall site would have **major** adverse impacts on environmental justice communities.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.2.4. Impacts of Alternative B on Environmental Justice

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction, operations, and decommissioning of Alternative B would avoid impacts on marine navigation within Lewis Bay (compared to the Covell's Beach landfall site). Offshore export cable installation or removal would not obstruct the bay's navigation channel, and dredging of the channel could continue. As a result, Alternative B would avoid impacts on marine-dependent businesses in Lewis Bay and Hyannis harbor, reducing potential impacts on employment and services in the environmental justice communities around Lewis Bay and Hyannis Harbor. Alternative B would therefore also reduce the potential major impacts on commercial fishing environmental justice communities in comparison to the Proposed Action. Other environmental justice impacts of Alternative B would be the same as the Proposed Action. Accordingly, Alternative B would have **moderate** impacts on environmental justice communities due to impacts on subsistence and commercial fishing and for-hire recreational fishing.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative B on environmental justice would be the same as the Proposed Action: **minor**.

3.4.2.5. Impacts of Alternative C on Environmental Justice

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction, operations, and decommissioning of Alternative C would provide more unobstructed space in the northern portion of the WDA for use by commercial fishing and for-hire recreational vessels. In particular, as discussed in Section 3.5.2.5, moving WTGs away from the northern portion of the WDA could reduce impacts on scallop fisheries and on the low-income workers in this industry. This consideration notwithstanding, the impacts of Alternative C on commercial fisheries would remain moderate. Other environmental justice impacts of Alternative C would be the same as the Proposed Action. Accordingly, BOEM anticipates Alternative C would have **moderate** impacts on environmental justice communities, unless the New Hampshire Avenue landfall site were used, in which case the impacts would be **major**.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative C on environmental justice would be the same as the Proposed Action: **minor**.

3.4.2.6. Impacts of Alternative D on Environmental Justice

Impacts of Alternative D1 and D2

Incremental Contribution of Alternative D1 and D2

<u>Direct and Indirect Effects of Routine Activities</u>

Alternatives D1 and D2 would result in different WTG configurations, each of which would require different navigation routes for subsistence and commercial fishing vessels and for-hire recreational vessels. Both configurations would marginally increase navigation flexibility for these vessels, but would not change the overall environmental justice impacts of the proposed Project as analyzed in Section 3.4.2.3 for the Proposed Action. Accordingly, BOEM anticipates the impact levels for Alternatives D1 and D2 would be the same as the Proposed Action: **moderate**, unless the New Hampshire Avenue landfall site were used, in which case the impacts would be **major**.

<u>Direct and Indirect Effects of Non-Routine Activities</u>

The impacts of non-routine activities associated with Alternatives D1 and D2 on environmental justice would be the same as the Proposed Action: **minor**.

3.4.2.7. Impacts of Alternative E on Environmental Justice

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Alternative E would include no more than 84 WTGs, each of which would likely have a generation capacity of approximately 9.5 MW, compared to the 100 WTGs (each with up to 8-MW capacity) in the Proposed Action. Having the same WDA with fewer WTGs would likely increase the spacing of WTGs and improve access to fishing locations and the ability of vessels to deploy fishing gear, but BOEM still anticipates this alternative to have a **moderate** impact on commercial fishing (see Section 3.4.5). Other environmental justice impacts of Alternative E would be the same as the Proposed Action. Accordingly, BOEM anticipates Alternative E would have **moderate** impacts on environmental justice communities, unless the New Hampshire Avenue landfall site were used, in which case the impacts would be **major**.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative E on environmental justice would be the same as the Proposed Action: **minor**.

3.4.2.8. Impacts of Alternative F (No Action Alternative) on Environmental Justice

As discussed in Sections 3.4.2.3 through 3.4.2.7, the action alternatives would generally have a negligible impact on environmental justice communities, except for **moderate** impacts related to commercial and subsistence fishing, as well as commercial activity in Lewis Bay if Vineyard Wind selects the New Hampshire Avenue landfall site and OECC route. If BOEM does not approve the proposed Project (either the Proposed Action or one of the alternatives listed above), these impacts would not accrue.

3.4.2.9. Comparison of Alternatives for Environmental Justice

All alternatives would have **negligible** impacts on areas with higher proportions of low-income and minority populations, but would have **moderate** impacts on low-income members of environmental justice communities who work in the commercial fishing and for-hire recreational boating industries due to the impact on subsistence fishing and commercial fishing. Construction and operations of the Proposed Action or Alternatives C, D1, D2, or E using the New Hampshire Avenue landfall site would have **major** impacts on environmental justice communities due to disruption of marine businesses that depend on access to Lewis Bay. Alternative B would avoid these impacts and would therefore have **moderate** impacts on environmental justice communities. As discussed in Section 3.4.2.2, BOEM based the analysis of impacts on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.2.3 through 3.4.2.8.

3.4.2.10. Cumulative Impacts

The area of analysis for cumulative impacts on environmental justice includes the counties where proposed onshore infrastructure and potential port cities are located as well as counties in closest proximity to the WDA (Barnstable, Bristol, Dukes, and Nantucket counties, Massachusetts; Providence and Washington counties, Rhode Island; and Fairfield and New London counties, Connecticut) (see Appendix C, Figure C.1-10). The proposed South Fork offshore wind energy project, a Tier 2 project located offshore Rhode Island approximately 30 miles (48 kilometers) west of the WDA, is the only project with the potential to generate cumulative environmental justice impacts (as described in Appendix C). The two Tier 1 offshore wind energy projects are outside of the geographic analysis area, and Tier 3, Tier 4, and Tier 5 projects are not reasonably foreseeable based on the assumptions outlined in Appendix C; however, any future development of these projects could contribute to cumulative effects. These effects may be similar to the Proposed Action and would likely include seafloor-disturbing activities, additional vessel traffic, and impediments to fishing access. For example, the BSW and Revolution Wind Tier 3 projects could contribute up to approximately 185 additional WTGs and accompanying export cables. It is anticipated that the effects associated with these projects would be similar to the Proposed Action; however, the extent of these effects would depend on project-specific information that is unknown at this time.

Implementation of the South Fork project as well as other Tier 3 projects, if they come to fruition, would result in additional vessel traffic, additional areas unavailable for commercial or recreational fishing or boating, and additional areas where vessels must navigate within or around WTGs and related structures. Cumulative impacts on environmental justice communities could occur as a result of impacts on the commercial fishing industry and recreation/tourism businesses, which provide jobs for members of low-income environmental justice communities, as well as impacts on recreational fishing, which could disproportionately impact low-income residents who practice subsistence fishing.

As a result, the Proposed Action would result in a moderate incremental contribution to environmental justice impacts when combined with the past, present, and reasonably foreseeable future activities. Because the South Fork project is unlikely to occur simultaneously with the Proposed Action, BOEM anticipates the overall cumulative activities considered in this analysis to cause **moderate** impacts on environmental justice.

BOEM anticipates the cumulative impacts of Alternatives B, C, D1, D2, and E on environmental justice, when combined with the past, present, and reasonably foreseeable future activities, would be the same as the Proposed Action: **moderate**.

3.4.2.11. Incomplete or Unavailable Information for Environmental Justice

There is no incomplete or unavailable information related to the analysis of environmental justice impacts.

3.4.3. Cultural, Historical, and Archaeological Resources

Cultural resources is an umbrella term for many heritage-related resources defined in several Federal laws and Executive Orders, including NEAP and the NHPA. Resources judged important under NHPA criteria are considered eligible for listing in the National Register of Historic Places (NRHP). These resources are termed "historic properties" and are protected under the NHPA. Archaeological resources comprise areas where human activity has measurably altered the earth or deposits of physical remains (e.g., artifacts) are found. Historic resources include standing buildings, bridges, dams, and other structures of historic or aesthetic significance. Generally, historic resources must be more than 50 years old to warrant consideration for the NRHP. More recent structures, such as Cold War-era resources, might warrant protection if they are of exceptional importance or have the potential to gain significance in the future.

3.4.3.1. Description of the Affected Environment for Cultural, Historical, and Archaeological Resources

The following section includes a summary of regional prehistory and history; a description of the proposed Project area; a summary of known resources within the proposed Project's area of potential effect (APE); and aspects of the various types of cultural resources that the proposed Project could affect.

Regional Prehistoric and Historic Setting

Table 3.4.3-1 presents a summary of the prehistoric and historic cultural contexts for southern New England (Gray & Pape 2018).

Table 3.4.3-1: Summary of Southern New England Prehistoric and Historic Context

Period	Description
Paleoindian (12,500–10,000 B.P.)	Earliest human occupation of southern New England. Region populated by small, highly nomadic family groups of hunter-gatherers. Much of Nantucket Sound was exposed land and likely occupied by Paleoindian groups due to lower sea levels associated with the last Ice Age.
Archaic (10,000–3,000 B.P.)	Typically divided into three sub-periods: Early (10,000–8,000 B.P.); Middle (8,000–6,000 B.P.); and Late (6,000–3,000 B.P.). During the Early Archaic, the population of southern New England continued to practice a highly mobile, nomadic hunter-gather lifestyle adapted to the warming conditions and changing environment. By the Late Archaic, local populations developed a more locally focused subsistence economy and a semi-sedentary lifestyle.
Woodland (3,000–400 B.P.)	Typically divided into three sub-periods: Early (3,000–2,000 B.P.); Middle (2,000–1,000 B.P.); and Late (1,000–400 B.P.). Appearance of the first ceramic vessel technology occurred during the Early Woodland period. Populations became increasingly sedentary throughout the Woodland Period. By the end of the Late Woodland period, populations were living in settled, agricultural villages. The southern New England tribes encountered by European settlers, including the Pawtucket, Nipmuc, Wampanoag, and Pequot, were established during this period.
Exploration (A.D. 1000–1620)	Viking explorers reach North America ca. A.D. 1000. Early European contact by explorers and anglers during the 16th century. Bartholomew Gosnold visits Nantucket in 1602. John Smith explores the Southern New England coastline in 1614–1615. Puritan colonists establish the Plymouth Colony in 1620, the first successful European settlement in Southern New England.
Settlement (A.D. 1620–1720)	Trade and conflict between Native American groups and European colonists. Growth of the Plymouth Colony. Martha's Vineyard colonized with the establishment of Edgartown in 1641–1642. Nantucket colonized by Thomas Macy and family in the winter of 1659–1660. Beginning of shore-based whaling on Nantucket. The towns of Barnstable and Yarmouth founded in the late 17th century.
Colonial and Early National (A.D. 1720–1815)	Increase in trade between Europe and New England leading to the growth of commercial cities along the Southern New England coast. Colonization of interior New England. Removal, forced migration, and/or extermination of Native American populations. Seven Years' War between England, France, and their respective colonies. American Revolution (1775-1783). Growth of maritime economy, including fishing and whaling. War of 1812 (1812-1814) with England. Growth of industrial mill towns throughout New England.
Early Industrial (A.D. 1815–1865)	Population growth and rapid industrialization across New England. Rapid growth of shipbuilding, fishing, trade, and whaling industries. "Golden Age" of Southern New England whaling industry on Nantucket and coastal cities such as New Bedford and New London. United States Civil War (1861–1865).
Late 19th Century–Early 20th Century (A.D. 1865–1950s)	Decline in merchant marine and whaling industries across Southern New England. Population decline associated with American westward expansion and rise of mid-west industrial centers. Development of tourism industry on Martha's Vineyard, Nantucket, Cape Cod, and across southern New England. Growth of recreational fishing industry and maritime tourism economy.

B.P. = before present; A.D. = anno Domini

Project Area

The proposed Project area for cultural resources is equivalent to the Project's APE, as defined in the implementing regulations for Section 106 of the NHPA in 36 CFR § 800 (Protection of Historic Properties). In 36 CFR § 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties, if present (36 CFR § 800.16)." BOEM (2018c) defines the Project APE as the following:

- The depth and breadth of the seabed potentially impacted by any bottom-disturbing activities;
- The depth and breadth of terrestrial areas potentially impacted by any ground-disturbing activities;
- The viewshed from which renewable energy structures, whether located offshore or onshore, would be visible; and
- Any temporary or permanent construction or staging areas, both onshore and offshore.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the following aspects of cultural resources:

- Physically altering, damaging, or destroying all or part of a resource;
- Altering characteristics of the surrounding environment that contribute to the resource's significance; or
- Introducing visual or audible elements that are out of character with the property or that alter its setting; neglecting the resource to the extent that it deteriorates or is destroyed.

Vineyard Wind has conducted onshore and offshore cultural resource investigations to identify known and previously undiscovered cultural resources within the following areas that the proposed Project could potentially impact. Cultural resource investigations are ongoing; the final marine archaeological assessment and the terrestrial archaeological survey report will be provided to BOEM in late 2018. Table 3.4.3-2 summarizes the results of completed studies. The referenced reports contain more detailed information.

Table 3.4.3-2: Summary of Cultural Resource Investigations and Cultural Resources in the Project Area

Project Area/APE	Studies	Summary of Findings
Onshore	Upland Cabling Routes: Archaeological Due Diligence Report (PAL 2017)	• Desktop-based archaeological due diligence of known archaeological sites within 0.5 mile (0.8 kilometer) of OECRs as well as six variants and one substation parcel. • Twenty-nine pre-contact and two post-contact archaeological sites are within 0.5 mile (0.8 kilometer) of the studied routes. • One archaeological site (19-BN-829) is located within and/or adjacent to the western OECR; six archaeological sites (19-BN-238, 19-BN-74, 19-BN853, 19-BN-959, 19-BN-960, and 19-BN-961) are located within and/or adjacent to the eastern OECR.
Offshore	Marine Archaeological Services Report (Gray & Pape 2018)	• Vineyard Wind performed desktop study/analysis and marine remote sensing surveys of portions of the Wind Development Area (WDA) and Offshore Export Cable Corridors (OECCs); surveys are ongoing. • Vineyard Wind collected data to identify and/or assess the potential for submerged, terrestrial pre-contact (Paleoindian and Archaic) archaeological sites and post-contact maritime resources. • Preliminary results of desktop study suggest archaeological sensitivity for pre-contact cultural resources within the project areas are temporally and spatially limited. The seabed furthest offshore in the WDA may contain Paleoindian material, while the area along the OECC to approximately 10 feet (3 meters) deep may additionally contain Archaic Period materials. The remaining nearshore areas have the potential to contain material from all three periods. The geophysical and geotechnical data do not indicate any direct evidence of pre-contact sites. • The marine remote sensing surveys covered 45% of the lease area, surveying over 772 miles (1,243 kilometers) of linear transects within the lease area and over 155 miles (249 kilometers) of linear transects within the OECCs. In 2017 approximately 175 km of linear transects were examined within the OECC. The surveys identified one shipwreck site in the WDA, which the report authors recommended for avoidance. • The proposed OECC crosses the seabed of the Nantucket Sound Traditional Cultural Property.

Project Area/APE	Studies	Summary of Findings
Viewshed	Visual Impact Analysis for Historic Resources (Epsilon 2018d)	• Evaluated visual impacts to historic properties through a Geographic Information System-based computer simulation and field-based study. Evaluated potential adverse effects to historic properties based on the view of the WDA from historic properties and landscapes. • The Historic Properties Visual Impact Assessment identified a variety of historic properties that the proposed Project may affect. These include National Historic Landmarks, properties listed on the National Register of Historic Places, properties on the Massachusetts State Register of Historic Places, and properties on the Inventory of Historic and Archaeological Assets of the Commonwealth.
Viewshed	Vineyard Wind Project: Visual Impact Assessment (Saratoga Associates 2018)	• The Wampanoag Tribe of Gay Head (Aquinnah) considers the Gay Head Cliffs, including certain unencumbered views from the cliffs, as important cosmological and ceremonial cultural resources. Consultations with this tribe, along with the Shinnecock, Mashpee, Mohegan, Pequot, and Narragansett Tribal Nations, are ongoing.

APE = area of potential effect; NHPA = National Historic Preservation Act; OECC = Offshore Export Cable Corridor; OECR = Onshore Export Cable Route; VIA = visual; WDA = Wind Development Area

Condition and Trend

New historic properties are constantly being identified, and there is a high likelihood that additional historic properties will be identified within the Project area due to ongoing surveys.

3.4.3.2. Environmental Consequences

Relevant Design Parameters

The list below details the proposed-Project design parameters that would influence the magnitude of the impacts on cultural resources. Appendix G includes a discussion of the PDE and maximum-case scenario for cultural resources.

- Direct impacts on terrestrial cultural resources (e.g., archaeological sites) would depend on the location of onshore ground disturbing activities. This includes the construction of the western OECR versus the eastern OECR, as well as cable landfalls at both New Hampshire Avenue and Covell's Beach versus just the latter.
- Direct impacts on underwater cultural resources (e.g., archaeological sites and submerged landscapes) would depend on the location of offshore bottom-disturbing activities. This includes the locations where Vineyard Wind would embed the WTG and ESP towers into the seafloor in the WDA and the location of the cable in the OECC.
- Indirect (i.e., visual) impacts on cultural resources (e.g., historic architectural structures, landscapes, and traditional cultural properties) would depend on the design, height, number, and distance of WTGs visible from these resources.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the OECC and OECRs, the landfall site to be used, the selected WTG design (8 MW to 10 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule. The following assessment is based on the maximum-case scenario (see Appendix G).

3.4.3.3. Impacts of Alternative A (Proposed Action) on Cultural, Historical, and Archaeological Resources

Incremental Contribution of the Proposed Action

The section below summarizes the potential direct and indirect impacts of the Proposed Action on cultural resources during the various phases of the Proposed Action.

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations, maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines the direct and indirect impacts. Potential direct impacts on cultural resources include damage or destruction of a terrestrial archaeological site or traditional cultural property from onshore ground-disturbing activities and damage or destruction to a submerged archaeological site or other underwater cultural resource (e.g., shipwreck) from offshore bottom-disturbing activities, resulting in a loss of scientific or cultural value.

Potential direct impacts also include demolition of, damage to, or alteration of a historic architectural structure (e.g., historic building) or area (e.g., historic district), resulting in a loss of scientific or cultural value. Potential indirect (i.e., visual) impacts include introduction of visual elements out of character with the historic setting of a historic architectural resource or landscape, if that setting is a contributing element to the resource's eligibility to the NRHP.

Construction and Installation of Offshore Components

Vineyard Wind conducted a high-resolution geophysical survey and marine archaeological resource assessment of 45 percent (the northeast portion) of the Vineyard WLA in 2016, as well as 109 miles (175 kilometers) of the OECC in 2017. As a result of that survey, one potential archaeological resource—a shipwreck—was identified within the WDA and was recommended for avoidance (COP Volume II-C; Epsilon 2018a). Vineyard Wind completed their additional high-resolution geophysical surveys in 2018 to assess the remainder of the WLA. Vineyard Wind prepared a final marine archaeological assessment (COP Volume II-C; Epsilon 2018a). The marine archaeological survey was completed for the entire offshore APE, and if all potential archaeological resources—including the potential shipwreck identified in 2016—are avoided during construction, operations, maintenance, and decommissioning (through the placement of an avoidance buffer zone around these potential historic properties), there would be **negligible** impacts on these resources. As a result, the construction and installation of offshore components would have no direct impacts on marine historic properties. If resources are not avoided during construction, BOEM anticipates **minor** to **moderate** impacts on these resources depending on the nature of impacts. The final determination of impacts is dependent on avoidance, minimization, or mitigation of adverse effects determined through BOEM's Section 106 review process and included as conditions of approval of the COP. BOEM could reduce potential impacts of construction by requiring one or more of the following mitigation measures as a condition of COP approval (see Appendix D):

- Avoidance (which would result in **negligible** direct impacts) or additional investigations and/or mitigations (which would result in **minor** direct impacts) of potential submerged archaeological resources:
  - Vineyard Wind must avoid any *potential* archaeological resource (i.e., one or more geophysical survey anomalies or targets with the potential to be an archaeological resource); or, if Vineyard Wind cannot avoid the resource, they must determine whether it constitutes an identified archaeological resource.
  - Vineyard Wind must avoid any *identified* archaeological resource; or, if Vineyard Wind cannot avoid the identified resource, they must perform additional investigations for the purpose of determining eligibility for listing in the NRHP.
  - Vineyard Wind must avoid any archaeological resources determined *eligible* for listing on the NRHP or BOEM would require additional mitigations for the purposes of resolving adverse effects per 36 Code of Federal Regulations (CFR) § 800.6.

Vineyard Wind also conducted a historic properties visual impact assessment (COP Appendix III-H.b, Volume III; Epsilon 2018a). The study included viewshed assessments within the visual impact APE of Martha's Vineyard, Nantucket, Nantucket Sound, and the towns of Mashpee, and Barnstable, Massachusetts. The Martha's Vineyard viewshed APE is located along the southern shore of the island.

The following identified historic properties are located in the APE:

1. Gay Head Light (MHC# GAY.900)
2. Edwin Vanderhoop Homestead (GAY.40)
3. Gay Head—Aquinnah Shops Area (GAY.B)
4. Elijah Smith House (CHL.39)
5. Nathan Mayhew Gravestone (CHL.802)
6. Elliot Mayhew House (CHL.12)
7. Martha's Vineyard American Revolution Battlefield (CHLE)
8. Vincent Mayhew House (CHL.A)
9. Edgartown Village Historic District (EDG.A and EDG.B)

The Nantucket viewshed assessment determined that the Proposed Action would be visible from the Nantucket National Historic Landmark, which includes the entire island of Nantucket and the adjacent islands of Tuckernut and Muskeget. The viewshed assessment also determined that the Proposed Action would be visible from Nantucket Sound, a property determined eligible in 2010 as a traditional cultural property associated with the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head-Aquinnah (YAR.917/BRN.9072/EDG.907). Additionally, in clear conditions, the Proposed Action would be partially visible from Gay Head cliffs on Martha's Vineyard. From this location, the closest visible WTG is 24 miles (39 kilometers) away (see simulation in COP Appendix III-H.a; Epsilon 2018a). Finally, the Mashpee and Barnstable viewshed assessments did not identify any historic properties from which the Proposed Action would be visible.

If indirect visual effects on all historic properties introduced during construction, operations, maintenance and decommissioning are resolved through minimization and mitigation, there would be **minor** impacts on these resources. The final determination of **minor** impacts is dependent on minimization and mitigation of adverse effects determined through BOEM's Section 106 review process and included as conditions of COP approval. Additionally, a determination of the impacts of these visual elements on the Wampanoag Tribe of Gay Head (Aquinnah; see discussion in Section 3.4.2) will be made in consultation with the Aquinnah, and other federally recognized tribes. BOEM could require, as a condition of COP approval, additional mitigation requiring that structures be equipped with an ADLS that would only activate the required warning lights when an aircraft is in the vicinity of the WDA; this would reduce the visibility of the structures and thus reduce the visual impact (see Appendix D).

Construction and Installation of Onshore Components

Vineyard Wind conducted desktop research to identify known archaeological sites within the onshore component of the Proposed Action (COP Appendix III-G, Volume III; Epsilon 2018a). The survey identified one archaeological site (19-BN-829) that could be impacted by ground-disturbing activities associated with the construction of the western OECR. The survey identified six archaeological sites (19-BN-238, 19-BN-74, 19-BN853, 19-BN-959, 19-BN-960, and 19-BN-961) that could be impacted by ground-disturbing activities associated with the construction of the eastern OECR. Vineyard Wind subsequently conducted a reconnaissance level archaeological survey of the onshore component of the Proposed Action, including background research and a pedestrian survey. The survey "identified known archaeological sites, previous disturbance, and addressed potential effects to archaeological sites" (COP Section 7.3, Volume III; Epsilon 2018a).

Vineyard Wind will complete a terrestrial archaeological survey to identify archaeological resources by November 2018. If a terrestrial archaeological survey is completed for the entire onshore APE, and all potential archaeological resources are avoided by re-routing construction corridors around site boundaries (through the placement of an avoidance buffer zone around these potential historic properties), there would be **negligible** impacts on these resources. As a result, BOEM anticipates that the construction and installation of onshore components would have no direct impacts on terrestrial archaeological resources. The final determination of **negligible** impacts is dependent on avoidance, minimization, or mitigation of adverse effects determined through BOEM's Section 106 review process and included as conditions of COP approval.

Vineyard Wind would use a new operations and maintenance facility in Vineyard Haven on Martha's Vineyard. At the time of preparation of this Draft EIS, information was lacking to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port.

BOEM could reduce potential impacts of construction by requiring one or more of the following mitigation measures as a condition of COP approval (see Section 2.2.1):

- Avoidance (which would result in **negligible** direct impacts) or additional investigations and/or mitigations (which would result in **minor** direct impacts) of potential terrestrial archaeological resources:
  - Vineyard Wind must avoid any *identified* archaeological resource or TCP; or, if Vineyard Wind cannot avoided the resource, they must perform additional investigations for the purpose of determining eligibility for listing in the NRHP.
  - Vineyard Wind must avoid any archaeological resources or TCPs determined *eligible* for listing on the NRHP or BOEM would require additional mitigations for the purposes of resolving adverse effects per 36 CFR § 800.6.

Operations and Maintenance

Operations and maintenance of offshore components would have no direct impacts, resulting in **negligible** impacts, on cultural resources after construction and installation of the proposed infrastructure as Vineyard Wind would have avoided cultural resources. Indirect (i.e., visual) impacts to the historic properties would be **minor,** similar to the construction and installation of the Proposed Action.

Operations and maintenance of onshore components would have **negligible** impacts on cultural resources because proposed infrastructure would have avoided these resources.

Decommissioning

The decommissioning of the Proposed Action would have no direct impacts on cultural resources, provided Vineyard Wind avoids identified cultural resources during construction, and would not encounter new cultural resources. Any indirect (i.e., visual) impacts would be temporary and **minor**.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities would generally require intense, temporary activity to address emergency or urgent conditions. The impact level associated with non-routine activities would depend on the magnitude of the activity. BOEM anticipates that non-routine activities would have **negligible** impacts on cultural resources because the activities would avoid these resources.

Conclusion

Based on the analysis above, and assuming the self-imposed measures by Vineyard Wind (i.e., avoidance, minimization, and mitigation of identified cultural resources through completion of the Section 106 process) and mitigation measures conditioned by BOEM's approval of the COP, the Proposed Action would have **negligible** to **minor** impacts on cultural resources. BOEM could reduce potential impacts of construction by requiring one or more of the following mitigation measures as a condition of COP approval (see Appendix D):

- Avoidance (which would result in **negligible** direct impacts) or additional investigations and/or mitigations (which would result in **minor** direct impacts) of potential submerged archaeological resources:
  - Vineyard Wind must avoid any *potential* archaeological resource (i.e., one or more geophysical survey anomalies or targets with the potential to be an archaeological resource); or, if Vineyard Wind cannot avoid the resource, they must determine whether it constitutes an identified archaeological resource.
  - Vineyard Wind must avoid any *identified* archaeological resource; or, if Vineyard Wind cannot avoid the identified resource, they must perform additional investigations for the purpose of determining eligibility for listing in the NRHP.
  - Vineyard Wind must avoid any archaeological resources determined *eligible* for listing on the NRHP or BOEM would require additional mitigations for the purposes of resolving adverse effects per 36 CFR § 800.6.
- Avoidance (which would result in **negligible** direct impacts) or additional investigations and/or mitigations (which would result in **minor** direct impacts) of potential terrestrial archaeological resources:
  - Vineyard Wind must avoid any *identified* archaeological resource or TCP; or, if Vineyard Wind cannot avoided the resource, they must perform additional investigations for the purpose of determining eligibility for listing in the NRHP.
  - Vineyard Wind must avoid any archaeological resources or TCPs determined *eligible* for listing on the NRHP or BOEM would require additional mitigations for the purposes of resolving adverse effects per 36 CFR § 800.6.

In addition, the analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.3.4. Impacts of Alternative B on Cultural, Historical, and Archaeological Resources

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

The only difference between Alternative B and the Proposed Action is that Alternative B does not permit the use of the New Hampshire Avenue landfall site. Elimination of the New Hampshire Avenue (Yarmouth) landfall would eliminate the need for the eastern OECR. As a result, the proposed Project would result in no impacts on the six archaeological sites (19-BN-238, 19-BN-74, 19-BN853, 19-BN-959, 19-BN-960, and 19-BN-961) identified along the eastern OECR. BOEM anticipates **negligible** impacts onshore during construction and installation due to avoidance of identified resources. All other impacts would be the same as under the Proposed Action, **negligible** to **minor** impacts.

Operations and Maintenance

Operations and maintenance of onshore components would continue to have no impacts on cultural resources, resulting in **negligible** impacts. Operations and maintenance of offshore components would have no direct impacts on cultural resources resulting in **negligible** impacts. Indirect (i.e., visual) impacts on the 11 historic properties described above would be **minor**.

Decommissioning

The decommissioning of the proposed Project would have no direct impacts on cultural resources. Any indirect (i.e., visual) impacts would be temporary and **minor**.

Direct and Indirect Effects of Non-Routine Activities

Direct and indirect effects of non-routine activities on cultural resources would be the same as those of the Proposed Action: **negligible**.

Conclusion

Alternative B would have **negligible** to **minor** impacts on cultural resources assuming the implementation of the measures described above (i.e., avoidance of identified cultural resources, completion of additional onshore archaeological investigations and compliance with Section 106 of the NHPA). The use of Alternative B would result in avoidance of known terrestrial cultural resources.

3.4.3.5. Impacts of Alternative C on Cultural, Historical, and Archaeological Resources

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction and Installation

The relocation of the northernmost WTG locations to the southern portion of the WDA would reduce indirect (i.e., visual) impacts on the historic properties on Martha's Vineyard, the Nantucket Historic District, and Nantucket Sound, from which the proposed Project would be visible (see Section 3.4.3.3). BOEM anticipates Alternative B would result in **minor** impacts even with the elimination of the northernmost locations, because the proposed Project would still be visible from these historic properties, but would reduce indirect impacts.

Operations and Maintenance

Operations and maintenance of onshore components would continue to have no impacts on cultural resources, resulting in **negligible** impacts. Operations and maintenance of offshore components would have no direct impacts on cultural resources resulting in **negligible** impacts. Indirect (i.e., visual) impacts on the 11 historic properties described above would be **minor** even with the elimination of the northernmost locations, because the proposed Project would still be visible from these historic properties.

Decommissioning

The decommissioning of the proposed Project would have no direct impacts on cultural resources. Any indirect (i.e., visual) impacts would be temporary and **minor**.

Direct and Indirect Effects of Non-Routine Activities

Direct and indirect effects of non-routine activities on cultural resources would be the same as under the Proposed Action: **negligible**.

Conclusion

Alternative C would have the same **negligible** to **minor** impacts on cultural resources assuming the implementation of the measures described above as the Proposed Action (i.e., avoidance of identified cultural resources, completion of additional onshore archaeological investigations and compliance with Section 106 of the NHPA). Mitigation measures identified above would also be applicable to this alternative.

3.4.3.6. Impacts of Alternatives D1 and D2 on Cultural, Historical, and Archaeological Resources

Incremental Contribution of Alternatives D1 and D2

Direct and Indirect Effects of Routine Activities

Construction and Installation

Construction and installation impacts on cultural resources would be the same as under the Proposed Action, as long as Vineyard Wind completes marine archaeological surveys prior to construction, and avoids any potential cultural resources identified along the southern row of WTG towers: **negligible** to **minor** impacts.

Operations and Maintenance

Operations and maintenance of onshore components would continue to have no impacts on cultural resources, resulting in **negligible** impacts. Operations and maintenance of offshore components would have no direct impacts on cultural resources resulting in **negligible** impacts. Indirect (i.e., visual) impacts on the 11 historic properties described above would be **minor**.

Decommissioning

The decommissioning of the proposed Project would have no direct impacts on cultural resources. Any indirect (i.e., visual) impacts would be temporary and **minor**.

Direct and Indirect Effects of Non-Routine Activities

Direct and indirect effects of non-routine activities on cultural resources would be the same as under the Proposed Action: **negligible**.

Conclusion

Alternatives D1 and D2 would have the same **negligible** to **minor** impacts on cultural resources assuming the implementation of the measures described above as the Proposed Action (i.e., avoidance of identified cultural resources, completion of additional onshore archaeological investigations and compliance with Section 106 of the NHPA). Mitigation measures identified above would also be applicable to this alternative.

3.4.3.7. Impacts of Alternative E on Cultural, Historical, and Archaeological Resources

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Construction and Installation

Construction and installation direct impacts on cultural resources would be the same as under the Proposed Action, **minor**. Indirect (i.e., visual) impacts to the historic properties described above could be slightly less than under the Proposed Action, depending on which 16 WTG towers placements are eliminated, resulting in **minor** impacts.

Operations and Maintenance

Operations and maintenance of onshore and offshore components would have no impacts on cultural resources, resulting in **negligible** impacts. Indirect (i.e., visual) impacts on the 11 historic properties described above could be slightly less than under the Proposed Action, depending on which WTG towers are eliminated. Indirect impacts would be **minor**.

Decommissioning

The decommissioning of the proposed Project would have no direct impacts on cultural resources. Any indirect (i.e., visual) impacts would be temporary and **minor**.

Direct and Indirect Effects of Non-Routine Activities

Direct and indirect effects of non-routine activities on cultural resources would be the same as under the Proposed Action: **negligible**.

Conclusion

Alternative E would have the same **negligible** to **minor** impacts on cultural resources assuming the implementation of the measures described above as the Proposed Action (i.e., avoidance of identified cultural resources, completion of additional onshore archaeological investigations and compliance with Section 106 of the NHPA). Mitigation measures identified above would also be applicable to this alternative.

3.4.3.8. Impacts of Alternative F (No Action Alternative) on Cultural, Historical, and Archaeological Resources

Under the No Action Alternative, there would be no onshore ground-disturbing activities, no offshore bottom-disturbing activities, and no proposed-Project components visible from historic architectural resources.

3.4.3.9. Comparison of Alternatives for Cultural, Historical, and Archaeological Resources

The action alternative with the fewest impacts on cultural resources is Alternative B, which would have only slightly fewer impacts than the Proposed Action as a result of avoidance of terrestrial cultural resources. Alternative E could also have fewer impacts than the Proposed Action, depending on which WTG towers placements are eliminated. Both of these alternatives, however, would result in **minor** impacts on cultural resources. All other alternatives would have the same impacts on cultural resources as the Proposed Action.

3.4.3.10. Cumulative Impacts

The area of analysis for cultural resources includes the current direct and indirect areas of potential effect as well as the locations of any known/planned future offshore wind leases off the Coast of Cape Cod, Nantucket, and Martha's Vineyard (see Appendix C, Figure C.1-11).

Under the Proposed Action, the construction and installation of offshore components, as well as their operation and maintenance, would have **negligible** direct impacts on cultural resources, pending completion of the Section 106 process. As a result, offshore components would not contribute to direct cumulative impacts on cultural resources. The construction and installation of offshore components, as well as their operation and maintenance, would have **minor** indirect (i.e., visual) impacts on the historic properties listed above. Offshore components would contribute to indirect cumulative impacts resulting from overall offshore wind energy development activities in the indirect APE. The reasonably foreseeable project outlined in Appendix C that would also contribute to these indirect cumulative impacts includes the South Fork Wind Farm (OCS-A 0486), a Tier 2 project. Although not considered reasonably foreseeable, of the four Tier 3 projects discussed in Appendix C, two of them (BSW and Revolution Wind) are within the geographic analysis area and could contribute to cumulative effects if they came to fruition.[22] These effects may be similar to the Proposed Action and would likely include ground-disturbing activities and the introduction of visual elements, including up to an additional approximately 185 WTGs. However, the extent of these effects would depend on project-specific information that is unknown at this time, such as the location of onshore and offshore ground-disturbing activities, the size of WTGs, and potential mitigation measures. Due to the distance of these projects from the historic properties, the Proposed Action, when combined with past, present, and future projects, would have **minor** to **moderate** effects on cultural resources.

The construction and installation of onshore components would have **minor** impacts on the archaeological sites listed above. Since there are no reasonably foreseeable projects within the direct APE, however, the construction and installation of onshore components would not contribute to direct cumulative impacts on the archaeological sites. The operation and maintenance of onshore components would have **negligible** direct impacts on cultural resources. As a result, the operation and maintenance of onshore components would not contribute to direct cumulative impacts on cultural resources. The construction and installation of onshore components, as well as their operation and maintenance, would have **negligible** indirect impacts on cultural resources. As a result, onshore components would not contribute to indirect cumulative impacts on cultural resources.

BOEM anticipates the cumulative impacts on cultural resources to be the same under Alternatives B, C, D1, D2, and E as under the Proposed Action: **negligible** to **moderate**.

[22] The other two Tier 3 projects, as well as the two Tier 1 projects, are outside of the geographic analysis area described in Appendix C.

3.4.3.11. Incomplete or Unavailable Information for Cultural, Historical, and Archaeological Resources

The following pending actions and data gaps need to be assessed to complete the evaluation of the proposed Project's impacts on cultural resources:

- Additional marine surveys, as well as the final marine archaeological assessment report (pending according to COP Volume II-C; Epsilon 2018a);
- Onshore archaeological survey report (COP Section 7.3, Volume III; Epsilon 2018a) to become available the first week of November 2018;
- Possible Additional archaeological investigations (i.e., mitigation measures) to be developed and conducted to resolve adverse effects in consultation with the MHC (pending according to COP Section 7.3; Volume III; Epsilon 2018a), as well as the final report(s) for these investigations; and
- Completion of the Section 106 process.

Despite the pending actions listed above, sufficient information exists to support the findings presented herein. In the unlikely event that the pending actions produce new information that would change the findings, BOEM would prepare a supplement to this document pursuant to 40 CFR § 1502.9(c)(1)(ii).

3.4.4. Recreation and Tourism

This section describes and analyzes the potential impacts of the proposed Project on recreation and tourism resources and activities. This includes visual resources that the proposed Project could impact. In this Draft EIS, BOEM defines visual resources consistent with Bureau of Land Management's definition; that is, the visible physical features on a landscape, including natural elements such as topography, landforms, water, vegetation, and manmade structures (BLM 1984). Section 3.4.1 discusses the economic aspects of tourism in the proposed Project area.

3.4.4.1. Description of the Affected Environment for Recreation and Tourism

Regional Setting

Proposed Project facilities would be located within and off the coast of Massachusetts, supported by ports in the neighboring states of Connecticut and Rhode Island. The coastal areas of these states support ocean-based recreation and tourist activities that include recreational boating and fishing, charter fishing, sailboat races, bird and wildlife viewing (including whale watching), swimming, and other activities. As indicated in Section 3.4.1, recreation and tourism contribute substantially to the economies of the coastal counties of Rhode Island, Connecticut, and Massachusetts.

Coastal Massachusetts, Rhode Island, and Connecticut have a wide range of visual characteristics, with communities and landscapes ranging from large cities to small towns, suburbs, rural areas, and wildlife preserves. As a result of the proximity of the Atlantic Ocean, as well as the views associated with the shoreline, coastal New England has been extensively developed for water-based recreation and tourism.

The scenic quality of the coastal environment is important to the identity, attraction, and economic health of many of the coastal communities. Additionally, the visual qualities of these historic coastal towns, which include marine activities within small-scale harbors, and the ability to view birds and marine life, are important community characteristics.

Project Area

Overview

Recreational and tourist-oriented activities in the proposed Project area are those oriented towards the southern coast of Cape Cod and around Martha's Vineyard, Nantucket, and the nearby small islands. Water-oriented recreational activities in the proposed Project area include boating, visiting beaches, hiking, fishing, shellfishing, and bird and wildlife viewing. Boating covers a wide range of activities, from ocean-going vessels to small boats that used by residents and tourists in sheltered waters, and includes sailing, sailboat races, fishing, shellfishing, kayaking, canoeing, and paddleboarding.

Commercial businesses offer boat rentals, private charter boats for fishing, whale watching and other wildlife viewing, and tours with canoes and kayaks. Many of the activities make use of coastal and ocean amenities that are free for public access. Nonetheless, these features function as key drivers for many coastal businesses, particularly those within the recreation and tourism sectors. As discussed in Section 3.4.1, recreation and hospitality are major sectors of the economy in Barnstable, Dukes, and Nantucket Counties, supported by the ocean-based recreation uses.

Inland recreation facilities are also popular but bear less of a relationship to possible impacts of the proposed Project; this section does not address them in detail. These include inland waters such as ponds and rivers, wildlife sanctuaries, golf courses, athletic facilities, parks and picnic grounds.

Coastal and Offshore Recreation

Barnstable County

Barnstable County has more than 150 public beaches, several private beaches, 30 harbors, 40 marinas and boatyards, and approximately two dozen private boating and yacht clubs (Epsilon 2018a). Cape Cod National Seashore is located along the county's eastern coast.

The Town of Barnstable has 170 miles (274 kilometers) of coastline with only 9.4 miles (15 kilometers) available for public recreation, of which approximately 2.4 miles (4 kilometers) are publicly controlled and easily accessible (Ridley 2018). The 14 public beaches account for 133 acres (0.54 km^2), while public boat landings occupy 12 acres (0.05 km^2). The town issued 2,760 recreational shell-fishing permits in 2017. During the summer, the public beaches are crowded, and beach parking lots frequently reach capacity by mid-morning.

The Town of Yarmouth's 39 miles (62.8 kilometers) of saltwater shorefront form the backbone of the town's tourist-based economy. The most heavily used beaches are on Cape Cod Bay, Lewis Bay, and Nantucket Sound. The town operates four public marinas and nine boat ramps. Swimming, fishing, shellfishing, and boating occur at Lewis Bay, Bass River, Parker's River, Nantucket Sound, Bass Hole, and Cape Cod Bay (Town of Yarmouth 2015).

Offshore cables would cross Muskeget Channel and Nantucket Sound, areas extensively used for recreational boating and fishing. For the New Hampshire Avenue cable landfall option, the OECC would traverse Lewis Bay, with landfall adjacent to Englewood Beach and a public marina. Lewis Bay is one of the busiest boating centers on Cape Cod. It is the primary harbor in Hyannis, and is the homeport of two ferry services to Martha's Vineyard and Nantucket. In addition, Lewis Bay supports recreational fishing and shellfishing, recreational boating, and public beaches. Lewis Bay is shallow, with depths generally less than 20 feet (6.1 meters). Since 1940, the route from Hyannis Harbor through Lewis Bay into the Nantucket Sound has been a federally designated navigation channel. This designation allows the use of federal funds for dredging to maintain an open channel with depths of 12 feet (3.7 meters) (USACE 2018a). The U.S. Army Corps of Engineers (USACE) last dredged the channel in 2013. Periodic dredging would be needed to maintain the bay's depth (Cape Cod Life 2017).

Dukes County and Martha's Vineyard

Dukes County has five harbors, two marinas, three yacht clubs, and 15 public beaches. Recreational boaters use all of the harbors. Martha's Vineyard, the largest island in the County, has 211 miles (340 kilometers) of shoreline of which about 68 miles (109 kilometers) are publicly accessible (Martha's Vineyard Commission 2010).

Nantucket County

Nantucket County has about 110 miles (177 kilometers) of shoreline, of which 80 miles (129 kilometers) are sandy beach open to the public. Nantucket has two harbors, both of which are popular seasonal destinations for recreational and commercial vessels. The island also has two yacht clubs, multiple marinas, and two public access boat ramps (Epsilon 2018a).

Onshore Recreation

The Covell's Beach landfall site is located on Craigville Beach Road near the paved parking lot entrance to Covell's Beach, a public beach owned by the Town of Barnstable. Vineyard Wind anticipates construction staging operations to use the paved beach parking lot.

The New Hampshire Avenue (Lewis Bay) landfall site would be located inside Lewis Bay where a road dead-ends west of Englewood Beach at a low concrete bulkhead. Construction staging operations would occur at the paved parking area for Englewood Beach, located approximately 300 feet (92 meters) north of the dead-end. Both landfall sites are adjacent to seasonal homes.

The western OECR (extending from Covell's Beach to the proposed substation) would not be adjacent to any public recreation or open space features. The eastern OECR (extending from the New Hampshire Avenue landfall site) would run beneath the public road adjacent to Sandy Pond Park and the Horse Pond Conservation Area, a natural area with trails. The proposed substation would not be adjacent to any recreation facilities. Construction of the onshore cable duct banks would occur over a 12-month period and would cause periodic disruption to local roads (see Section 3.4.6 for road listing). However, the COP establishes that Vineyard Wind would not conduct activities along the OECR within public roadways from Memorial Day through Labor Day unless authorized by the host town. Ongoing work could extend through June 15, subject to authorization of the host town. Vineyard Wind plans to consult with the towns regarding the construction schedule and develop a Traffic Management Plan to minimize disruptions in the vicinity of construction and installation activities (Epsilon 2018a).

Vineyard Wind plans to locate the Operations and Maintenance Facilities at Vineyard Haven, and would also use the port facilities at the MCT. New Bedford Harbor is primarily industrial, with minimal recreational boating activity, and is not near parks, public beaches, or other recreation resources. The Vineyard Haven Harbor supports a mix of recreational, ferry, and commercial fishing vessel activity. No public parks, beaches, or other public recreational facilities are immediately adjacent to the harbor. Section 3.4.7 discusses the existing demands and capacities of New Bedford, Vineyard Haven, and other harbors potentially affected by the proposed Project.

Visual Resources

The proposed Project's WTGs would be in open ocean approximately 14 miles (22.5 kilometers) south of Martha's Vineyard.

The overall affected environment for visual resources is the area from which any portion of the proposed Project facilities would be visible (visual study area). A 627-foot-high (191-meter-high) wind turbine would potentially be visible from a distance of up to 35.3 miles (56.8 kilometers) when considering only the obscuring effect of the curvature of the earth's surface. Therefore, the affected environment for visual impacts is a 35.3-mile (56.8-kilometer) radius of the WDA. This distance is a conservative limit to potential views; beyond this point, an entire 627-foot (191-meter) high turbine, as measured from sea level to the tip of the blade, would be below the horizon from the perspective of a viewer on the ocean surface or at beach elevation (Epsilon 2018a). Between 27.4 and 35.3 miles (44.1 and 56.8 kilometers), only the rotor blades would be potentially visible above the horizon from the perspective of a beach-elevation viewer.

The top of the turbine nacelle (397 feet [121 meters] above mean sea level [AMSL]) would be visible to a viewer at the ocean surface or at beach elevation at distances less than 27.4 miles (44.1 kilometers) (Epsilon 2018a). This includes aviation hazard lighting affixed to the top of the nacelle (see Section 3.4.7), which would potentially be visible at night (Saratoga Associates 2018).

These limits of visibility are considered conservative because they do not account for weather conditions, sea spray, haze, and air pollution, which would fully or partially obscure the WTGs from view both day and night.

Field observations indicate that coastal topography, vegetation, and structures screen proposed Project visibility from inland points. The onshore visual study is therefore limited to recreational areas and activities on the immediate shoreline of the Massachusetts mainland; the southern coastline and some elevated locations on Nantucket and Martha's Vineyard (COP Appendix III-H.a, Figures 4 and 5; Epsilon 2018a); and shorelines facing the WDA on Cuttyhunk Island, Nomans Island, Muskeget Island, and Tuckernuck Island.

Construction of proposed onshore Project components could potentially be visible from recreation areas immediately adjacent to the OECRs and the onshore substation.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the following recreational and visual resources.

- Offshore facilities (during operations and maintenance, unless otherwise specified):
  - Recreational fishing and shellfishing, to the extent that fish and shellfish populations are impacted by construction, operations, and maintenance of the proposed Project;
  - Recreational boating activity (including whale watching, sailing, power boating, and other on-water activities) in the vicinity of offshore WTGs;
  - Recreational fishing through both improved fishing conditions (if the WTGs act as fish aggregating structures) and potential conflicts between WTGs and fishing gear;
  - Boating in shallow waters, or fishing methods that require contact between fishing gear and the ocean or bay floor, in locations where the cables are protected rather than buried completely, or where shifting sediment causes cables to be exposed;
  - Daytime and nighttime views from the mainland, Martha's Vineyard, Nantucket, and open ocean in the direction of the proposed WTGs, at distances up to 35.3 miles (56.8 kilometers) from the WDA, where not obscured by the horizon line, topography, structures, or vegetation;
  - Recreational boating and fishing in Lewis Bay, if the OECC impacts dredging operations; and
  - Potential charter boat cruises to view the offshore wind facility.

- Onshore facilities (during construction and maintenance activities):
  - At the cable landfall sites, access to the beaches and beach parking areas at Covell's Beach or Englewood Beach;
  - Along the cable routes, access to town parks adjacent to roads affected by the OECRs, specifically Sandy Pond Park and Horse Pond Conservation Area in Yarmouth;
  - Along the cable routes and near the onshore substation, potential impacts of construction dust and noise on recreational users located proximate to the proposed-Project facilities; and
  - From recreational areas that have views of onshore facilities, where not obscured by topography, structures, or vegetation.

Condition and Trend

While the proposed Project area has a strong tourism industry and abundant coastal and offshore recreational facilities, many of which are associated with scenic views, local jurisdictions face challenges maintaining the recreational resources. The primary concern for the ocean-based resources is protection of water quality. The following are recreation-related planning goals of the jurisdictions (Town of Barnstable 2010; Cape Cod Commission 2014; Martha's Vineyard Commission 2010; Ridley 2018; Town of Yarmouth 2015):

- Restoring natural resources that support recreational opportunities by improving coastal water quality through enhanced wastewater treatment and stormwater management;
- Promoting ecotourism and balancing visitors needs with protection of the natural resources;
- Increasing availability of public water access;
- Improving recreational facilities for year-round residents, especially providing recreation centers and adequate athletic facilities; and
- Completing pathway networks and greenways.

3.4.4.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on recreation and tourism include the following elements of the maximum-case scenario (as described in Appendix G):

- The design, height, and number of WTGs relative to onshore and offshore viewers. Maximum visual impact is evaluated based upon the largest number of WTGs under consideration: 106 positions using the 8-MW turbines, each of which would have a height of 627 feet (191 meters) to the tip of the blade (see the Visual Impact Analysis discussion and simulations in the COP Volume III, Appendix III-H.a; Epsilon 2018a).[23]
- Design/visibility of lighting on the WTG nacelle and potential mitigation options to reduce light pollution (see Appendix D). The greatest nighttime visual impact results from the aviation obstruction lighting requirement of two red flashing lights per WTG nacelle, with 30 flashes per minute.
- Arrangement of WTGs and accessibility of WDA to recreational boaters. Vineyard Wind's WTG layout would consist of a grid-like pattern with spacing of 0.76 to 1 nautical mile between WTGs with corridors in a northwest/southeast and northeast/southwest direction.
- The route chosen for the OECC that could affect recreational marine traffic (sailing, power boating, whale watching, etc.), as well as recreational fishing or shellfishing due to differing marine traffic densities and use of the near-shore coastal area.
- The onshore cable landfall site chosen and the selected OECR.
- The time of year during which onshore and near shore construction occurs. Tourism and recreational activities in the study area tend to be higher from May through September, and especially from June through August.

Potential Variances in Impacts

Variability of the proposed-Project design as a result of the PDE includes the OECC and OECRs, the WTG design selected (e.g., 8 MW, 10 MW machines), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule. The impact assessment in this chapter analyzes the maximum-case scenario.

The Project's effects on nonmarket values would also vary. Nonmarket values "reflect the benefits individuals attribute to experiences of the environment, uses of natural resources, or the existence of particular…conditions that do not involve market transactions and therefore lack prices" (BLM 2013). In the context of the proposed Project, nonmarket

[23] Although Vineyard Wind proposes 106 WTG placement locations as part of the PDE, no more than 100 total WTGs would be installed as part of the proposed Project.

values could include perceptions of visual resources that are not reflected in economic outcomes, or the social and cultural values associated with healthy commercial or recreational fishing or boating industries. Nonmarket values are inherently subjective, and would vary from person to person. The studies cited in the discussion of visual impacts in Section 3.4.4.3 address nonmarket values associated with visual resources.

3.4.4.3. Impacts of Alternative A (Proposed Action) on Recreation and Tourism

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with Proposed Action construction, operations and maintenance, and decommissioning.

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations and maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct impacts would include the temporary or permanent loss of access to or enjoyment of onshore or offshore recreation areas, activities, resources, or facilities due to the presence of construction activity, WTGs, or other components of the Proposed Action. Indirect impacts would include the economic consequences of altered or reduced use of recreation areas, activities or facilities, such as reduced tourism employment or revenues (see Section 3.4.1.3). Changes in fish, shellfish, and marine mammal populations that are the basis of recreational activities (fishing, shellfishing, and whale watching) could impact tourism and recreational activities (see Sections 3.3.6.2, 3.3.5.2, and 3.3.7.2).

The sections below summarize the potential direct and indirect impacts of the Proposed Action on recreation and tourism during the various phases of the Proposed Action.

Construction and Installation of Offshore Components

Offshore construction and installation of the Proposed Action would temporarily restrict access to the OECC route. An average of four cable-laying, support, and crew vessels and a maximum of six vessels may be deployed along sections of the OECC during construction and installation activities (COP Volume III, Section 7.8.2.1.2 and Appendix III-I; Epsilon 2018a). Construction and installation is anticipated to occur from winter through fall 2021 (COP Volume I, Figure 1.5-1; Epsilon 2018a); while it is not specified how long vessels would be present at a given location, there would be at least one location where cable splicing is necessary, requiring a vessel to remain at the same location for several days (COP Volume I, Section 4.2.3.3; Epsilon 2018a). Section 3.4.7.2 discusses impacts on vessel navigation, including proposed safety zones, duration of OECC construction, and mitigation.

In addition to recreational sailboats and powerboats, commercial ferry services operating out of Hyannis, Martha's Vineyard, and Nantucket would cross the OECC route. Selection of the New Hampshire Avenue landfall site would result in an OECC route through Lewis Bay, which would impact the ferry and other vessel traffic based in and near Hyannis, one of the densest marine traffic areas in the study area (USCG 2016). The temporary displacement of marine traffic from Lewis Bay during OECC installation would have a greater impact than in Nantucket Sound due to the greater density of vessel movements and the absence of alternative routes into and out of Lewis Bay. The impact would be greatest at the mouth of Lewis Bay, which ferry vessels traverse multiple times a day. BOEM could require additional mitigation of the following nature (see Appendix D):

- Require that the OECC within the federally designated Lewis Bay navigation channel be buried at a depth (to be determined by the USCG) sufficient to allow ongoing maintenance dredging or future increased channel depth; or
- Require that OECC construction use a route that avoids the federally designated Lewis Bay navigation channel altogether.

Recreational boaters outside of Lewis Bay would generally be able to avoid Proposed Action vessels and access restrictions associated with the OECC. The temporary need for slight changes in navigation routes due to Proposed Action construction would constitute a **minor** impact. Vessel travel requiring a specific route that crosses or approaches the OECC, especially within Lewis Bay, could potentially experience **moderate** impacts. While Hy-Line Cruises does not anticipate disruptive impacts on their ferry routes during the cable-laying process, they requested frequent Notices To Mariners and routine radio communication as OECC routes and construction plans are finalized (COP Appendix III-I; Epsilon 2018a). COP Appendix III-I describes proposed marine vessel operator stakeholder engagement and communication procedures, which would include communication with recreational fishing interests and ferry operators, which may help mitigate impacts on vessel operators (Volume III; Epsilon 2018a).

Construction within the WDA, anticipated to take place over a 1.5- to 2-year period, beginning in the second or third quarter of 2020 and extending through mid-2022, would also impact recreational boaters (COP Volume I, Figure 1.5-1; Epsilon 2018a). Vineyard Wind would use a flexible, temporary safety zone around active construction areas, rather than one zone around the whole WDA, so that vessels could traverse areas of the WDA where construction is not occurring. Recreational boating activity within the WDA, approximately 36 miles (57.9 kilometers) from Hyannis and 15 miles (24.1 kilometers) from the south coast of Martha's Vineyard, is much less frequent than in coastal areas (see Section 3.4.4.1). Vineyard Wind would mitigate impacts through communication efforts resulting in a **minor** temporary impact.

Long-distance sailing races occasionally traverse the WDA. Two of these, the Transatlantic Race and the Marion to Bermuda Race, are scheduled to occur in June 2019. These races typically occur every 2 to 4 years; therefore, the next running after 2019 could occur during construction within the WDA (Transatlantic Race 2018; McLean 2018). Vineyard Wind would work with event organizers and the USCG in advance of these events (see Section 3.4.7.3) (COP Appendix III-I, Section 8.2.2; Epsilon 2018a). The need to adjust racing routes to avoid construction areas and the associated safety zones, with the proposed safety measures, would result in **moderate** impacts on the sailing community.

Ongoing traffic from Proposed Action-related vessels, including large vessels carrying assembled WTGs or WTG components from the MCT to the WDA, could also complicate recreational-vessel navigation. Marine construction traffic would be primarily from the MCT in New Bedford Harbor, with potentially modest amounts of traffic from other ports. Over the course of the entire construction phase, an average of 25 vessels would be present in the WDA or OECC, and the Proposed Action would generate an average of seven daily vessel trips between both the primary and secondary ports and the WDA or OECC. During the period of maximum activity, an average of 46 construction vessels would be present in the WDA or OECC, and Proposed Action construction would generate an average of 18 construction vessel trips per day in or out of construction ports. In maximum conditions, this could theoretically include up to 46 trips in a single day, including up to 4 trips per day to or from secondary ports, with the remainder originating or terminating at the MCT (COP Appendix III-I, Section 5.2.2; Epsilon 2018a). Recreational vessels would experience delays within the ports serving the construction, especially New Bedford Harbor, as described in more detail in Section 3.4.7. Outside of the harbor areas, the construction vessel traffic would have **negligible** impacts on recreational boating.

Even where areas within or near the WDA are available for recreational boating during construction, increased noise from construction within the WDA could temporarily inconvenience recreational boaters, with **minor** impacts. Noise from pile driving, the noisiest aspect of WTG installation, is estimated to be 60 dB on the A-weighted scale at a distance of 1 nautical mile from the construction zone (COP Appendix III-I, Section 7.5.1.1; Epsilon 2018a), comparable to the noise level of a normal conversation (OSHA 2011).

The temporary disruptions to or changes in offshore fish, shellfish, and whale populations would have a **moderate** impact on charter or individual fishing, shellfishing, or whale-watching activities, although whale-watching voyages typically travel north of Cape Cod, away from the WDA. Section 3.4.5 addresses the Proposed Action's impacts on charter fishing.

Overall, construction and installation of the Proposed Action offshore components would have temporary, **moderate** impacts on recreation and tourism.

Construction and Installation of Onshore Project Components

Installation of the OECC landfall and onshore cable components of the Proposed Action are anticipated to occur over a period of approximately 19 months, from fall 2019 through spring 2021 (COP Volume I, Figure 1.5-1; Epsilon 2018a). As noted in 3.4.4.1, construction within the ROW of public roads would not occur between Memorial Day and Labor Day, unless authorized by the host town, and Vineyard Wind plans to develop a Traffic Management Plan. Vineyard Wind would not perform activities at the landfall site where transmission would transition from offshore to onshore during the months of June through September, unless authorized by the host town. Typical construction hours would extend from 7:00 a.m. to 6:00 p.m., with nighttime work performed only when necessary (e.g., crossing a busy road).

Onshore construction and installation would result in the following impacts on recreation and tourism:

- The landfall sites would experience disturbance for two construction events: installation of the cable onshore/offshore transition vaults, and HDD or trenching in preparation for joining the onshore and offshore cables. Construction of the Covell's Beach landfall site could prevent the use of part of the beach parking lot, and could discourage beach visitation due to noise and activity associated with construction. Similarly, construction of the New Hampshire Avenue landfall site could prevent use of part of a parking lot used by Englewood Beach visitors, while construction noise and activity could disturb residents and visitors in the area. These impacts would be unavoidable during construction, but would be temporary, and would avoid the summer peak tourism season; therefore, onshore construction would have **moderate** impacts on recreation and tourism at the landfall sites.
- Cable installation from the landfall beach to the substation would temporarily slow traffic on roads adjacent to the OECR, inconveniencing drivers accessing tourist or recreational areas. The Traffic Management Plan, coordination with towns, and avoidance of summer months would minimize traffic disruptions. Accordingly, construction of the OECR would have **minor** temporary impacts on recreation and tourism.

- As part of the HCA with the Town of Barnstable, if Vineyard Wind selects the Covell's Beach landfall site, they would provide funds to the town for reconstruction of a bathhouse at Covell's Beach (Town of Barnstable 2018b). This would be a **minor beneficial** impact for recreation.
- One variant for the OECR from the New Hampshire Avenue Landfall Site—Eastern Variant #3 (see Figure 2.1-1 in Chapter 2 and COP Figure 2.2.1 [Volume I; Epsilon 2018a]) would locate the OECR along the same alignment as a planned extension of the Cape Cod Rail Trail, from Willow Street in Yarmouth to Mary Dunn Way in Barnstable (Cape Cod Commission 2013). As stated in the HCA with the Town of Barnstable, Vineyard Wind would coordinate construction with trail proponents, and would conduct preparatory work to facilitate subsequent bike path installation (Town of Barnstable 2018b). These efforts would be a **minor beneficial** impact for recreation.
- The proposed substation site is located within an industrial area, and BOEM anticipates its construction to have **negligible** impacts on recreational or tourism activities.

Construction activities at the MCT and other harbors used for construction staging, including onshore storage, fabrication, and shipping activity, would be consistent with existing industrial uses at these facilities, and BOEM therefore anticipates them to have **negligible** impacts on tourism or recreational activities.

Operations and Maintenance of Offshore Components

During operations and maintenance of the Proposed Action, the permanent presence of WTGs would create new obstacles for recreational vessels. AIS transmissions found that recreational vessels ranging in size from 16 to 61 meters (52 to 200 feet) navigated within the WDA in 2016 and 2017, representing approximately 10 percent of all AIS vessel transmissions. In comparison, recreational vessels in Nantucket Sound accounted for 48 and 45 percent of all AIS transmissions in 2016 and 2017, respectively (COP Appendix III-I: Epsilon 2018a). At their lowest point, WTG blades would be 89 feet (27 meters) above the surface. At this height, larger sailboats would need to navigate around the RSA, while smaller vessels could navigate unobstructed (except for the WTG monopiles). The AIS data from 2016 and 2017 also showed that two sailing vessels with a mast height greater than 89 feet (27 meters) traversed the WDA multiple times during these years (COP Appendix III-I Epsilon 2018a).

To the degree that the WTGs and OECC would affect the habitat and abundance of species targeted by recreational fishing, the Proposed Action could impact recreational fishing and shellfishing. As addressed in Section 3.3.6, the scour protection around the WTG foundations would likely attract forage fish as well as game fish, which could provide new opportunities for recreational anglers. However, the magnitude of benefits to recreational fishermen from WTGs providing new structure for fish may be reduced due to the distance from shore (Starbuck and Lipsky 2013). Operations and maintenance of the Proposed Action would therefore have **negligible beneficial** impacts on recreational fishing.

Offshore wind projects such as the Proposed Action often raise concerns about the impacts of visible WTGs on recreation and tourism activities, particularly along coastal areas. To local residents and tourists, these coastal areas are considered to be highly scenic, and public places with ocean views are important recreational and tourist destinations. The COP's Visual Impact Analysis (COP Appendix III-H.a; Epsilon 2018a) provides visual simulations of the Proposed Action from 20 observation points. WTGs would be visible from south-facing coastlines and some elevated areas on Nantucket, Martha's Vineyard, several smaller islands (Tuckernuck, Muskeget, Nomans, and Cuttyhunk), and substantial portions of Cape Cod's southern coastline (COP Figure 3, Appendix III-H.a; Epsilon 2018a). In general, the COP concludes that "from all coastal vantage points WTGs [would] appear low on the distant horizon and [would be] difficult to perceive" in clear conditions, and that WTGs would not be discernible during hazy or foggy daytime conditions. The meteorological assessment indicates that haze, fog, and other atmospheric conditions limit visibility to less than 10 miles (16.1 kilometers) approximately 30 percent of the time on an annual basis. The proposed WTGs, which are approximately 14.7 miles (23.7 kilometers) from the closest coastline, would be obscured by atmospheric conditions for an even greater percentage of the time (COP Appendix III-H.a; Epsilon 2018a).

At night, required aviation obstruction lighting on the WTGs, consisting of red lights on the nacelle flashing 30 times per minute, would be visible in clear conditions from most coastal locations within about 27.4 miles (44.1 kilometers). This would include Nantucket, Martha's Vineyard, Nomans Land, Muskeget Island, and Tuckernuck Island, but not the mainland of Cape Cod. The required USCG marine vessel safety lights on the WTG foundations would not be visible from land. The visibility of aviation obstruction lighting would be substantially limited by the distance from coastal vantage points. The Visual Impact Assessment states that, "At greater than 23 km (14 mi) aviation obstruction lights will be visible very low on the horizon and will appear to shimmer and vary in intensity due to the slow flash rate, intermittent shadowing as rotating blades pass in front of the light source, and atmospheric variations. Visibility can be frequently reduced or blocked by fog, snow, particulate matter, smog or any combination of thereof" (COP Appendix III-H.a, Section 6.2.1; Epsilon 2018a).

Additionally, BOEM could require the utilization of an ADLS as a mitigation measure to be implemented as a condition of COP approval (see Chapter 2). An ADLS, if utilized, would only activate FAA hazard lighting when an aircraft is near the WTGs (within 3 nautical miles from and within 1,000 feet above a wind turbine). The system would therefore reduce the visibility of nighttime lighting and further reduce nighttime visual impacts. An analysis of FAA radar returns in proximity to the WDA for the period between October 1, 2016 and September 30, 2017 indicated that an ADLS system would have been activated at night 235 times during the year, with a total of 3 hours and 49 minutes of light activation time (i.e., approximately one minute per activation); this equates to lights being activated less than 0.1 percent of nighttime hours (COP Appendix III-N; Epsilon 2018a).

For viewers on vessels near the WDA, the visual contrast introduced by the WTGs and ESPs would be stronger than from the coast. See Figure 3.4.4-1 for the area within which the WTGs would be visible. "In a close approach, the very large form and strong geometric lines of both the individual WTGs and the array of WTGs could dominate views, and the large sweep of the moving rotors would command visual attention" (COP Appendix III-H.a; Epsilon 2018a), although the impact on any single viewer would be subjective (Brownlee et al. 2012).

Numerous studies and surveys have evaluated the impacts of offshore wind energy facilities on tourism. A 2018 University of Rhode Island study of the impacts of the Block Island Wind Farm includes a literature review (Bidwell and Smythe 2017, Appendix I). Key findings included:

- Concerns about visual impacts of offshore wind facilities decrease as distances of the wind facility from shore increase;
- More frequent visitors to an area may be most concerned about potential wind facilities based on their desire to preserve natural or pristine settings; and
- Tourist attitudes towards wind facilities are influenced by personal factors, beliefs about renewable energy and the environment, motivations for tourism, and feelings about the landscape.

Most studies in the literature review used surveys to determine potential impacts of not-yet-built wind facilities; however, some were able to assess the impacts of constructed wind energy facilities. A 2012 review of two studies of existing wind facilities in England and Scotland concluded that the wind facilities did not result in decreased tourist numbers, tourist experience, or tourist revenue. A 2013 study of wind facilities in Denmark, England, and Scotland also found no negative impact on tourism from offshore wind facilities.

The University of Rhode Island study included a series of focus groups representing boating, fishing, and coastal recreation participants, interest groups, and businesses, which discussed the five-turbine close-to-shore Block Island Wind Farm (Bidwell and Smythe 2017, Appendix IV). Overall, participants assessed the impact on recreation and tourism as more beneficial than negative. The focus groups concluded that:

- The wind facility attracted tourists, leading to new opportunities for charter boat businesses;
- The foundations of the WTGs attracted abundant marine life, providing an excellent location for fishing or shellfishing;
- The attraction of numerous fishing boats to the WTGs could be a disadvantage, due to perceived crowding; and
- Most participants saw the aesthetic impact of the five WTGs as primarily beneficial, although some visitors and boaters expressed negative perceptions.

The University of Delaware recently evaluated the impacts of visible offshore WTGs on beach use, based on surveys of beachgoers using visual simulations (Parsons and Firestone 2018). Generally, the closer the WTGs are to shore, the greater the share of respondents reporting that their experience would have been worsened. A break-even point occurred at 15 miles (24.1 kilometers), about the distance of the Proposed Action's closest WTGs from Martha's Vineyard beaches. At this distance, the percentage of respondents who reported that their beach experience would be worsened by the visibility of WTGs was about the same as the percentage of those who reported that their experience would be improved (about 16 percent for each response—the remaining 68 percent of respondents indicated that the visibility of WTGs would neither improve nor worsen their experience). Visual disruption of the seascape was the primary source of worsened experience, while knowledge of environmental benefits (i.e., energy produced without use of fossil fuels) was the primary source of improved experience (Parsons and Firestone 2018).

The results described above indicate varied reactions by beach visitors to offshore wind, ranging from seeking out beaches providing views of offshore wind to preferring to visit beaches without such views. Factors specific to the study area tend to alleviate the potential effects on beach visitors who prefer not to view WTGs. The frequent presence of maritime haze and fog (see Appendix B) would make the Proposed Action's WTGs imperceptible from the shoreline on many days. Recreational boaters may choose to avoid the WDA, but would have ample areas of open water in Nantucket Sound and the open Atlantic Ocean more than 35.3 miles (56.8 kilometers) from the nearest WTG.

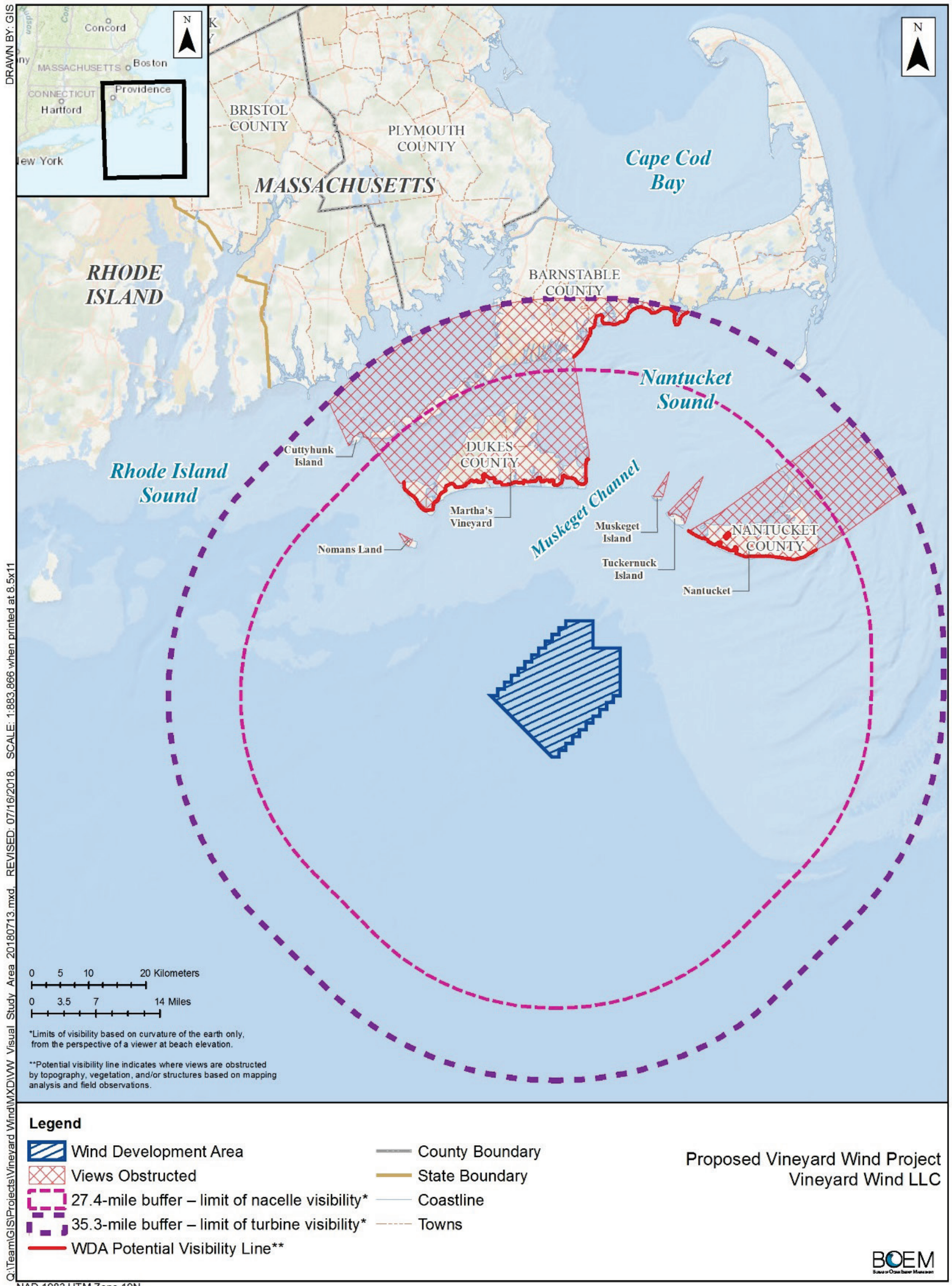


Figure 3.4.4-1: Area within which WTGs would be Visible

Based on findings cited above, and the fact that nearly all coastal public viewpoints are more than 15 miles (24.1 kilometers) from the closest WTGs, the Proposed Action would have **negligible** impacts on establishments that depend on tourism and recreational activities. At these distances, most visitors would not change their selection of coastal locations based on offshore wind visibility; visitors who would avoid coastal areas where offshore WTGs are visible are likely to be balanced by visitors who would choose those sites. Businesses offering charter boat excursions may find new opportunities in providing WDA boat tours.

Considering these factors, BOEM expects the impact of visible WTGs on the use and enjoyment of recreation and tourist facilities and activities during operations and maintenance of the Proposed Action to be **minor**.

Operations and Maintenance of Onshore Project Components

BOEM anticipates **negligible** impacts on tourism or recreational activities from operation of the onshore components. The onshore landfall site and cables would be underground and the proposed substation site would be within an industrial complex. Occasional routine maintenance to cables could temporarily disrupt road traffic.

At the time of preparation of this Draft EIS, insufficient information was available to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port. Operations and maintenance activities would generate an average of one vessel trip per day between Vineyard Haven Harbor and the WDA for observation, with additional vessel trips (totaling up to three trips per day) occurring as needed for repair and maintenance activities. This vessel traffic at Vineyard Haven Harbor, as well as vessel traffic to and from the MCT (for larger repairs) would be consistent with the industrial or working seaport character of these marine facilities, and would not impact ongoing recreational use of these harbors. The Operations and Maintenance Facilities at Vineyard Haven would be an indoor monitoring facility, consisting of office, warehouse, and dock space, and would be indistinguishable from other industrial or commercial businesses and maritime activities near or in the harbor. Operations and maintenance of the Proposed Action would therefore have negligible impacts on onshore recreation and tourism.

Decommissioning

Impacts during decommissioning would be similar to the impacts during construction and installation. Temporary disruptions of marine traffic would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles and ships WTGs to ports for further disposal. Removal of the OECC, if required, would also generate temporary disruptions of marine traffic. Removal of onshore cable ducts, if required, would be similar to the installation process. As with construction, decommissioning activities would have larger impacts if conducted during the summer season.

Provided that Vineyard Wind uses the same mitigation for decommissioning as proposed for the construction and installation process, including communication with vessel operators and scheduling onshore construction for September through May, decommissioning of the Proposed Action would have **minor** impacts on recreation and tourism.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. Activities requiring repair of WTGs, equipment or cables, or spills from maintenance or repair vessels would generally require intense, temporary activity to address emergency conditions or respond to an oil spill (see COP Appendix 1-A; Epsilon 2018a). The presence of onshore construction equipment, as well as the unexpectedly frequent vessel activity in Vineyard Haven Harbor or New Bedford Harbor, and in offshore locations above the OECC or near individual WTGs, could temporarily prevent or deter recreation or tourist activities near the site of a given non-routine event. With implementation of mitigation measures such as communication and coordination with vessel operators, the impacts of non-routine activities on recreation and tourism would be **minor**.

Conclusion

Construction and installation of the Proposed Action would have **minor** to **moderate** impacts on offshore and onshore recreation and tourism due to the presence of construction activity in Nantucket Sound and other waterbodies used by recreational vessels, as well as at public beaches adjacent to the onshore landfall sites. Stronger impacts (i.e., **moderate** instead of **minor**) would occur if the Proposed Action uses the New Hampshire Avenue cable landfall site, which would result in OECC construction through the heavily used Lewis Bay and would disrupt access to a public beach and boat ramp. Potential impacts on recreation and tourism would be **minor** if the Covell’s Beach cable landfall site is used.

Operations and maintenance of the Proposed Action would have **minor** impacts on recreation and tourism. Within Nantucket Sound, the OECC would inconvenience recreational vessels only during maintenance and repair operations. The WTGs would be an inconvenience for some recreational vessel navigation, but would not impede overall recreational vessel travel. The visibility of WTGs would have minimal effects on recreation and tourism due to the distance (typically greater than 15 miles [24.1 kilometers]) between viewers on land and the closest WTG. The impacts would be reduced, although still considered **minor**, if BOEM were to require an ADLS as a condition of COP approval.

Impacts during decommissioning would be **minor** to **moderate,** similar to those anticipated for construction and installation.

3.4.4.4. Impacts of Alternative B on Recreation and Tourism

Alternative B is the same as the Proposed Action, except that the only OECC landfall site that Vineyard Wind would consider is the Covell's Beach landfall site, with the corresponding OECC route. The sections below list the difference in impacts for Alternative B as compared to the Proposed Action.

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and Installation

Alternative B would avoid potential conflicts with recreational boaters and ferry services in Lewis Bay (see Section 3.4.4.1) during construction and installation of the OECC and cable landfall site, and would also eliminate impacts on Englewood Beach and residences near the cable landfall. Lewis Bay supports high volumes of marine traffic and is the terminus for the Hy-Line and Steamship Authority ferry services to Nantucket and Martha's Vineyard, which support tourism on the mainland and the islands (USCG 2016). Other impacts of Alternative B, including impacts on Covell's Beach, would be the same as the Proposed Action. As a result of the avoided impact on users of Lewis Bay, the overall impact of Alternative B on recreation and tourism during construction and installation would be less severe than for the Proposed Action, but would still be **minor** based on the impact levels defined in Section 3.1.

Operations and Maintenance

Operations and maintenance of Alternative B would have the same effects on recreation and tourism as the Proposed Action except that it would eliminate potential impacts from the OECC within the Lewis Bay navigation channel. As a result, operations and maintenance of Alternative B would still have **minor** impacts on recreation and tourism.

Decommissioning

Decommissioning of Alternative B would have the same impacts as the Proposed Action, except that it would avoid disruption of Lewis Bay during OECC removal, and would therefore have **minor** impacts on recreation and tourism.

Direct and Indirect Effects of Non-Routine Activities

Alternative B would avoid the possibility of a non-routine event that disrupts recreational boating, swimming, and fishing within Lewis Bay. Non-routine activities associated with Alternative B would therefore have **negligible** to **minor** impacts on recreation and tourism.

Conclusion

Alternative B would have **minor** impacts on recreation and tourism during construction, operations and maintenance, and decommissioning.

3.4.4.5. Impacts of Alternative C on Recreation and Tourism

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction, operations and maintenance, and decommissioning of Alternative C would provide more unobstructed space for navigation in the northern portion of the WDA, closer to ports and other shore facilities commonly used by recreational vessels. This would result in a small reduction of the impact on recreational vessel navigation.

Moving WTGs away from the northern portion of the WDA would reduce visual impacts on land-based recreation areas by placing fewer WTGs within view of the shore. Depending on exact siting, WTG blades may no longer be visible from the shoreline of mainland Cape Cod. WTG blades and nacelles would remain visible from Nantucket and Martha's Vineyard, as discussed in Section 3.4.4.3 above, and would still have a **minor** impact on recreation and tourism during operations and maintenance. Other components of the impact on recreation and tourism would be unchanged from the impacts analyzed in Section 3.4.4.3 for the Proposed Action. Accordingly, the impact levels for Alternative C are anticipated to be the same as for the Proposed Action:

- **Moderate** impacts during construction and installation and decommissioning if the New Hampshire Avenue OECC landfall site is selected, and **minor** impacts if the Covell's Beach OECC landfall site is selected; and,
- **Minor** impacts during operations and maintenance.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative C would be the same as those for the Proposed Action: **minor.**

Conclusion

Alternative C would have **minor** to **moderate** impacts on recreation and tourism during construction and decommissioning and **minor** impacts during operations and maintenance.

3.4.4.6. Impacts of Alternative D on Recreation and Tourism

Impacts of Alternative D1 and D2

Incremental Contribution of Alternative D1 and D2

Direct and Indirect Effects of Routine Activities

Alternative D (including Alternatives D1 and D2) would result in different WTG configurations, each of which would require different navigation routes for recreational vessels. Both configurations would marginally increase navigation flexibility for recreational vessels, but would not change the overall impacts of the Project on recreation and tourism as analyzed in Section 3.4.4.3 for the Proposed Action. Accordingly, the impact levels for Alternative D (including Alternatives D1 and D2) are anticipated to be the same as for the Proposed Action:

- **Moderate** impacts during construction and decommissioning if the New Hampshire Avenue OECC landfall site is selected, and **minor** impacts if the Covell's Beach OECC landfall site is selected; and,
- **Minor** impacts during operations and maintenance.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative D would be the same as the Proposed Action: **minor**.

3.4.4.7. Impacts of Alternative E on Recreation and Tourism

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Under Alternative E, Vineyard Wind would implement taller, higher generation capacity WTGs. As a result, the maximum rotor extension would be approximately 69 feet (21 meters) taller, while the hub height would be approximately 39 feet (12 meters) greater. Only 84 WTGs would be required as opposed to as many as 100 WTGs for the Proposed Action.

Construction and Installation

The impacts of construction and installation of Alternative E would be similar to the Proposed Action. Fewer WTGs would be constructed within the WDA for Alternative E, but as noted in Section 3.4.4.3, Vineyard Wind would use a temporary safety zone around active construction areas, rather than one zone around the whole WDA, so that vessels could traverse areas where construction is not occurring. In addition, recreational boating within the WDA is less frequent than in coastal areas and Vineyard Wind would mitigate impacts through communication efforts, resulting in a **minor** temporary impact within the WDA.

Accordingly, the overall impact of Alternative E would be the same as the Proposed Action: **moderate** if the New Hampshire Avenue OECC landfall site is selected and **minor** if the Covell's Beach OECC landfall site is selected.

Operations and Maintenance

During operations and maintenance, recreational boaters in the WDA would still need to navigate among WTGs and ESPs; however, the distance between these structures could be larger than under the Proposed Action, depending on ultimate siting locations.

As stated in Section 3.4.4.1, the analysis area for visual impacts is based on the 10 MW turbine. Even though Alternative E would utilize a larger turbine than the Proposed Action, the "difference in WTG hub height is not perceivable at a distance of over 23 km (14 mi), the closest approximate distance from the Project to land" (COP Appendix III-H.a; Epsilon 2018a). Because the difference in WTG heights would not be perceptible, the lower number of WTGs would be the primary factor affecting degree of visual impact.

Thus, Alternative E would have lower visual impacts on shore-based recreation and tourism sites and water-based recreational activity than the Proposed Action. However, the WTGs would still be visible from coastlines as analyzed for the Proposed Action, and the impact would not change sufficiently to reduce the level of impact to negligible. Accordingly, the impact during operations and maintenance would be the same as for the Proposed Action: **minor**.

Decommissioning

Although less construction activity would be needed for decommissioning a smaller number of WTGs, the impacts of decommissioning of Alternative E would be substantially the same as the Proposed Action. The impact would be the same as for the Proposed Action: **moderate** if the New Hampshire Avenue OECC landfall site is selected and **minor** if the Covell's Beach OECC landfall site is selected.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative E would be the same as the Proposed Action: **minor**.

Conclusion

The impacts of Alternative E on recreation and tourism would be incrementally lower than the Proposed Action, but would still have the same impact magnitudes. Construction and decommissioning of Alternative E would have **minor** to **moderate** impacts on recreation and tourism, while operations and maintenance would have **minor** impacts.

3.4.4.8. Impacts of Alternative F (No Action Alternative) on Recreation and Tourism

If BOEM does not approve the proposed Project (either the Proposed Action or an alternative that involves construction of WTGs in the WDA), there would be no impacts to recreation and tourism activities related to coastal, natural, and manmade resources such as visits to beaches, fishing, boating, sailing, wildlife viewing, and swimming. These activities would continue to draw customers for local businesses that provide services such as tours, boating and fishing, and lodging and food, as well as tourist-oriented artisans, retail businesses, and commercial recreation. Local governments would continue to support and at the same time address the challenges of a tourism-dependent economy, and would seek to promote year-round industries with skilled jobs. Public and private stakeholders would continue to address environmental challenges that impact recreation and tourism activities, such as municipal drinking water quality, stormwater run-off, and preservation of habitat and natural areas along the coast and inland waterways. Possible benefits to recreation and tourism, which include the potential for charter tours to the WDA, and improved recreational fishing due to the attraction of fish to the WTG scour protection, would not be realized.

3.4.4.9. Comparison of Alternatives for Recreation and Tourism

Alternatives B, C, and E would have lower overall impacts on recreation and tourism than the Proposed Action: Alternative B would avoid direct impacts on recreational activities associated with construction or decommissioning within Lewis Bay, reducing the potential impact on recreation and tourism during construction and decommissioning from **moderate** to **minor**. In the case of Alternatives C and E, the reduced impact on recreation and tourism would be due to reduced visual impact, more unobstructed space for navigation in the northern part of the WDA (Alternative C) and more unobstructed space within the WDA generally (Alternative E). The reduced impact would not result in a change in the impact rating. Alternatives D1 and D2 would not have meaningfully different impacts on recreation and tourism as compared to the Proposed Action. As discussed in Section 3.4.4.2, the analysis of impacts is based on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.4.3 through 3.4.4.7.

3.4.4.10. Cumulative Impacts

The area of analysis for cumulative impacts on recreation, tourism, and visual impacts includes the footprint of the proposed Project, plus the 35.3-mile (56.8-kilometer) visual analysis area (see Appendix C, Figure C.1-12). The proposed South Fork offshore wind energy Tier 2 project is within the geographic analysis area described above and has the potential to generate cumulative impacts on recreation and tourism. The NJ State Waters/Nautilus-Atlantic City Wind Farm and CVOW (OCS-A 0497) Tier 1 projects are outside of the geographic analysis. All four of the Tier 3 offshore wind energy projects are not reasonably foreseeable based on the assumptions outlined in Appendix C; however, any future development of these projects could contribute to cumulative effects. These effects may be similar to the Proposed Action and would likely include ground-disturbing activities and the introduction of visual elements. However, the extent of these effects would depend on project-specific information that is unknown at this time, such as the location of onshore and offshore ground-disturbing activities and the size and number of WTGs. Due to the distance of these projects from the proposed Project area, the Proposed Action, when combined with past, present, and future projects would have **minor** to **moderate** effects on recreation and tourism.

The Nautilus and CVOW projects are hundreds of miles from the Proposed Action (outside of the analysis area), would have minimal if any cumulative impact on recreational boating, and would have no cumulative visual impact. The South Fork project would be sited within 30 miles (48.3 kilometers) of the Vineyard WLA, and would have cumulative impacts on navigation for the minority of recreational boaters and tour businesses who navigate as far from shore as the Vineyard WLA. The South Fork project would produce additional vessel traffic during construction and additional areas where vessels must navigate within or avoid WTGs and related structures. Cumulative impacts on recreation and tourism could also occur as a result of increased disturbance to fish, shellfish, and marine mammal populations during construction, as evaluated in Sections 3.3.6.2, 3.3.5.2, and 3.3.7.2. If the South Fork wind energy project is under construction at the same time as the Proposed Action, marine traffic at New Bedford and other ports would experience cumulative impacts that could result in additional delays for recreational vessels.

Construction noise would not be cumulative, even if the Proposed Action and South Fork Wind projects were under construction at the same time, because the distances are such that the noise from one construction area would dissipate before the noise travelled to the nearby project. Visual impacts would be cumulative only if more than one wind energy project is visible from the same coastal vantage point, thereby increasing the number of WTGs visible. No cumulative visual impacts would result from reasonably foreseeable projects.

As a result, the Proposed Action when combined with past, present, and future projects would result in a moderate incremental contribution to recreation and tourism impacts, when combined with the past, present, and reasonably foreseeable future activities. Because the projects listed above are unlikely to occur simultaneously with the Proposed Action, BOEM anticipates the overall cumulative activities considered in this analysis to cause **moderate** impacts on recreation and tourism.

The cumulative impacts of Alternatives B, C, D1, D2, and E on recreation and tourism, when combined with past, present, and future projects, would be the same as the Proposed Action: **moderate**.

3.4.4.11. Incomplete or Unavailable Information for Recreation and Tourism

There is no incomplete or unavailable information related to the analysis of impacts on recreation and tourism.

3.4.5. Commercial Fisheries and For Hire Recreational Fishing

BOEM’s Scoping Summary Report (see Section 4.3) indicates that over 20 percent of the substantive comments identified during the public scoping period addressed the topic of commercial fisheries and for-hire recreational fishing, making this the most commonly discussed resource or NEPA topic identified during the comment period. This section identifies the existing commercial and for-hire recreational fishing that are present within the state and federal waters off Massachusetts and Rhode Island, as well as fishing in the Deepwater WLA, Vineyard WLA, and the WDA (Figure 1.1-1). Commercial fisheries refer to fishing activities that sell catch for profit, whereas for-hire fishing boats sell recreational fishing trips to anglers. The purpose of this section is to identify key fisheries regionally and within the proposed Project area, and to understanding the relative importance of these areas to these fisheries. Section 3.4.4 discusses recreational fishing.

3.4.5.1. Description of the Affected Environment for Commercial Fisheries and For-Hire Recreational Fishing

Regional Setting

Commercial Fishing

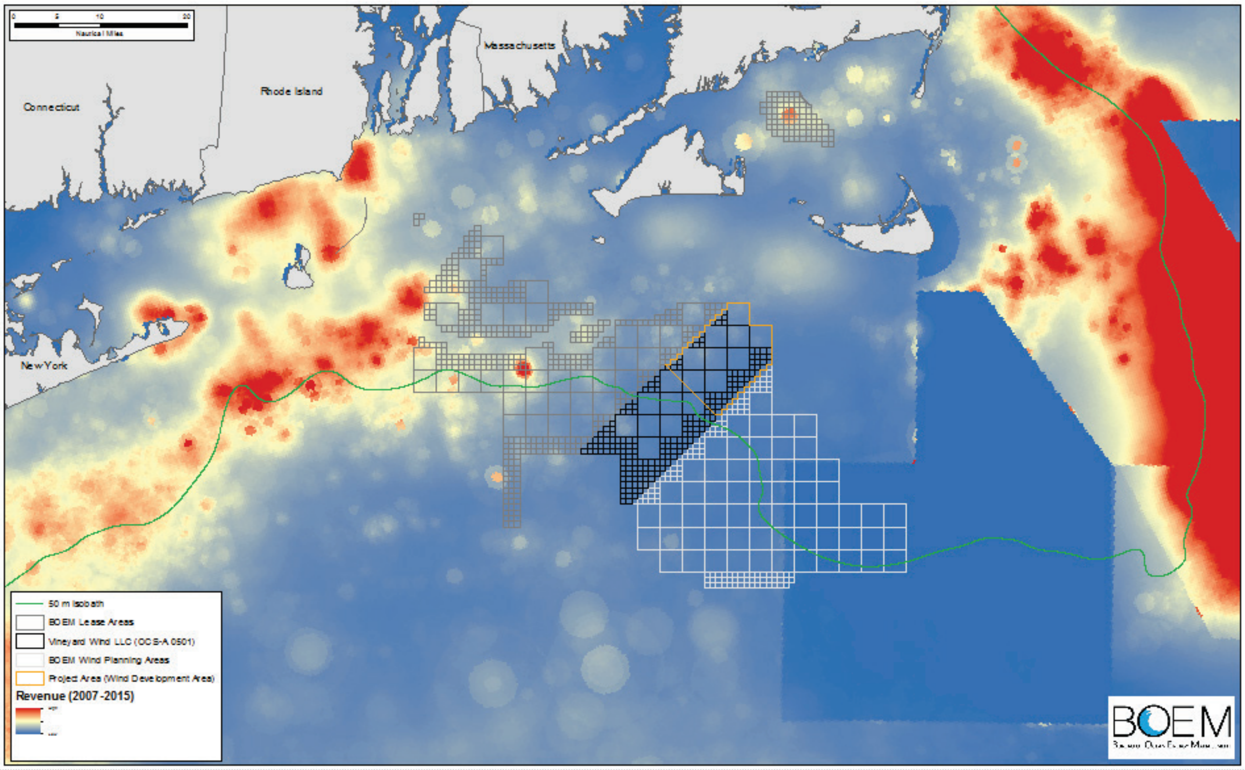
The fisheries resources in federal waters off New England provide a significant amount of revenue. New Bedford, Massachusetts has consistently been the highest value producing U.S. fishing port (NOAA 2018k). In 2016, at the New Bedford port, commercial fishing landed more than 106.6 million pounds of products valued at $326.5 million (NOAA 2016b). Point Judith, Rhode Island, landed 53.4 million pounds in 2016, valued at $55.7 million. Table 3.4.5-1 lists the value and volume of landings of selected regional ports. The regional setting extends primarily over the fishing ports and waters in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, although vessels from other ports may occasionally operate in the area. Commercial vessels active in the Vineyard WLA and the WDA may be homeported and/or land product in ports in those states.

Table 3.4.5-1: Value and Volume of Commercial Fishery Landings by Port (2014-2016; ranked by millions of 2016 dollars)

National Rank	Port	2014		2015		2016	
		Volume (pounds)	Revenue	Volume (pounds)	Revenue	Volume (pounds)	Revenue
1	New Bedford, MA	140.0	$328.8	123.8	$321.9	106.6	$326.5
15	Point Judith, RI	57.3	$50.4	46.2	$46.2	53.4	$55.7
18	Gloucester, MA	61.4	$45.8	67.7	$44.4	63.4	$52.4
33	Provincetown-Chatham, MA	20.0	$29.0	21.2	$30.6	26.5	$32.8
51	Fairhaven, MA	6.4	$16.9	5.8	$17.8	3.9	$21.8
68	Montauk, NY	11.8	$16.9	11.6	$15.9	11.8	$16.3
74	North Kingstown, RI	21.3	$11.2	16.1	$11.1	17.6	$13.7
92	Newport, RI	6.4	$6.8	8.3	$7.5	6.6	$8.0

Source: NOAA 2016b, 2016c

Regional commercial fisheries are known for the large landings of herring, menhaden, clam, squid, scallop, skates, and lobster, and for being a notable source of profit from scallop, lobster, clam, squid, and other species (NOAA 2016b). Figure 3.4.5-1 shows fishing revenue intensity in the region around the WDA; the fishing revenue is for all federally managed fisheries aggregated for the years 2007-2015. Commercial fisheries obtained the greatest concentration of revenue from around the 164-foot (50-meter) contour off Long Island and George’s Bank. NMFS has excluded mobile gear fishing in parts of George’s Bank for fish stock rebuilding. Moderate revenue fishing areas (yellow in Figure 3.4.5-1) are apparent within and in the vicinity of the WDA. Chart plotter data submitted by commercial vessels targeting squid and whiting reflects fishing in these areas. To better understand the importance of different gear types, the sections below provide an in-depth analysis by FMP within both the MA WEA and WDA.



Note: Based on federally reported vessel trip reports and conversion by Northeast Fisheries Science Center (G. DePiper, Pers. Comm., August 2016); top 5 percent of revenue clipped to lessen high-value scallop revenue skew of regional revenue.

Figure 3.4.5-1: Fishing Intensity Based on Average Annual Revenue for Federally Managed Fisheries (2007-2015)

Economic Importance

The commercial fishing fleets contribute to the overall economy in the region through direct employment, income, and gross revenues, as well as through products and services to maintain and operate vessels. In 2015, commercial fisheries in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey created 61,865 jobs, generated $2,761 million in sales, and contributed $1,380 million in value added (gross domestic product; NOAA 2017a). In Massachusetts, of the 52,710 jobs created, commercial harvesters held 10,923 and retail created 39,323, with the remaining in seafood processing (1,509) and seafood wholesaling and distribution (955). Further, commercial harvesters received $302.5 million in income, retailers $369.6 million, seafood processors $83.1 million, and seafood wholesalers and distributors $55.2 million. In Rhode Island, of the 4,522 jobs created, 2,016 were held by commercial harvesters and 2,107 were created in retail, with the remaining in seafood processing (284) and seafood wholesaling and distribution (115); commercial harvesters generated $42.5 million in income (NOAA 2017a).

Massachusetts Wind Energy Area and Vineyard Wind Lease Area

The Vineyard WLA is located in the MA WEA[24] (Figure 1.1-1); the following analysis starts at the larger MA WEA and then narrows down to the lease area. An analysis at the WDA level, which is in the northern part of the WLA, is included later in this appendix. As shown in Table 3.4.5-2, the NOAA Northeast Fisheries Science Center (NOAA NFSC) identified the top ports where vessels caught fish within the MA WEA: Warren, Tiverton, Little Compton, and Point Judith in Rhode Island; Montauk, New York; and New Bedford, Massachusetts (Kirkpatrick et al. 2017). In general, smaller ports located near a WEA tend to have a larger share of total revenue harvested in a WEA, but often represent a relatively smaller proportion of the total landed revenue. For example, New Bedford had average annual revenues of more than $1.4 million within the MA WEA, but that represents only 0.5 percent of the port's total landed revenue. By contrast, the much smaller port of Tiverton, Rhode Island obtained 7.7 percent of its revenue from within the MA WEA.

[24] The MA WEA analyzed constitutes the Bay State Wind and Vineyard Wind leases, plus areas slated for lease sale at the time of this Draft EIS. It does not include the export cable route.

Table 3.4.5-2: Top Commercial Fishing Ports that Harvested within the MA WEA (2007-2012)

	Average Annual Revenue from MA WEA	Share of Total Revenue Harvested in the MA WEA Compared to Total Port Revenue
Tiverton, RI	$64,543	7.7%
Little Compton, RI	$59,391	3.4%
Point Judith, RI	$666,623	2.1%
Montauk, NY	$211,825	1.3%
New Bedford, MA	$1,416,869	0.5%

Source: Kirkpatrick et al. 2017
Note: Warren, RI, not listed due to confidentially considerations (i.e., fewer than three vessels)

The Rhode Island Department of Environmental Management (RI DEM) used a Vessel Monitoring System (VMS) analysis to identify five landing ports that used the Vineyard WLA (Livermore 2017).[25] The RI DEM analysis (Table 3.4.5-3) also shows the variability in catch over time, as Port Judith landings varied from just over $53,000 in 2014 to more than $1.1 million in 2012, which coincides with a peak year for the squid industry that is primarily based in that port.[26] This information matches Point Judith- and Montauk-based vessel chart plotter data regarding the use of this area (NOAA 2018n). The RI DEM analysis also identified the ports of New Bedford and Point Judith as having relatively higher value of landings from the Vineyard WLA. More details about commercial fishing ports are available in the COP Volume III, Section 7.6 (Epsilon 2018a).

Table 3.4.5-3: Value of Port Landings Harvested from the Vineyard WLA, 2011-2016

Port	2011	2012	2013	2014	2015	2016
Chatham, MA	C	C	$37,210	$97,471	$21,322	$65,332
Montauk, NY	$9,028	$117,822	$25,834	C	C	C
New Bedford, MA	$215,068	$615,914	$512,301	$884,508	$177,390	$37,783
New London, CT	0	C	C	C	C	$5,011
Point Judith, RI	$243,604	$1,104,900	$181,732	$53,159	$245,188	$54,498

Source: Livermore 2017
Notes: (C) = confidential landings (fewer than three vessels). Total confidential landings are $451,469.80 (i.e., the sum of all Cs in the table). The following ports were also considered; however, the data were either confidential (i.e., fewer than three separate contributors to the data) or there were no landings in those ports from the Vineyard WLA: Barnegat Light, NJ; Belford, NJ; Boston, MA; Cape May, NJ; Gloucester, MA; Hampton Bays, NY; Harwich Port, MA; Little Compton, RI; Mystic, CT; Newport, RI; North Kingstown, RI; Point Pleasant, NJ; Providence, RI; Provincetown Wharf, MA; Shinnecock Reservation, NY; Stonington, CT; Wakefield, RI; Westport, MA; and Woods Hole, MA.

Based on the RI DEM VMS analysis (Livermore 2017), bottom trawl, dredge, and gill net represent the primary gear types deployed in the Vineyard WLA (Table 3.4.5-4). This is consistent with the NOAA NFSC assessment at the MA WEA level (Kirkpatrick et al. 2017). This study found that most dredge revenue is landed in Massachusetts or Rhode Island, while most bottom trawl revenue is landed in Rhode Island, along with Montauk, New York. Most gill net revenue from the MA WEA is landed in Massachusetts, primarily in New Bedford, but also in Chatham and Fairhaven. Midwater trawl use is heavier in the MA WEA relative to other WEAs, but total revenue sourced by this gear is still less than 1 percent of the total landings of that gear type.

Table 3.4.5-4: Value of Landings Caught by Each Gear Type within the Vineyard WLA, 2011-2016

Gear	2011	2012	2013	2014	2015	2016
Dredge, Scallop	C	C	$860,813	$487,985	$123,481	$42,930
Gill Net, Sink	$67,574	$72,631	$105,557	$48,132	$21,448	$41,888
Otter Trawl, Bottom	$1,971,065	$114,507	$110,062	$258,652	$321,660	$436,298

Source: Livermore 2017
Notes: (C) = confidential landings (fewer than three vessels). Total confidential landings are $114,792. The following gear types were also considered; however, the data were either confidential for all years (i.e., fewer than three vessels) or there were no landings from the Vineyard WLA: dredge, ocean quahog/surfclam; otter trawl, bottom, shrimp; and pair trawl, midwater.

[25] The VMS monitors the movement of commercial fishing vessels and helps to characterize the density of commercial fishing activity. The analysis was based on VMS data within WEAs in southern New England; data may underrepresent the value of harvest, as not all FMPs require the use of VMS. In addition, VMS data for the squid fishery is very sparse as VMS was only required for squid vessels starting in 2014 and did not have full coverage in 2017. In general, VMS as a source of location data underrepresents fishing activity, and therefore revenue, for many fisheries in a particular area.

[26] Note: VMS was not required until 2014 for squid vessels.

Table 3.4.5-5 shows the average revenue exposed to the MA WEA, which is less than 4 percent of total landed revenue for all FMPs. Exposure is defined as the *potential* for an impact from WEA development if a harvester opts to no longer fish in the area and cannot capture that income in a different location. Revenue exposure does not account for mitigation measures nor the potential for continued fishing to occur. Therefore, the exposure measures presented here do not measure economic impact or loss. Rather, they set the foundation for the impact analysis by identifying the total dollar value that may theoretically be impacted. However, in characterizing potential impacts, BOEM has looked at several sources of data including both satellite derived (VMS) data and vessel logbook derived (Vessel Trip Report) data. When Kirkpatrick et al. (2017) is analyzed alongside other data sources, such as the RI DEM study (Livermore 2017), input from industry on their use of the area, and VMS from regional planning body data portals, the data form the best available science for characterizing commercial fishing in the proposed Project area. See a discussion of data limitations in COP Volume III, Section 7.6.2.1 (Epsilon 2018a).

Table 3.4.5-5: Average Revenue by Fisheries Management Plan Harvested within the MA WEA (2007-2015)

FMP	Revenue Harvested from MA WEA	Average Annual Revenue from MA WEA	Share of Total Revenue Harvested from MA WEA
Mackerel, Squid, Butterfish	$3,049,550	$338,839	0.9%
Surfclam/Ocean Quahog	$7,221,868	$802,430	1.3%
Summer Flounder, Scup, Black Sea Bass	$2,077,677	$230,853	0.7%
Northeast Multispecies	$1,382,447	$153,605	1.5%
Sea Scallop	$1,518,370	$168,708	0.0%
Skate	$1,822,790	$202,532	2.4%
Monkfish	$2,688,270	$298,697	1.6%

Data Source: G. DePiper, Pers. Comm., August 2016

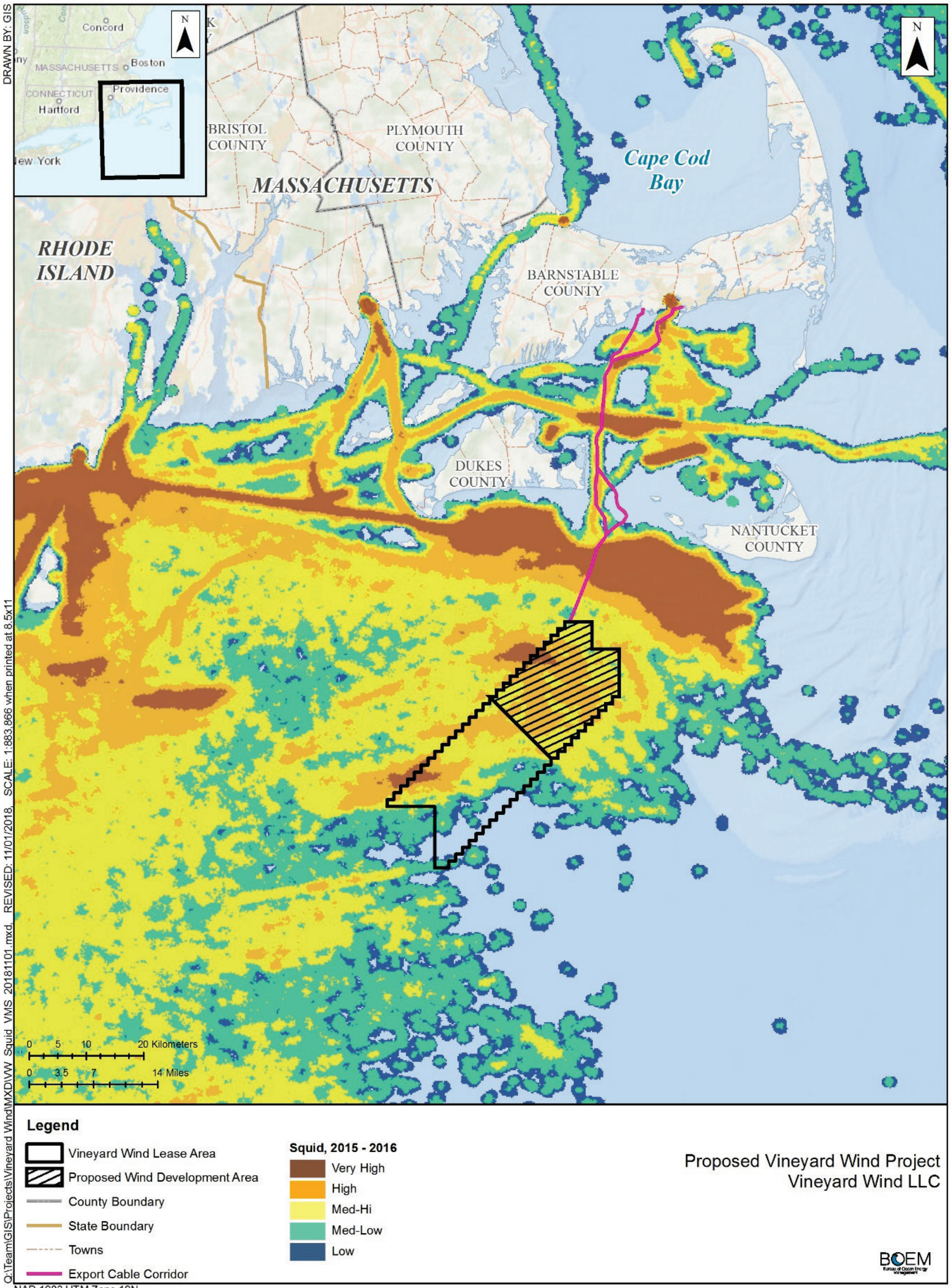
NMFS has indicated that other important species in the area include Atlantic cod, Atlantic mackerel, windowpane flounder, and whiting (*Merlangius merlangus*). Data gaps may exist for fisheries that can opt out of VMS reporting, such as whiting, butterfish, fluke, scup, black sea bass, and red hake. Squid and mackerel fishing's VMS requirements started in 2014. The RI DEM analysis by Livermore (2017) identified key species harvested within Vineyard's WLA (in terms of value) as squid, mackerel, butterfish FMP and sea scallop (Table 3.4.5-6). These FMPs show significant annual variation, which fits with the dynamic nature of fisheries. Scallop had peak years in 2011 and 2015, while the squid, mackerel; the butterfish FMP had a peak year in 2016, with more than $1.37 million caught within Vineyard WLA (Livermore 2017). Comparison of VMS data in 2015-2016 shows intensive use of the area for squid fishing (Figure 3.4.5-2).

Table 3.4.5-6: Value of Landings of Each Species (or Grouped Species in a Shared FMP) Caught within the Vineyard WLA, 2011-2016

Species or FMP	2011	2012	2013	2014	2015	2016
Bluefish FMP	$141	$1,054	$1,199	$1,167	$976	$1,018
Dogfish, Smooth	$33	$270	—	C	C	$369
Dogfish, Spiny	$387	$20	$1,247	$498	C	$258
Dory, American John	C	$230	C	$312	C	C
Monkfish FMP	$44,620	$28,287	$58,723	$107,314	$20,690	$50,280
Northeast Multispecies FMP	$7,844	$23,754	$8,467	$7,481	$77,026	C
Northeast Small Mesh Multispecies FMP	$105,568	$144,312	$54,234	$61,118	$95,737	$473,310
Sea Scallop FMP	$486,967	$42,904	C	$860,827	$123,921	$3,768
Skate FMP	C	$18,529	$14,798	C	$8,983	$21,790
Squid Mackerel Butterfish FMP	$111,097	$132,060	$19,930	$21,504	$65,001	$1,371,305
Summer Flounder, Scup, Black Sea Bass FMP	$29,096	$129,631	$28,643	$14,868	$74,051	$132,282

Source: Livermore 2017

Notes: (C) = confidential landings (fewer than three vessels) and (—) = no landings. Total confidential landings are $49,605.36 (i.e., the sum of all Cs in the table). The following species/FMPs were also considered; however, the data were either confidential for all years (i.e., fewer than three vessels) or there were no landings from the Vineyard WLA: bonito, Atlantic; cunner; conger eel; fourspot flounder; hake, spotted; Atlantic halibut; spot; tautog; swordfish, sea robins, and blueline tilefish.



Source: Northeast Ocean Data 2018

Figure 3.4.5-2: Squid Fishing Intensity Based on VMS Data (2015-2016)

NOAA NEFSC also identified that more than $280,000 of lobster pot gear revenue comes from within the MA WEA, which is primarily landed in Massachusetts (Kirkpatrick et al. 2017). After scallops, the state's second most valuable fishery is lobster, which has annual average landings of approximately $61 million. Much of the southern New England lobster fleet has transitioned to a mixed crustacean fishery targeting both Jonah crabs and lobsters (ASMFC 2018c). Comments during scoping of this Draft EIS indicated that a majority of lobster effort is west of the proposed Project area (see Figure 3.4.5-4).

Wind Development Area[27]

BOEM analyzed an expanded data set including two additional years (G. DePiper, Pers. Comm., August 2016) that is isolated to federally permitted commercial fishing activity within the WDA. Figure 3.4.5-3 shows that commercial fisheries harvested $3.37 million in revenue in the mackerel/squid/butterfish FMP and surfclam/ocean quahog FMP over an 11-year period. When looking at the value of the catch within the WDA as a percentage of an FMP's total revenue, the greatest use was from the northeast multispecies (small mesh) FMP and mack/squid/butterfish FMP, but they are both less than 0.5 percent of their total respective FMPs.

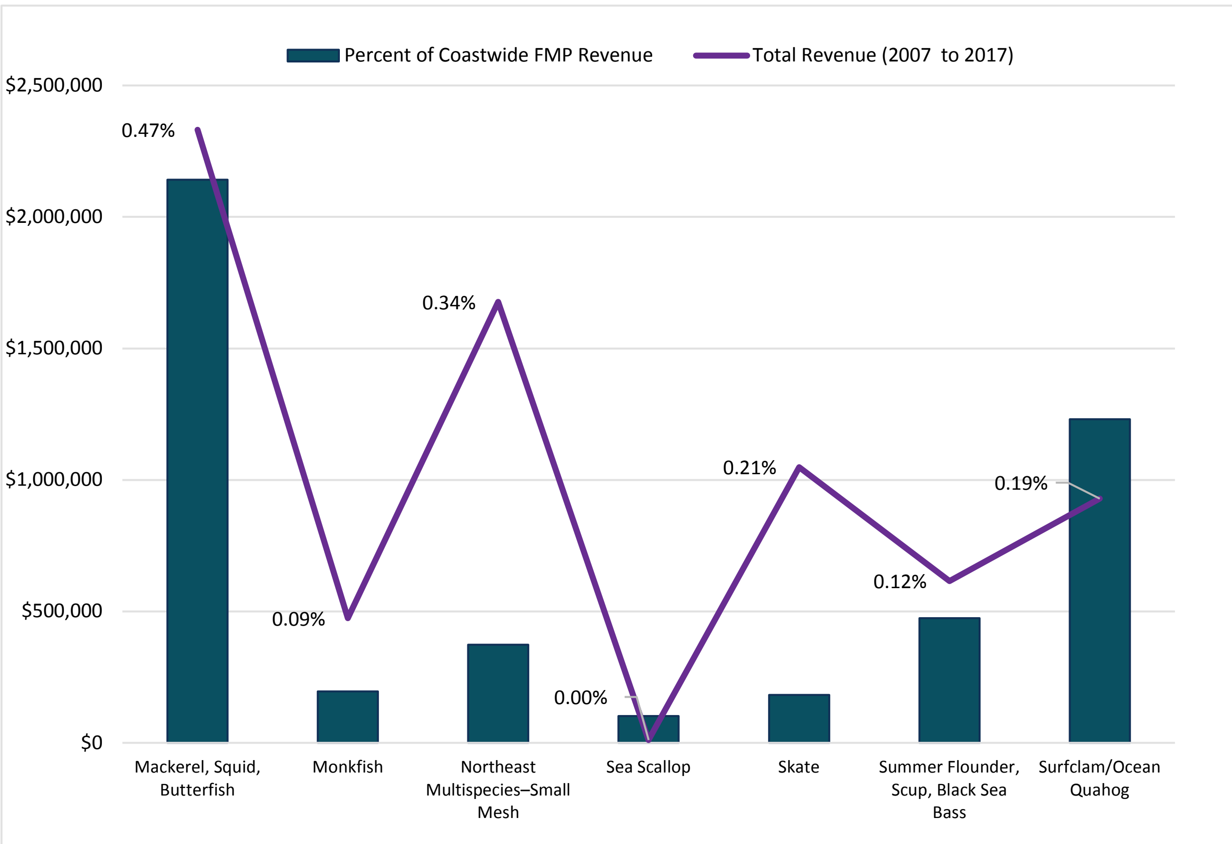


Figure 3.4.5-3: Revenue from Harvests within the WDA by Various Fisheries Management Plans (2007-2017)

Tables 3.4.5-7a and 3.4.5-7b show the annual value of landings for Vineyard Wind WDA for the top seven FMPs during that same timeframe. There has been substantial variability in the year-to-year harvest of various species in the WDA. The following sections look more in-depth at the top FMPs that the proposed Project would potentially impact.

[27] The WDA encompasses 45.3 percent of the entire Vineyard WLA and 10.2 percent of the MA WEA.

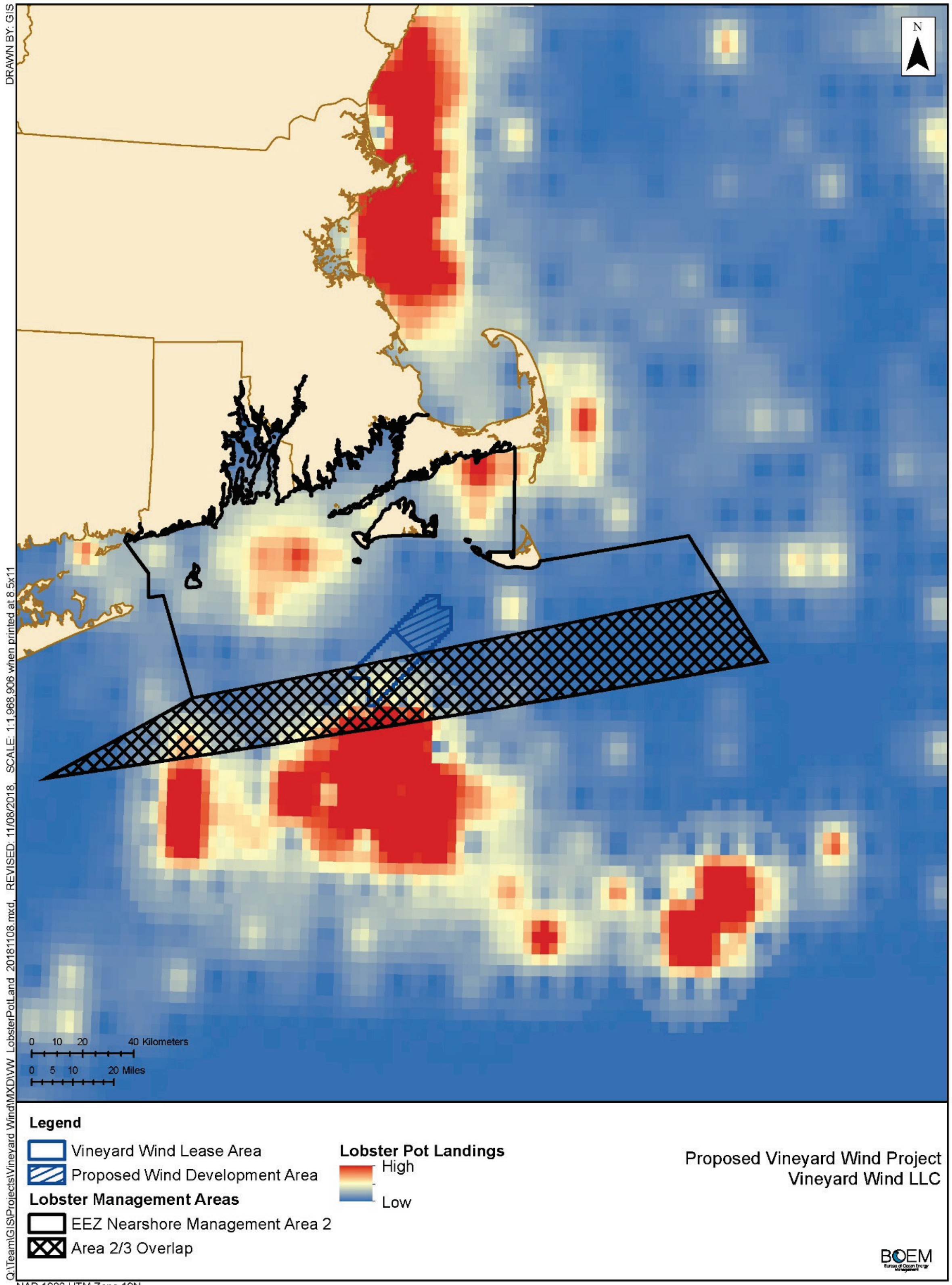


Figure 3.4.5-4: Lobster Pot Landings 2001-2010

Table 3.4.5-7a: Value of Landings by Fisheries Management Plan for the WDA, 2007-2017

FMP	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mackerel, Squid, Butterfish	$10,876	$146,010	$124,961	$34,247	$108,695	$151,816	$91,875	$187,815	$224,636	$932,616	$128,183
Monkfish	$23,143	$4,738	$4,741	$16,189	$32,808	$45,118	$17,120	$11,795	$10,296	$21,576	$8,232
Northeast Multispecies–Small Mesh	$30,823	$39,655	$74,015	$21,326	$27,491	$24,468	$29,709	$26,341	$25,560	$33,294	$40,813
Sea Scallop	$11,735	$21,855	$10,704	$4,879	$3,745	$7,775	$1,680	$2,787	$6,719	$26,780	$3,300
Skate	$43,850	$15,381	$18,880	$18,524	$32,957	$10,236	$15,839	$8,284	$4,037	$11,126	$3,381
Summer Flounder, Scup, Black Sea Bass	$26,409	$3,839	$11,855	$12,890	$26,131	$30,603	$59,151	$48,129	$91,636	$90,987	$72,393
Surfclam/Ocean Quahog	$310,099	$268,700	$294,982	$139,873	$47,429	$5,870	$19,198	$8,598	$16,337	$109,162	$10,617
Grand Total	$456,935	$500,178	$540,137	$247,928	$279,257	$275,886	$234,572	$293,750	$379,221	$1,225,542	$266,918

Table 3.4.5-7b: Landings by Fisheries Management Plan for the WDA as a Percentage of Total Coastwide FMP, 2007-2017

FMP	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mackerel, Squid, Butterfish	0.02%	0.35%	0.31%	0.10%	0.26%	0.35%	0.29%	0.52%	0.61%	1.62%	0.24%
Monkfish	0.09%	0.02%	0.03%	0.11%	0.16%	0.23%	0.10%	0.07%	0.06%	0.11%	0.05%
Northeast Multispecies–Small Mesh	0.27%	0.42%	0.71%	0.18%	0.25%	0.25%	0.35%	0.25%	0.26%	0.33%	0.50%
Sea Scallop	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
Skate	0.44%	0.20%	0.27%	0.23%	0.45%	0.14%	0.14%	0.08%	0.06%	0.18%	0.06%
Summer Flounder, Scup, Black Sea Bass	0.07%	0.01%	0.04%	0.04%	0.08%	0.09%	0.16%	0.13%	0.24%	0.24%	0.20%
Surfclam/Ocean Quahog	0.39%	0.39%	0.44%	0.23%	0.09%	0.01%	0.04%	0.02%	0.03%	0.19%	0.02%

Data source: G. DePiper, Pers. Comm., August 2016
FMP = Fisheries Management Plan; WDA = Wind Development Area

Summer Flounder, Scup, Black Sea Bass Fishery Management Plan

Summer flounder is most often landed January to September, with the peak in June through August. Three periods comprise the scup's quota. In spring and summer, scup migrate to northern and inshore waters to spawn. Black sea bass typically has peak harvest June through September. Between 2007 and 2017, annual commercial fishing revenue estimated from the WDA ranged from less than $4,000 to approximately $90,000.

Atlantic Mackerel, Squid, Butterfish Fishery Management Plan

The FMP covers longfin and illex squid, which make up the majority species landed in this FMP. Bottom and mid-water trawling account for most landings (ASMFC 2018b). As shown in Figure 3.4.5-2, there was variable density in vessels targeting squid throughout the WDA with patches of medium-low to medium-high density, and an area of very high density along the OECC. Eight out of the 11 years analyzed had over $100,000 but less than $300,000 in revenue from this FMP derived from the WDA, peaking at $932,616 in 2017. Based on VMS data and the RI DEM analysis, 2016 also was a high revenue year ($1 million for the entire lease area) and around the WDA, but with higher activity densities also seen north of the WDA.

Surfclam and Ocean Quahog Fishery Management Plan

As shown in Figure 3.4.5-5, VMS data for surfclam/ocean quahog is not typically targeted within the WDA; however, along the OECC there were areas where very high density was recorded. Surfclams are harvested principally via hydraulic dredging. The harvest of surfclam and ocean quahog in the WDA provided a high value of landings prior to 2011; however, since the harvest has substantially decreased in the WDA, valued at only $16,337 in 2015, increasing to $109,162 in 2016 and down to $10,617 in 2017.

Sea Scallop Fishery Management Plan

Sea scallop FMPs had medium-low or medium-low to medium-high VMS density in the WDA, and higher VMS density (up to high) along the OECC (Figure 3.4.5-6). Dredges are the primary fishing gear.

Offshore Export Cable Corridor

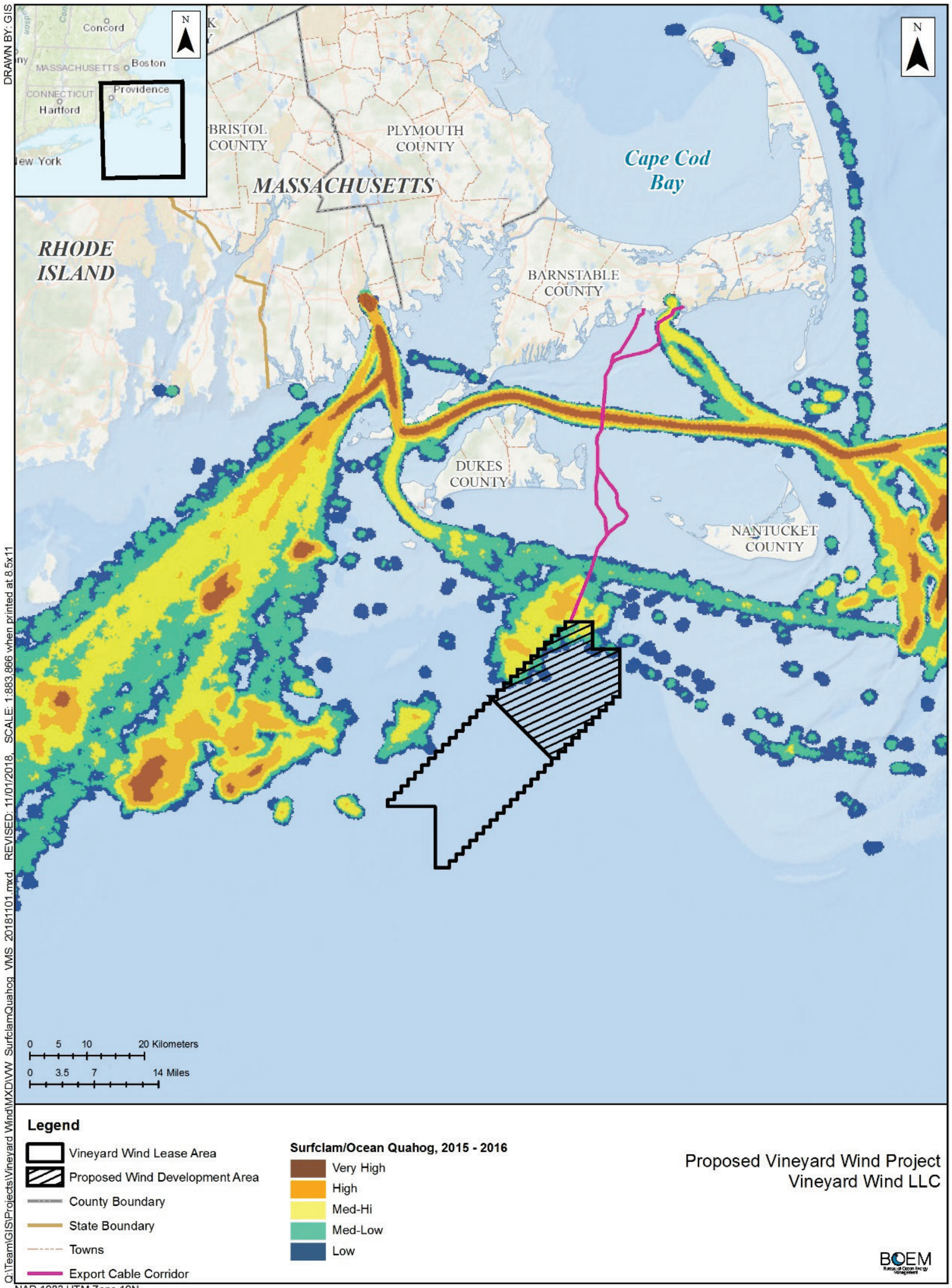
It is more challenging to quantitatively characterize fishing along OECC because it is a linear feature. In addition, fewer impacts are expected along the OECC due to the relatively narrow area being potentially disturbed. As shown on Figures 3.4.5-2, 3.4.5-5 and 3.4.5-6, the OECC intersects areas with high vessel density for fishermen targeting squid, surfclams/ocean quahogs and sea scallops. In addition, as shown in Figure 3.4.5-7, part of the OECC within state waters intersects an area of "high commercial fishing effort and value" identified in the Massachusetts Ocean Management Plan (MA EEA 2015). There is also low, medium-low to medium-high vessel density along the OECC, whereas vessel density in the WDA is characterized as low (Figures 3.4.5-8 and 3.4.5-9).

Massachusetts State-Regulated Fisheries

The MA DMF Draft Environmental Impact Report indicates that the OECC would pass through areas of commercial and recreational fishing and habitat for a variety of invertebrate and finfish species, including channeled whelk (*Busycotypus canaliculatus*), knobbed whelk (*Busycon carica*), longfin squid (*Doryteuthis pealeii*), summer flounder, windowpane flounder, scup, surfclam (*Spisula solidissima*), sea scallop, quahog (*Mercenaria mercenaria*), horseshoe crabs, and blue mussel (*Mytilus edulis*) (Epsilon 2018b).

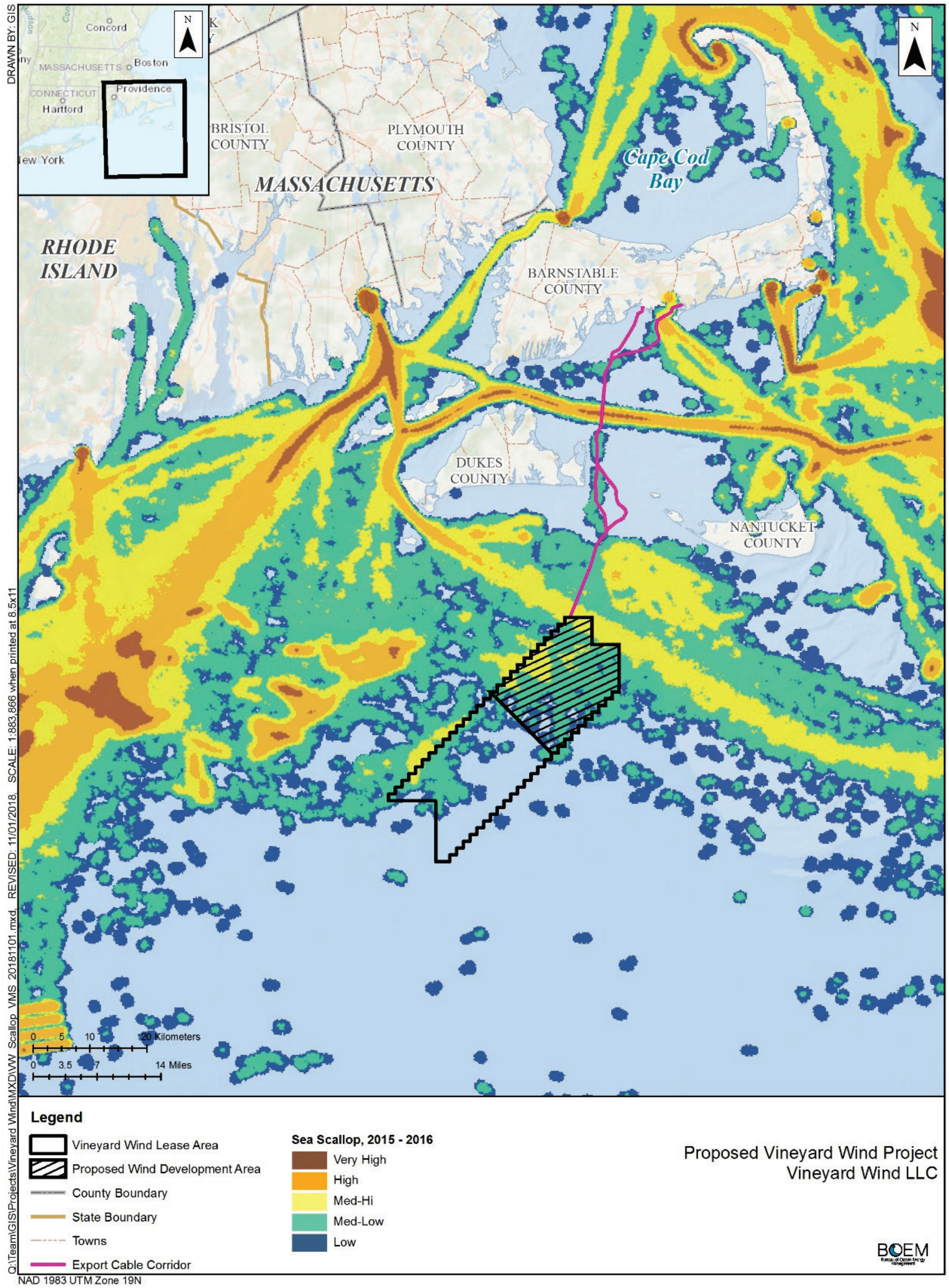
Blue mussel and kelp (*Saccharina latissima*) aquaculture operations are also located within Horseshoe Shoals (a subtidal area of Nantucket Sound) (Epsilon 2018b). Existing aquaculture operations lie near the southern portion of Horseshoe Shoals, near the Main Channel of Nantucket Sound. However, this is more than 4 nautical miles from the OECC. The project is not anticipated to impact leased aquaculture sites.

Fishing for whelk, often referred to locally as conch, is done from Horseshoe Shoals and other areas in Nantucket Sound. This fishery was valued at $4.8 million in 2016. Although this is a relatively new fishery that did not become heavily exploited until the early 2010s, signs indicate that the stocks are vulnerable to overfishing and may already be overfished. This fishery operates entirely within state waters, with a plurality of the total catch being taken from Nantucket Sound (Nelson et al. 2018).



Source: Northeast Ocean Data 2018

Figure 3.4.5-5: Surfclam/Ocean Quahog Fishing Intensity Based on VMS Data (2015-2016)



Source: Northeast Ocean Data 2018

Figure 3.4.5-6: Sea Scallop Fishing Intensity Based on VMS Data (2015-2016)

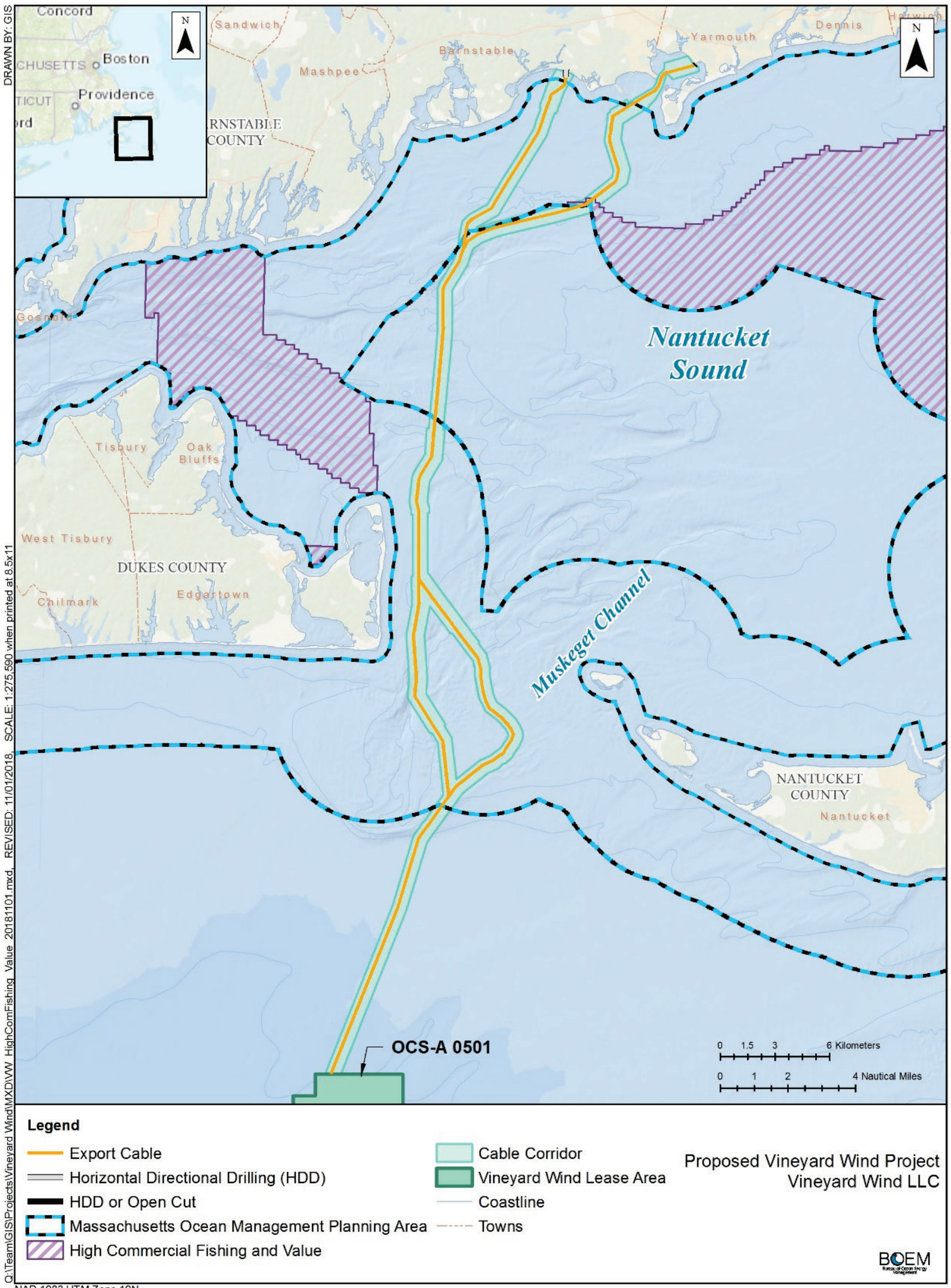
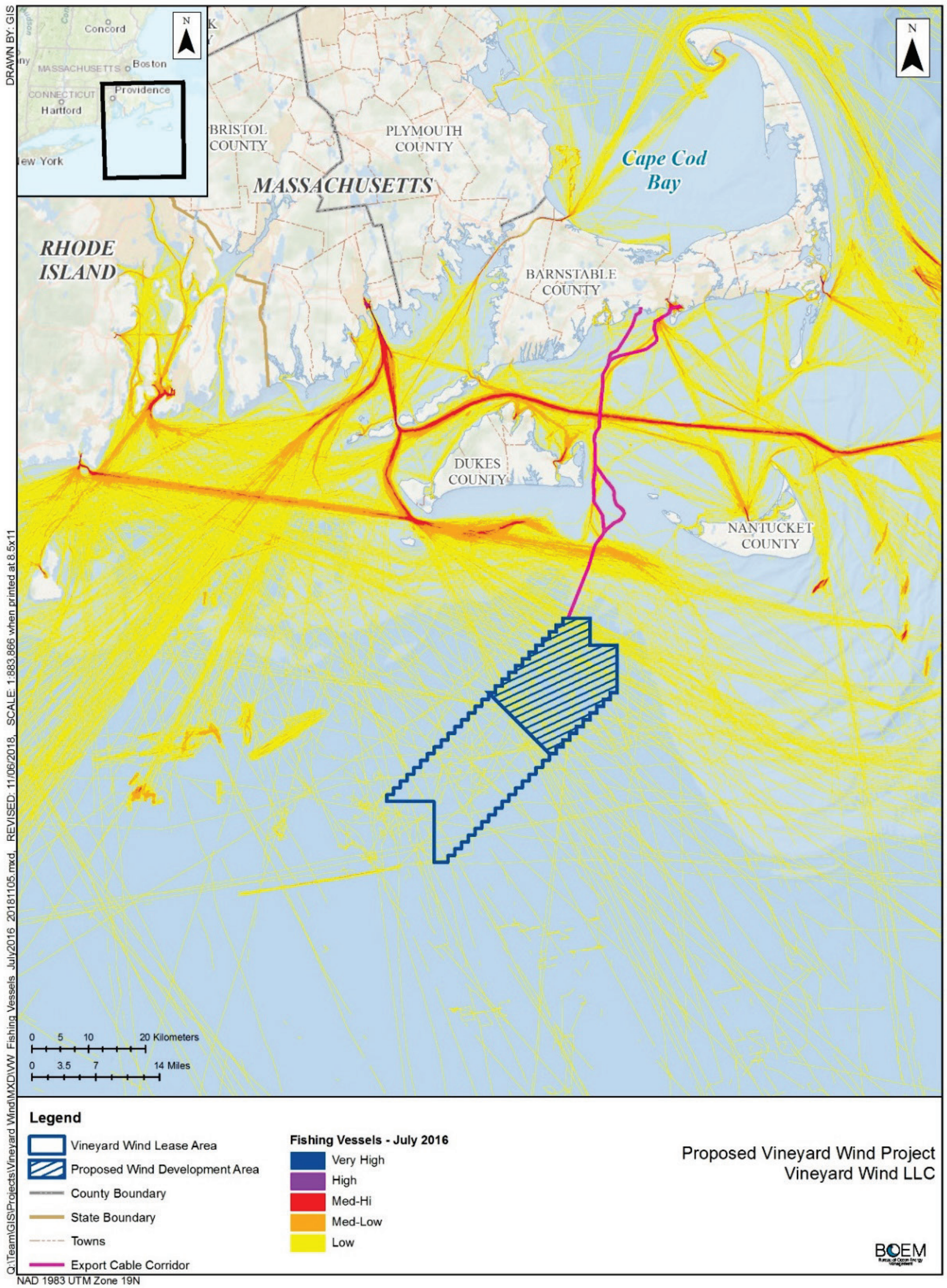
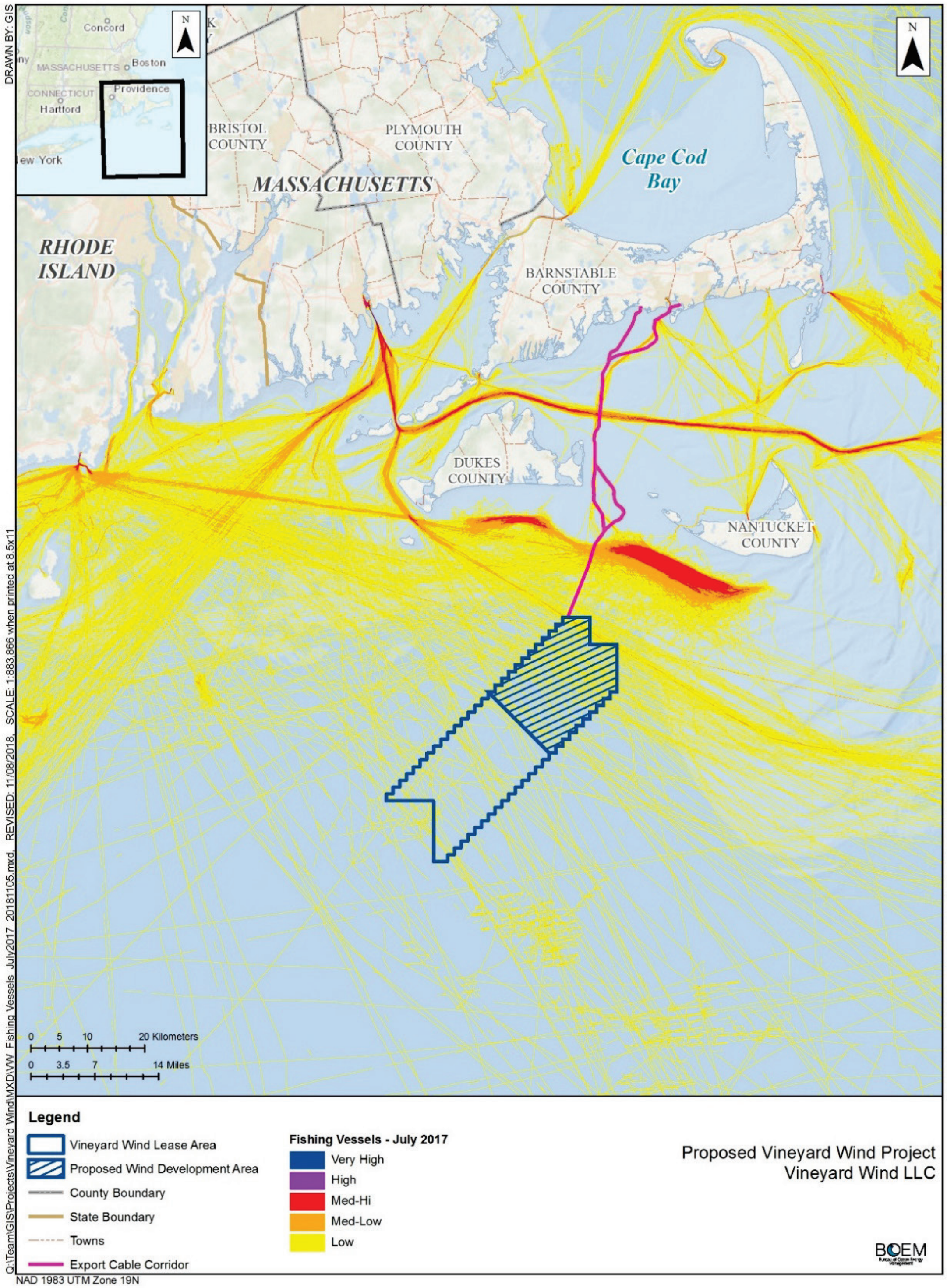


Figure 3.4.5-7: Massachusetts Ocean Management Plan Areas of High Commercial Fishing Effort and Value



Source: Northeast Ocean Data 2018

Figure 3.4.5-8: Fishing Monthly Vessel Transit Counts from 2016 AIS Northeast and Mid-Atlantic (July 2016)



Source: Northeast Ocean Data 2018

Figure 3.4.5-9: Fishing Monthly Vessel Transit Counts from 2017 AIS Northeast and Mid-Atlantic (July 2017)

The lobster fishery in Massachusetts is the most lucrative fishery harvested within the state's waters, but it is now in a depleted condition (Dean 2010; MA DMF 2017). Despite the reduced landings (17.6 million pounds in 2016), rising prices bolster the fishery's value, which was more than $82 million in 2017 (MA DMF 2017). Recently, there has been very little lobster catch from nearshore waters south of Cape Cod; therefore, most vessels from this area now venture far offshore to target lobster in deeper waters (Dean 2010; MA DMF 2017; Abel 2017).

Horseshoe crab spawning areas are associated with Covell's Beach and Great Island Beach (Epsilon 2018b). This fishery, while significant to the state, is patchy and variable from year to year. Although most of the catch comes from Cape Cod Bay, some minor fishing occurs in Nantucket Sound and near the islands of Nantucket and Martha's Vineyard (Perry 2017; Burns 2018).

Lewis Bay supports a variety of marine resources including eelgrass, winter flounder, horseshoe crabs, and shellfish. Sections of the Lewis Bay shoreline are mapped soft shell clam, American oyster (*Crassostrea virginica*), and quahog habitat. Oyster aquaculture grants are present along the eastern shoreline. Bay scallop habitat and seasonal bay scallop fisheries occurs in most of Lewis Bay. Surfclam habitat and patchy eelgrass beds occur in waters offshore of Covell's Beach.

For Hire Recreational Fishing

For-hire recreational fishing is also an important economic sector regionally with peak activity June through August (NOAA 2017c). Regionally in 2015, the industry created 2,232 jobs, generated $326 million in sales, and contributed $192 million in value added. The Marine Recreational Information Program data show that mackerels, cod, and striped bass were the most-caught species within the Massachusetts for-hire recreational fishery. Black sea bass, scup, striped bass, summer flounder, and tautog were the most-caught species within the Rhode Island for-hire recreational fishery (NOAA 2017b).

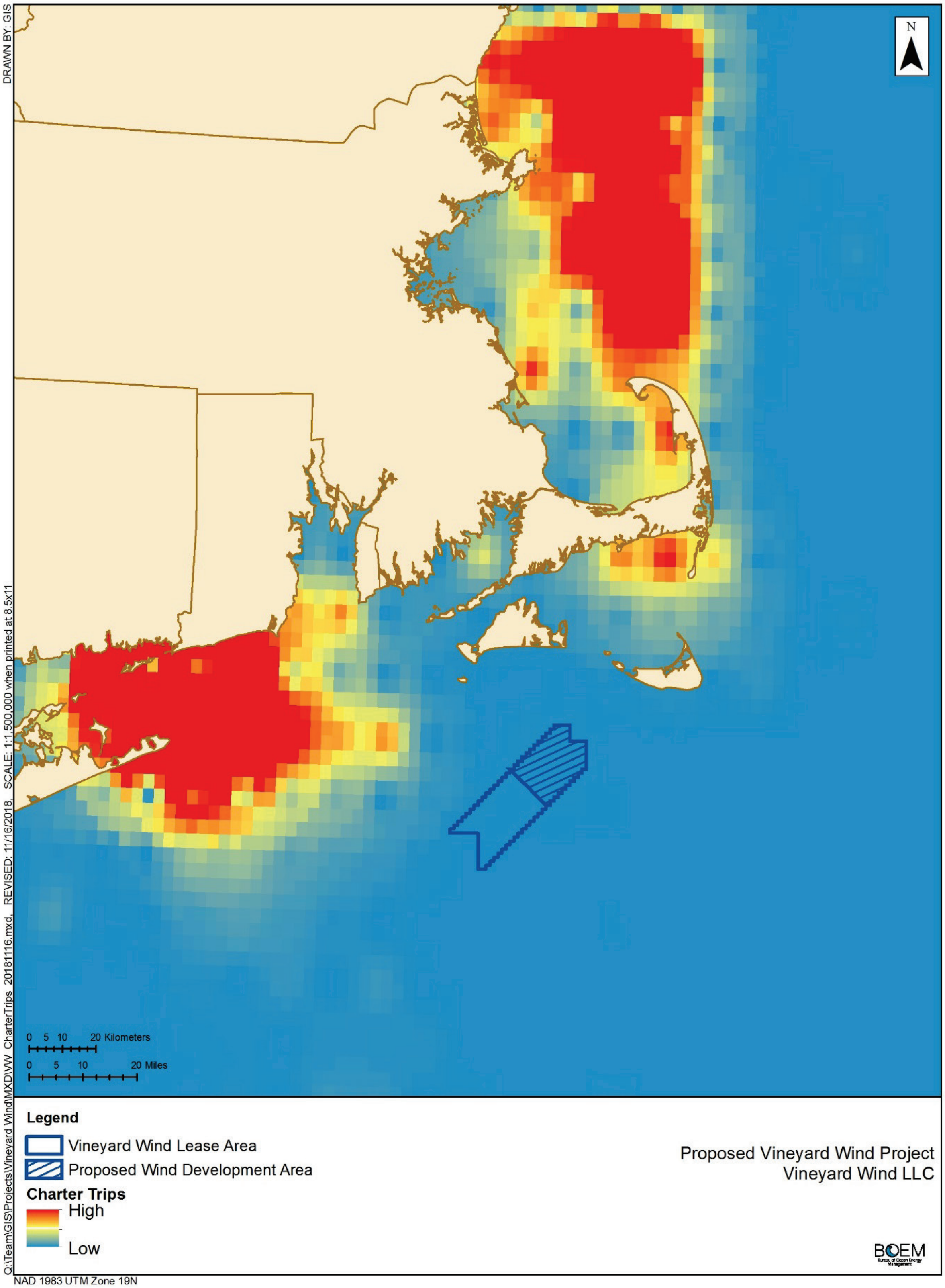
In 2017, there were 128,453 party- and charter-boat fishing trips out of Massachusetts and 33,289 out of Rhode Island. However, there is substantial variability year to year with as few as 49,969 trips in 2016 from Massachusetts. Based on the number of trips over the past 10 years, there are on average 115,500 party- and charter-boat fishing trips per year out of Massachusetts and 41,100 out of Rhode Island (NOAA 2017c). On average, party and charter boats account for 14 percent of all recreational boats off the coast of Massachusetts and 9 percent off the coast of Rhode Island (NOAA 2017c). As shown in Figure 3.4.5-10, the most recent refined charter boat data available shows that a majority of vessel activity is near shore. NOAA estimated that 97 percent of the 2011 recreational effort from Massachusetts occurred within 3 nautical miles of shore (BOEM 2012c).

The highest density of recreational vessels is reported within Nantucket Sound and within 1 nautical mile of the coastline (COP Appendix III-I, Section 4.2; Epsilon 2018a). Table 3.4.5-8 shows the average annual for-hire recreational fishing boat trip based on federally reported vessel trip reports that come within 1 nautical mile of the MA WEA (i.e., exposed). NOAA NFSC found only about 0.2 percent of for-hire boat trips from Massachusetts, New Hampshire, New York, and Rhode Island were near the MA WEA (Kirkpatrick et al. 2017).

Table 3.4.5-8: Average Annual For-Hire Recreational Trips within 1 Mile of MA WEA, 2007–2012

Port Group	Exposed For-Hire Boat Trips
Barnstable, MA	2
Falmouth, MA	1
Nantucket, MA	1
Oak Bluffs, MA	1
Onset, MA	1
Montauk, NY	16
Narragansett, RI	8
South Kingstown, RI	2
Westerly, RI	1

Source: Kirkpatrick et al. 2017



Source: BOEM 2012c

Figure 3.4.5-10: Vessel Trip Report Data for Charter Vessels (2001-2010)

Popular recreational fishing areas include "The Dump" in the southern end of the MA WEA adjacent to the WDA, where recreational vessels harvest yellowfin tuna, albacore tuna, and mahi. Other recreational fishing locations include "The Owl," "The Star," and "Gordon's Gully" in the WDA, and the "FM Hole" in the Vineyard WLA (see Salty Cape 2018 for relative locations; see also Figure 3.4.5-11). Species caught by recreational vessels in these areas include bluefin tuna, mako, thresher sharks, white marlin, and yellowfin tuna. Along the OECC, harvested species often include striped bass, bluefish, bonito, false albacore, and bluefin tuna, as well as summer flounder, black sea bass, and scup (COP Volume III, Section 7.6.5; Epsilon 2018a). In general, for-hire recreational fishing boats from the Massachusetts area most often catch cod, hake, striped bass, and mackerel (COP Volume III, Section 7.6.5; Epsilon 2018a).

Conditions and Trends

There is substantial variability in the volume and value landed of various species fished within the WDA. For example, as stated in Table 3.4.5-7, surfclam/ocean quahog harvested from within the WDA was valued at $310,099 in 2007, whereas in 2017 only $10,617 was landed (29 times less). Similarly, mackerel, squid, and butterfish FMP from within the WDA was valued at $932,616 in 2016 and $128,183 in 2017 (a seventh of 2016 landings). In general, based on catch data for the last decade, the total annual revenue from within the WDA varied from $200,000 to $550,000, with a high of $1.2 million landed in 2016. Year to year variation in available catch, fishing effort as well as quotas set for commercial and recreational fisheries to protect stocks and prevent overfishing, introduce significant fluctuations in how much is landed every year from within the WDA, the MA WEA, and other locations. As a result, it is challenging to predict what the commercial fishing revenue from specific fishing areas, such as the WEA, will look like going forward. However, the activity and value of fisheries in recent years as described in the previous sections are expected to be indicative of future conditions and trends.

Aspects of Resource Potentially Affected

Aspects of resources potentially affected focus on impacts related to offshore resources (e.g., fish stocks) and activities (e.g., fishing vessel navigation and transit routes). More specifically, the proposed Project and its alternatives could have the following effects on commercial fisheries and for-hire recreational fishing that may result in changes to fishing revenues and costs:

- Construction and installation:
  - Increase in vessel traffic in ports or restricted access to the water due to increased use of ports by proposed Project vessels during construction;
  - Temporary disruption to access due to the presence of proposed Project vessels and construction activities in the WDA and along the OECC;
  - Changes to the accessibility to/availability of fish within the WDA and along the OECC due to environmental impacts (e.g., sediment dispersion, noise and vibration), which are fully discussed in Section 3.3.6; and
  - Displacement of fishing vessels, leading to increased conflict over other fishing grounds.
- Operations and maintenance:
  - Changes to the accessibility to/availability of fish within the WDA and along the OECC in areas of maintenance activities due to environmental impacts;
  - Changes to vessels transit routes due to the presence of proposed Project infrastructure within the WDA during operations (e.g., affecting travel time and trip costs);
  - Changes to fishing locations/effort/profit due to gear incompatibility with proposed Project infrastructure within the WDA and along the OECC, particularly areas with protected unburied cables that could cause snags;
  - Damage or loss of deployed gear due to striking or hooking on proposed Project infrastructure (e.g., protected unburied cables).
  - Changes to the distribution and availability of fish within and in proximity of the WDA and along the OECC due to habitat change (e.g., currents altered, electromagnetic fields from cables), which are fully discussed in Section 3.3.6;
  - Changes to the distribution and availability of recreational fish within and in proximity of the WDA due to habitat change (e.g., WTG as fish-attracting devices), which are fully discussed in Section 3.3.6; and
  - Displacement of fishing vessels, leading to increased conflict over other fishing grounds.
- Other (non-routine):
  - Increased risk of collision between vessels or fishing vessel collision with offshore structure, which could result in increased risk of oil spill or other discharge (assessed as part of Section 3.4.7).

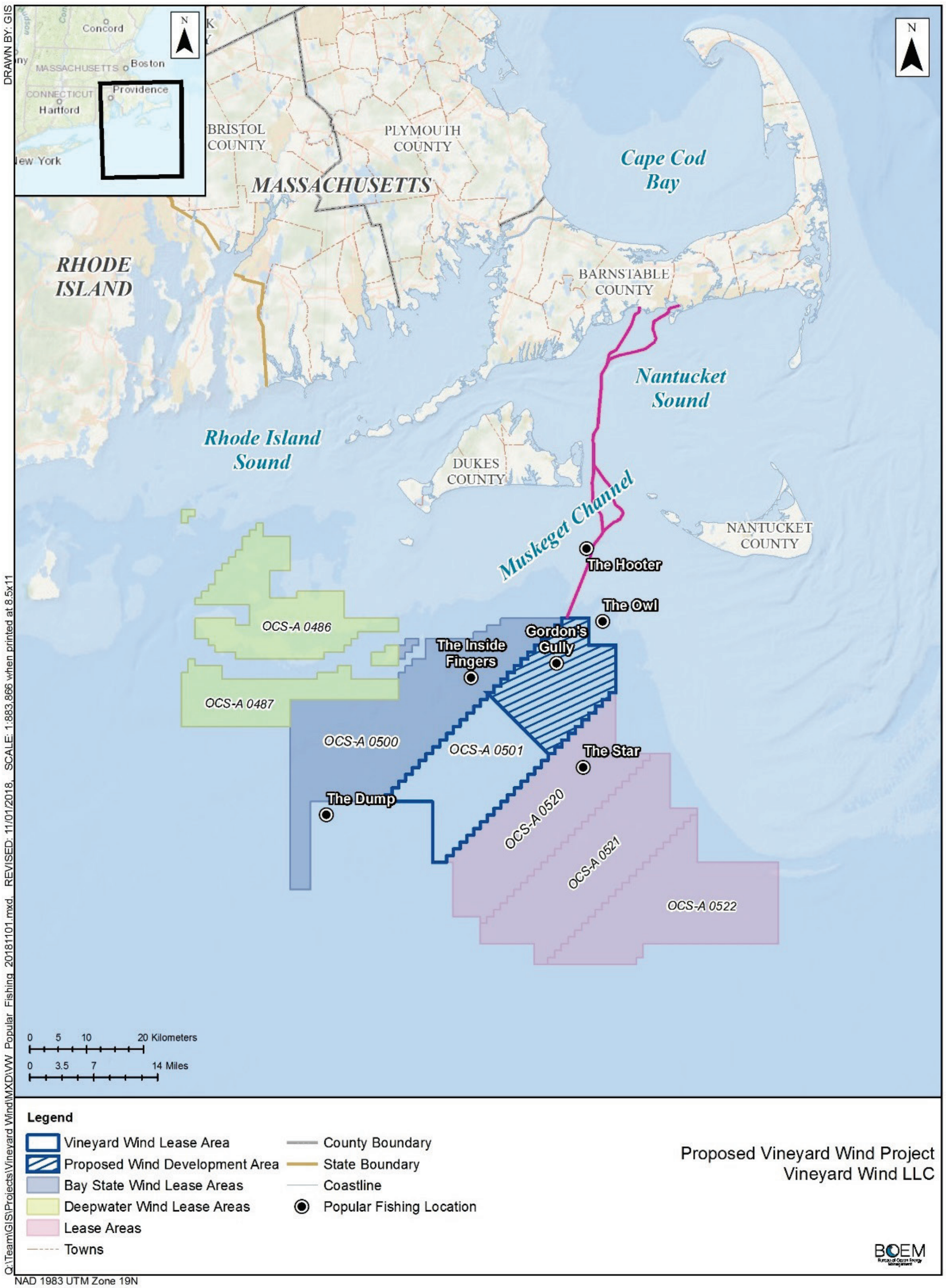


Figure 3.4.5-11: Popular Fishing Spots

The proposed Project has the potential to affect the following fisheries in the WDA and the OECC:

- Fixed gear fisheries (gill nets, traps/pots) that mainly target lobster, monkfish, skate, summer flounder/scup/black sea bass, and various crabs;
- Bottom trawl mobile gear fisheries that mainly target squid, monkfish, multispecies (groundfish), summer flounder, scup, black sea bass, and whiting; and
- Dredge fisheries that mainly target scallop and Atlantic surfclam/ocean quahog.

3.4.5.2. Environmental Consequences

Relevant Design Parameters

The maximum-case scenario for commercial and recreational fisheries is for an approximately 800-MW wind energy facility with 100 turbine locations laid out in a grid-like pattern with spacing of 0.75 to 1 nautical mile. Design parameters that may influence access, fishing compatibility, and navigational impacts on commercial fishing as described in Appendix G include:

- Number and type/size of foundation used for the WTGs and ESPs (90 34-foot [10.3-meter] monopiles and 10 jacket foundations has the greatest footprint)
- The landfall location options: New Hampshire Avenue in Yarmouth and the Covell's Beach in Barnstable. The export cable landfall has the potential to interfere with nearshore fishing grounds during construction.
- The route of the inter-array cables and the offshore export cable, including the ability to reach target burial depth or use cable protection measures when burial is insufficient. Vineyard Wind would bury the inter-array cables (connecting the WTGs and the ESPs within the WDA) and export cable to a target burial depth of 5 to 8 feet (1.5 to 2.5 meters). Vineyard Wind anticipates no more than 10 percent of the cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shells. Such covers can change the fish habitat (soft-bottom habitat to hard-bottom habitat) and can also damage fishing gear and equipment, which in turn could cause a potential safety hazard should gear snag or hook on seabed structures.
- The time of the year during which construction occurs. For-hire recreational fisheries are most active when the weather is more favorable, while commercial fishing is active year round with many species harvested throughout the year. However, certain fisheries have peak times. Construction activities can affect access to fishing areas and availability of fish in the area, thereby reducing catch and fishing revenue.

Appendix G provides information on the PDE and maximum-case scenario. Sections 3.3.6 and 3.4.7 cover design parameters related to environmental impacts (e.g., cable installation method) and impacts on navigation (e.g., radar interference).

Potential Variances in Impacts

Variations within the PDE that could influence the maximum-case scenario include:

- Total duration of offshore cable installation;
- Area required for scour protection and cable protection;
- Facility layout;
- Additional mitigations Vineyard Wind may offer as part of current negotiations with fishing industry (e.g., compensation funds) and required by state permitting (e.g., time of year restrictions for near-shore cable installation); and
- Construction schedule, which is dependent on weather and logistics.

3.4.5.3. Impacts of Alternative A (Proposed Action) on Commercial Fisheries and For Hire Recreational Fishing

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with construction, operations, maintenance, and decommissioning of the Proposed Action.

Direct and Indirect Effects of Routine Activities

Routine activities include construction, operations, maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Direct impacts include the temporary or permanent reduction in catch or loss of access to fishing areas due to the presence of construction activities or changes in fish and shellfish populations that are the basis of fishing activities. Direct impacts also include temporary or permanent reduction in fishing activities and fishing revenue due to characteristics of the Proposed Action. This could include abandonment of fishing locations due to difficulty in maneuvering fishing vessels, fear of allisions with Proposed Action components (e.g., WTGs), increased risk of collisions with construction or lay vessels, and/or fear of damage or loss of deployed gear. Indirect impacts include implications in the management of fisheries resources due to changes in fishing effort (duration, location, methodology). For example, some New England fisheries are managed by an allocation of Days at Sea. If the duration of fishing trips changes as a result of the Proposed Action, the Days at Sea allocations may need to be revisited. Furthermore, if for similar reasons as described above, fisheries research vessels are unable to access an area due to operational safety concerns then NMFS survey methodology may need to change to account for the inability to sample certain areas with the NMFS survey vessel.

Construction and Installation

Construction and installation of Proposed Action components could result in four main impacts on commercial fisheries and for-hire recreational fishing:

- Increase in vessel traffic in ports and resulting delays or restrictions in access to ports due to increased use by vessels during construction;
- Temporary disruption in access to areas that fall within safety zones around vessels and construction activities in the WDA and along the OECC;
- Temporary changes to the availability of fish within the WDA and along the OECC and other impacted areas due to activities that would cause fish to disperse to other areas (e.g., to avoid pile driving noise, sediment disturbance, or decreased productivity/recruitment success), as described in detail in Section 3.3.6; and
- Displacement of fishing vessels from areas impacted from Proposed Action activities, leading to increased conflict over other fishing grounds.

Navigation—Port Impacts

Construction of the Proposed Action would require a range of vessels, including vessels for transferring crew, transporting heavy cargo, and conducting heavy lifts, as well as multipurpose vessels and barges. The COP identifies the MCT as the primary port to be used by Vineyard Wind as a construction staging area (COP Volume I, Section 3.2.5; Epsilon 2018a). However, given the scale of the Proposed Action and that other projects might be using the MCT, Vineyard Wind may need to stage some construction activities from other commercial ports. Other ports identified in the COP as potential staging areas include Brayton Point or Montaup in Massachusetts, Providence or Quonset Point in Rhode Island, New London or Bridgeport in Connecticut, or even Canadian ports (COP Volume I, Section 3.2.5, Table 3.2-1; Epsilon 2018a). Broad-beamed transfer barges or installation vessels could take up as much as one-third of the width of the entry channel for the Port of New Bedford, leaving little room for other vessels to maneuver.

Point Judith, Rhode Island and New Bedford, Massachusetts have been identified as the highest value ports in terms of landings and revenue in proximity to the Proposed Action. The presence of construction vessels could cause transit delays for existing vessels, and could cause some vessel operators to change routes or use an alternative port. Vineyard Wind would establish a marine coordination center to harmonize Proposed Action vessel movements with non-Proposed Action vessels and implement communication protocols to minimize impacts on other users of the port (COP Volume I, Section 4.2.2; Epsilon 2018a). Given the additional vessel volume in construction ports, the Proposed Action could result in vessel traffic congestion and reduced access to high-demand port facilities (e.g., fueling and provisioning), and could increase the risk of collision and allision (see Section 3.4.7 for additional information). While additional vessel volume could result in increased traffic congestion and competition for dockside services, Vineyard Wind's proposed marine coordination center is expected to mitigate those risks such that the net impact on commercial fisheries and for-hire recreational fishing would be **minor**.

Disruption of Fishing in WDA/OECC

The installation of components, as well as the presence of construction vessels, could restrict harvesting activities in the WDA and along the OECC. For safety, it is expected that there would be a temporary restriction zone of 0.3 miles (500 meters) for immediate work areas. The safety zone would be approximately 0.19 square mile (0.5 square kilometer) (Epsilon 2018c). Vineyard Wind expects that the majority of the WDA and OECC would remain open throughout construction activities (COP Volume III, Section 7.6.3; Epsilon 2018a). For fishing vessels operating within the WDA, the impacts would depend on what construction activity is occurring. BOEM anticipates the greatest impacts during the foundation and cable installation. Although large areas would not be restricted for long periods of time, temporary limitations to fishing activities could occur. Vineyard Wind would communicate in advance where and when constructions activities are scheduled to take place, so as to allow fishing vessels to alter their plans if needed to avoid impacted areas.

For export cable installation, Vineyard Wind would use a cable-laying vessel or barge to transport and install the export cable. Vineyard Wind would use a pre-lay grapnel run to locate and clear obstructions prior to cable laying. Vineyard Wind might also dredge to remove sand waves along the OECC. These activities would require communications with fixed-gear fisheries to ensure no gear is deployed in the path of installation. In addition, temporary limitations to fishing activities for all gear types could occur along the OECC while the site is being prepared and cables laid. Vineyard Wind would communicate where and when activities would occur in the OECC to avoid conflicts with fishing activities.

During construction activities, temporary and permanent fish habitat alterations may occur (see Section 3.3.6). For example, construction activity would disturb the seabed and result in a behavioral response from fish. The behavioral response would vary by species and could result in changed availability to a fishery, such as not biting at hooks or changed swim height. Other impacts, such as noise, may cause fish to move away from the source or result in the death of the fish if it is unable to move away from lethal exposure levels. Thus, if fixed-gear is set within the unmitigated 0.5-mile (0.8 kilometer) acoustic zone of injury for fish, the gilled or trapped fish may die prior to harvest. BOEM expects pelagic fish species to largely avoid areas of disturbance, but return shortly after such activities end. Sections 3.3.5 and 3.3.6 provide more details on impacts on habitat and species.

Fishing vessels may also choose to avoid fishing in proximity to construction activities, regardless of safety restrictions. During this time, they may relocate to other fishing locations and continue to earn revenue. However, this could cause increased conflict in those locations, and vessels may incur increased operating costs (e.g., additional fuel to arrive at more distant locations) and lower revenue (e.g., less productive area; less valuable species).

The for-hire recreational fishery has identified Gordon’s Gully, located in the southern part of the WDA, as an area that construction and installation activities may particularly impact. Trolling for highly migratory fish may involve many feet of lines and hooks behind the vessel and then following large pelagic fish once they are hooked. If the fishing is good in the area, then several vessels may be involved in the fishery. Given the navigational and maneuverability challenges under normal circumstances it is expected that this type of fishing may be further constrained where it overlaps with construction and installation activities. For-hire fishing would have more flexibility for use of the area during construction and installation (Michael Pierdinock, Pers. Comm., September 19, 2018; FAO 2018).

Commercial fishing vessels, although operating in a large licensed FMP area, have well established and mutually recognized traditional fishing locations; the relocation of fishing activity outside of the WDA or OECC may increase conflict among fishermen as other areas are encroached. The competition is expected to be higher for less-mobile species such as lobster, crab, surfclam/ocean quahog, and scallop, and less so for finfish. For example, the Proposed Action is located in Lobster Area (Nearshore Management Area 2). In that area, permits are spatially constrained to remain in that area. As a result of displacement during construction, BOEM expects increased competition over available fishing grounds where species presence is more static and regulations constrain where fishermen can fish. However, for pelagic species like squid if the center of the squid resource is located where construction activity is occurring then the resource may not be available during the time that the resource and construction activity overlap. Thus, construction and installation activities are expected to have a **moderate** impact on commercial fisheries and for-hire recreational fishing.

NOAA found that of the 218 pot and gillnet permits from Massachusetts (e.g., New Bedford, Westport, Fairhaven, Cape Cod, and other smaller ports), along with those from Rhode Island (e.g., Point Judith, Newport, Tiverton, Little Compton), approximately 25 permitted vessels would lose the majority of the revenue if not able to access traditional grounds within the whole MA WEA and the Deepwater WLA (Kirkpatrick et al. 2017). On average, a vessel would experience $819 per trip loss, with a maximum annual loss of slightly over $8,000 for one permitted vessel. Certain vessels may be financially impacted if they historically fish within the WDA or OECC. Given that the project footprint for the WDA and OECC is much less than the combined WEAs, the Proposed Action would have minimal impacts on the commercial fishing sector as a whole during construction, but may have on average **moderate** impacts on certain individual vessels that intensely use the Proposed Action area. Although BOEM may consider impacts to be **moderate** on average, it is important to consider that pelagic fishery resources are highly dynamic. In a given year, it is possible that the center of the resource’s exploitable biomass would be found within the WDA during construction and installation. In this situation, a large portion of annual income for vessels may be inaccessible during construction, resulting in **major** impacts on vessel owners for a given year that could have longer-term impacts due to low operating capital. Thus, even though the likelihood of the limited fishery resource availability and construction and installation co-occurring in time and space is low, impacts on some individual commercial fisheries operators may be **moderate** to **major** and impacts on individual for-hire recreational fishing operators **minor** to **moderate**. However, BOEM anticipates that the use of construction disruption payments to affected fishermen would reduce impacts to **minor** (see Appendix D).

Vineyard Wind has indicated they would consider measures to offset adverse impacts on fisheries, and their intention to adopt the regional transit lane discussed in Section 2.1.1.2 is one example. Vineyard Wind is also considering other measures, including compensation programs. However, the COP provides insufficient detail (Appendix III-E; Epsilon 2018a) to determine effectiveness. BOEM expects that disruptions to access or unavailability of fish as a result of the Proposed Action during construction and installation would affect all seven FMPs that are fished within the WDA (see Table 3.4.5-7). Mitigation under consideration by BOEM includes disruption payments to permitted vessels that can document historic use within the WDA or OECC to offset potential economic impacts (see Appendix D). Specifically, if this measure were applied, BOEM would expect that prior to in-water construction, fishermen with a demonstrated history of fishing in any area that would be effected during the in-water construction phase of the proposed Project would be compensated. Compensation programs would be directly negotiated between the lessee and impacted fishermen, or follow a compensation program similar to that described for the gear compensation program. Compensation could include direct payments to fishermen and/or could fund fishery directed projects (e.g., research; infrastructure improvements, seafood promotion, etc.).

Time of year installation restrictions for construction activities in the OECC are under discussion via the state permitting process. The Commonwealth of Massachusetts would like Vineyard Wind to schedule construction activities to avoid peak fisheries harvesting and spawning seasons in state waters (MA DMF 2018 a and b). BOEM could further reduce potential impacts to protect larval settlement and juvenile development of winter flounder by requiring a time of year restriction so that no in-water work can occur within Lewis Bay between January 15 and June 30. Additional time of year restrictions (e.g., to protect bay scallops development) could extend the restriction period for the Lewis Bay portion of the Proposed Action to September 30 to protect bay scallops from the spawning through larval settlement phases. Furthermore, horseshoe crab-related time of year restrictions for the Covell's Beach landing site of May 1 to July 1 protect adults staging to spawn as well as eggs, larvae, and newly settled juveniles. As another mitigation measure and as a condition of the COP, BOEM is considering a Dynamic Squid Fishing Avoidance Plan that would require daily communication between squid fishery representatives and Vineyard Wind so that harvesters are aware of the day's activities and the developer is aware of where fishing is occurring. A time of year restriction, however, would not result in benefits to squid eggs given that up to 80 squid vessels throughout the year (on average between 30 to 60) are bottom trawling on spawning squid and squid egg mops (based on the number of squid vessels in a given month from 2007 to 2017; NOAA 2018o).

Navigation—Transit through Construction Area

Offshore construction and installation of the Proposed Action would temporarily restrict access to the OECC route and WDA during construction. Construction support vessels, including vessels carrying assembled WTGs or WTG components, would be present in the waterways between the WDA and the ports used during Proposed Action construction and installation. The Proposed Action would result in an average of 25 vessels operating in the WDA or OECC at any given time, with a maximum of 46 vessels (COP Volume I, Section 4.2.4; Epsilon 2018a). "On average, four cable-laying, support, and crew vessels may be deployed along sections of the OECC during the construction and installation phase" (COP Volume III, Section 7.8.2.1.2; Epsilon 2018a).

Fishing vessels transiting between the Proposed Action ports and the WDA would be able to avoid the Proposed Action vessels and restricted safety zones though routine adjustments to navigation, which would be informed by Vineyard Wind's implementation of a Mariner Communication Plan and dedicated Maritime Coordinator to reduce vessel conflicts (see Section 3.4.7). For the nearshore portions of the OECC, non-Proposed Action vessels may need to travel a narrower lane near the OECC installation vessels due to submerged hazards and land masses and, thus, could potentially experience greater delays. Although fishing vessels may experience increased transit times in some situations, these situations are spatially and temporally limited and overall BOEM expects Proposed Action vessel activities in the open waters between the WDA and ports and along the OECC to have **minor** impacts on fishing vessels.

Operations and Maintenance

Effects from the operations and maintenance phase of the Proposed Action on commercial fisheries and for-hire recreational fishing could include:

- Changes to vessels transit routes and chosen fishing locations due to the presence of maintenance activities or the new infrastructure within the WDA during operations (e.g., affecting travel time and trip costs);
- Changes to the accessibility to/availability of fish within the WDA due to changes to fish habitat and/or conflict with conducting traditional fishing practices within a wind turbine array;
- Damage or loss of deployed gear due to gear striking or hooking on Proposed Action infrastructure (e.g., insufficiently buried cables, tangled on a foundation); and
- Displacement of fishing vessels, leading to increased conflict over other fishing grounds.

Navigation—Port Impacts

The operations and maintenance of the Proposed Action would require a much more limited number of vessels than construction activities, with most vessels used for routine operations and maintenance. Further, most operations and maintenance vessels would be transiting to and from the Proposed Action operations and maintenance facilities located in Vineyard Haven on Martha's Vineyard, as well as at the MCT (COP Volume I, Section 3.2.6; Epsilon 2018a). Vineyard Wind would use crew transport vessels (about 75 feet [22.9 meters] in length) to transfer personnel, parts, and equipment. Service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length) have onboard crew and maintenance team quarters, shop facilities, a large open deck, appropriate lifting and winch capacity, and, in some instances, a helipad. Vineyard Wind would likely base smaller vessels in Vineyard Haven, while larger vessels would use the MCT. It is estimated that there would be 256 crew transfer vessels a year, 110 multipurpose trip vessels a year, and 26 service operation vessels (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2018a). Given the relatively low number of Project vessel trips anticipated during operations, there would be a **minor** increase in vessel traffic because of the Proposed Action.

The location of the proposed infrastructure within the WDA could impact transit corridors and access to preferred fishing locations. Depending on the width and location of transit corridors through or around the WDA, commercial and for-hire recreational fishing fleets may find it more challenging to safely transit to and from homeports as there may be less space for maneuverability and greater risk of allision or collision if there is a loss of steerage. Transiting through the WDA could also create challenges associated with using navigational radar when there are many radar targets that may obscure smaller vessels and where radar returns may be duplicated under certain meteorological conditions like heavy fog. Larger vessels may find it necessary to travel around the WDA to avoid maneuvering among the WTGs. This is especially true for fishing vessels homeported in New Bedford, with the WDA being directly southeast of the port and regularly traversed by the commercial fleet. According to comments from commercial fishermen, the distance between wind turbines can make navigation or access more challenging for large fishing vessels trying to deploy fishing gear if spacing between WTGs is less than 1 nautical mile. In addition, smaller vessels could drift into WTG or ESP structures during times where steerage is limited due to haul back of gear or loss of power (BOEM 2018g). Fishing vessels not able to travel through the WDA or deploy fishing gear in the WDA would need to travel longer distances to get around the WDA or find alternative fishing locations. This can result in an increased travel time and trip costs. Additionally, as commercial fishing vessels typically stay out at sea over multiple days, BOEM expects that vessels would be navigating at nighttime or during adverse weather conditions. BOEM expects navigation in the WDA to be difficult at night, or in challenging weather conditions such as fog. Overall, BOEM expects the Proposed Action to have **moderate** impacts on fishing vessel movements within and near the WDA. For more discussion on vessel movements and impact assessment for fishing vessel navigation, see Section 3.4.7.

Disruption of Fishing in WDA/OECC

Vineyard Wind would bury the inter-array and export cables approximately 5 to 8 feet (1.5 to 2.5 meters) below the seabed. However, Vineyard Wind estimates that no more than 10 percent of the inter-array and export cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shell, which, once in place, could interfere with fishing gear, damage equipment, and pose a safety hazard for vessels using mobile gear. Where cable burial is not technically feasible due to bottom geology or topography, or due to the need to cross other infrastructure, concrete mattresses or rock placement would be permissible to secure and protect cables. Vineyard Wind would schedule regular remote surveys of cable placement during operations to confirm that cables remain buried and secure. BOEM anticipates **moderate** impacts on commercial fisheries, in particular trawlers, due to the potential for gear damage in these locations from the Proposed Action; however, the implementation by BOEM as part of the COP approval of cable burial at a minimum of 6.5 feet (2 meters) could be in effect between the WDA and Muskeget Channel to help avoid trawl and dredge hangs. Accessibility to fish can be further reduced for fisheries that use bottom trawls and dredge, as fishing gear can get caught on or entangled with protections placed over export cables, or with foundations of WTGs or ESPs.

Permanent habitat alteration in the form of scour and cable protection would reduce the habitat for species such as winter flounder and displace species that prefer soft-bottom habitat (e.g., squid) from the area immediately surrounding the foundation footprint. The creation of hard-bottom habitat would, however, benefit species such as American lobster, striped bass, black sea bass, and Atlantic cod—and potentially increase their habitat. Groundfish species can also experience changes in habitat as a result of changes to the ocean floor in the WDA. The base of WTGs also has the potential to serve as an artificial reef and attract forage fish and game fish. If the access to fishing locations is reduced, an artificial "sanctuary" for fish can also develop. The beneficial impact on fish populations due to the addition of hard bottom structures within the WDA could at least partially offset the adverse impacts of a decrease in the accessibility to/ availability of fish on sandy or soft benthos, although the fish species that are impacted would be different.

In order to better understand how fishing trips may be impacted by longer trip durations due to altered or slowed routes, NMFS provides an estimation of trip costs for commercial fisheries (see Table 3.4.5-9 below; Das 2013). The cost for commercial fishing vessels is typically divided into annual costs and trip costs, both of which affect net revenue. Annual costs include items such as permits, gear, and vessel maintenance. Trip costs are costs incurred during each fishing trip and include bait, fuel, loss or damage of gear, food, ice, oil, other supplies, and water. Trip costs typically increase with trip duration and the size of the vessel (see Table 3.4.5-9). In the considered data set, 64 percent of all trips were single-day trips, and 69 percent of all trips used medium-sized vessels. The average cost for a single-day trip in a medium-sized vessel was $358 (Das 2013). Multiday trips in medium-sized vessels had an average trip cost of $7,446 and $16,380 for large vessels (see Table 3.4.5-9). Trip costs also vary by gear type, and vessels equipped with midwater trawl, dredge, midwater pair trawl, and other types of trawl typically have higher average trip cost (Das 2013). Overall, fishing costs have been estimated to be approximately 50 percent of landed value (COP Volume III, Section 7.6; Epsilon 2018a), although there can be considerable variability depending on vessel size and gear, target species, trip duration, and fishing success. With respect to the individual cost items that make up the variable trip cost, the total average cost is highest for fuel (mean cost of $3,188, median cost of $301), food (especially for multiday trips, $258), the replacement of damaged equipment ($229) and ice ($207). In fact, Das (2013) found the cost of fuel accounted for about 78 percent of the total share of trip costs. The average cost for bait, water, supplies, and oil are typically less than $100, with the median value of bait often being $0, as many vessels do not use bait (Das 2013).

Table 3.4.5-9: Summary Statistics of Total Cost by Trip Duration and Vessel Length, 2008-2012

Length Categories	Large (>80 feet)	Medium (40 to 80 feet)	Small (smaller than 40 feet)
All Trips			
Number	2,852	14,272	3,417
Mean	$15,819	$2,750	$279
Standard Deviation	$9,571	$5,391	$429
Maximum	$75,180	$76,725	$6,305
Single Day Trips			
Number	114	9,455	3,246
Mean	$2,332	$358	$235
Standard Deviation	$1,695	$371	$310
Maximum	$8,200	$7,781	$6,305
Multiday Trips			
Number	2,738	4,817	171
Mean	$16,380	$7,446	$1,114
Standard Deviation	$9,350	$7,249	$1,065
Maximum	$75,180	$76,725	$5,422

Source: Das 2013
Note: Trip cost data were collected as a part of the Northeast Fishery Observer Program's data collection effort to inform fisheries decision-makers in the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, and National Marine Fisheries Service.

As expected, trip cost is highly positively correlated with fuel price and trip duration. The WDA is approximately 9.9 miles wide (16 kilometers) and 31 miles long (50 kilometers). Therefore, fishing vessels transiting through the middle of the WDA have only 9.9 miles (16 kilometers) to travel; however, vessels that may be required to avoid the WDA would need to travel around the WDA, both increasing the travel time and trip cost compared to a more direct route through the WDA. Fishing vessels traveling to more distant fishing locations would incur additional expenses if fishing within the WDA is no longer an option for those vessels due to safety concerns or difficulty deploying the gear (bottom trawl and dredge). Depending on fishing locations, the total trip time and catch revenue, the additional fuel costs associated with transit around the WDA could have a substantial impact on fisheries profits. Additional impacts of longer trips, also connected to the uncertainty of income due to the displacement of fishing locations, could result in non-market cultural impacts on families (e.g., increased time away from family). This is a concern; however, non-market values are not included in this assessment. In general, BOEM expects that potential changes to vessels transit corridors and chosen fishing locations as a result of the Proposed Action would have a **moderate** effect on commercial fisheries and for-hire recreational fishing.

The accessibility and availability of fish within the WDA/OECC may be affected by the location of the proposed infrastructure within the WDA, as well as rock or concrete covers placed in some locations along the OECC. Fisheries that use bottom trawls and dredge may find it challenging to deploy gear, maneuver, and fish in the WDA or along the OECC where cable protection measures have been deployed. Protections placed over cables or around foundations of WTGs or ESPs may catch or entangle fishing gear. Fishermen have expressed specific concerns about fishing vessels operating trawl gear that may not be able to safely deploy gear and operate in the WDA, given the size of the gear, the spacing between the WTGs, and the space required to safely navigate especially with other vessels present. Trawl and dredge vessels require a relatively large space between turbines to maneuver their gear, as the gear does not directly follow the vessel, fishermen have commented that a 1-nautical mile spacing between WTGs may not be enough to safely operate. BOEM expects that disruptions to access or unavailability of fish as a result of the Proposed Action during operations and maintenance may be limited to pelagic fisheries and highly migratory species.[28] Hook and line anglers targeting large pelagics such as makos, threshers, bluefin tuna, etc., need to safely navigate around the base of the WTGs to avoid damage to gear or entanglement (Michael Pierdinock, Pers. Comm., September 19, 2018). Recreational anglers harvesting tunas, sharks, and billfish also noted that spacing of the WTGs could impact access to fishing locations due to the large size, strength, and swimming speed of larger species that require significantly more space to fight on rod and reel compared to other species. Some commercial and for-hire recreational users recommend spacing of more than 3 nautical miles for WTGs. Even if fishing within a wind energy facility is technically feasible, vessel operators may nonetheless perceive they are not able to safely fish there, resulting in *de facto* exclusion areas. Indeed, Fishermen have voiced their reluctance to enter wind facilities, particularly during low-visibility weather events.

Vineyard Wind would inform fishermen of areas where foundation or cable protection is used. Vineyard Wind would develop a compensation program for damage to or loss of fishing gear and the loss or reduction of income to fishermen from the Proposed Action (see: COP Volume III Appendix E; Epsilon 2018a). Due to the mobile gear being actively pulled by a vessel over the seafloor the chance of snagging this gear on project infrastructure is much greater than if—in the case of fixed gear—the gear were just set on the infrastructure or waves or currents pushed the gear into the infrastructure. BOEM expects the risk of damage or loss of deployed gear as a result of the operations and maintenance would have a **moderate** effect on mobile gear commercial fisheries and for-hire recreational fishing. The operations and maintenance would have **minor** impacts on fixed gear fishermen.

If operational impacts on access to fishery resources were unmitigated, the impacts would be **moderate** to **major**. However, implementation of mitigation measures identified in Appendix D could reduce impacts to **minor** to **moderate** depending on the level and efficacy of the mitigation provided.

As with construction and installation of the Proposed Action, some commercial and for-hire recreational fishing vessels that currently fish in the WDA or along the OECC may choose to fish in other locations during the operations and maintenance of the Proposed Action. Choosing alternative locations with similar harvest potential and expenses could mitigate economic impacts from not fishing in the WDA; however, it could also potentially increase conflict over other fishing grounds. This displacement has the potential to impact the financial outcomes of fishing vessel owners. In addition, increased vessels fishing in the same locations may increase navigational hazards, and increase fishing pressure on other fish species in discrete areas. Mitigation measures and compensation plans would be in place for displaced fishermen from the WDA for potential decreases in revenue. Since the specifics of the mitigation plan are not currently available BOEM expects operations and maintenance of the Proposed Action on fishing within the WDA/OECC would have a **minor** to **moderate** impacts on the commercial fisheries and for-hire recreational fishing industry depending on the level of mitigation provided.

Although BOEM consider impacts to be **moderate** on average, it is important to consider that pelagic fishery resources are highly dynamic. In a given year, it is possible that the center of the resource's exploitable biomass would be found within the WDA during operations and maintenance. If that were to occur, some fisheries—like the squid trawl fishery—may not be able to safely operate and harvest the resource in the WDA using status-quo fishing techniques. In this situation, a large portion of annual income for vessels may be inaccessible during operations, resulting in **major** impacts on individual vessel owners for a given year that could have longer-term impacts due to low operating capital. Thus, even though the likelihood of the limited fishery resource availability and operations and maintenance co-occurring in time and space is low, impacts on some commercial fisheries may be **moderate** to **major** and impacts on for-hire recreational fishing **minor** to **moderate**. However, with mitigation measures identified in Appendix D of the Draft EIS that BOEM could approve as a condition to the COP, BOEM anticipates that the use of compensation payments to affected fishermen would reduce impacts to **minor** to **moderate.**

Impacts on Port Activities

The Proposed Action operations and maintenance facilities would be located in Vineyard Haven on Martha's Vineyard, as well as at the MCT. Therefore, most of the Proposed Action vessels would be operating from only those two locations (COP Volume I, Section 3.2.6; Epsilon 2018a). Vineyard Wind expects that that Vineyard Haven port would support smaller vessels, while larger vessels would use the MCT. As mentioned above, Vineyard Wind estimates that there would be 256 crew transfer vessels, 110 multipurpose trip vessels, and 26 service operation vessels per year

[28] Such as longfin squid and Atlantic mackerel

during operations (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2018a). At the time of preparation of this Draft EIS, information was lacking to perform a detailed indirect impact assessment of the modifications to and potential operation out of the Vineyard Haven port. As stated in Section 3.4.7.3, Project operations would generate an average of one to three daily vessel trips. Given this relatively low number of Project vessels trips, it is expected that the Proposed Action would have a **minor** impact on port activities and associated commercial and recreational fisheries. For more discussion, Section 3.4.7.

Decommissioning

Impacts during decommissioning would be similar to the impacts during construction and installation. Temporary disruptions to commercial and for-hire recreational fishing activities would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles WTGs and ESPs, removing them 15 feet (4.6 meters) below the mudline and shipping them to ports for disposal. Removal of scour protection around structures and the hard protection atop portions of cables would cause temporary impacts, but would alleviate the possibility of future hazards to fishing (gear damage, etc.). Removal of the OECC, if required, would also generate temporary disruptions. As with construction, decommissioning activities would have larger impacts if conducted during the peak fishing and spawning (e.g., squid) seasons.

BOEM anticipates that if the same mitigation is used for decommissioning as proposed for the construction and installation process, decommissioning of the Proposed Action would have **minor** to **moderate** impacts on commercial fisheries and for-hire recreational fishing depending on the available compensation.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. Non-routine activities associated with commercial and for-hire recreational fisheries primarily include increased risk of collision between Proposed Action vessels and fishing vessels or allisions with infrastructure such as WTGs and ESPs (see Section 2.3 and 3.4.7). As specified in the COP, the proponent would establish marine coordination to control vessel movements throughout WDA and the OECC (COP Volume I, Section 4.2.2; Epsilon 2018a). In addition, USCG approval would be required for the WTGs and ESPs to be designated as Private Aids to Navigation (PATONs), and WTGs and ESPs would be equipped with a number of navigational aids. In summary, BOEM expects that a risk of collision or allision between Proposed Action vessels and infrastructure with fishing vessels would have a **moderate** effect on commercial fisheries and for-hire recreational fishing. However, this impact with mitigation measures identified in Appendix D of the Draft EIS that BOEM could approve as a condition to the COP could be mitigated through the insurance claims process of Proposed Action vessels and/or fishing vessels potentially decreasing the impacts to between **minor** and **moderate**.

Conclusion

Overall, construction and installation of the Proposed Action would have **minor** impacts on commercial fisheries and for-hire recreational fishing due to increased use of ports; **moderate** to **major** impacts on commercial fisheries, primarily through inability to fish in the WDA and OECC when construction activities are occurring; and **minor** to **moderate** impacts on some fisheries resources in years where the resource is co-located with construction activity. However, BOEM anticipates that the use of construction disruption payments to affected fishermen would reduce impacts to **minor** to **moderate**. Construction and installation of the Proposed Action would have **minor** to **moderate** impacts on fishing vessels and for-hire recreational fishing given Vineyard Wind's communication plans and recreational vessel's operators' ability to adjust transit and fishing locations to avoid conflicts.

Overall, operations and maintenance of the Proposed Action would have a **minor** impact on vessel traffic due to the reduced number of vessels transiting the area compared to the status quo and construction and installation traffic. BOEM expects the potential change to vessels transit corridors and chosen fishing locations as a result of the Proposed Action would have a **moderate** effect on commercial fisheries and for-hire recreational fishing due to the increased time navigating the area and fuel costs. Furthermore, the risk of damage or loss of deployed gear as a result of operations and maintenance is expected to have a **moderate** effect on mobile gear commercial fisheries and for-hire recreational fishing due to striking or hooking on proposed infrastructure. The operations and maintenance would have **negligible** impacts on fixed-gear fishermen due to their gear being fixed in place. BOEM expects the potential displacement of fishing vessels and increased competition on fishing grounds as a result of the Proposed Action would have a **moderate** impact on commercial fisheries and for-hire recreational fishing. There would be a **minor** impact on port activities because of the Proposed Action with the estimated three vessel trips per day during regular operations. If operational impacts on access to fishery resources were unmitigated, the impacts would be **moderate** to **major** on commercial fisheries. BOEM could require one or more of the following additional mitigation measures of Vineyard Wind as a condition of COP approval (see Appendix D):

- Disruption payment for fishing industry during construction: Prior to in-water construction, compensate fishermen with a demonstrated history of fishing in the area(s) that would be excluded from fishing during the in-water construction phase of the project.
- Fishing gear loss or damage compensation: Implement a financial compensation program for damage to or loss of fishing gear due to collision with proposed Project infrastructure within the WDA and along the OECC.
- Dynamic squid fishing avoidance plan: Require daily communication plans between squid fishery representative and cable lay vessel operator to mitigate the potential for reduced access to squid resources by the commercial fishery in the spring and summer.
- Lewis Bay horseshoe crab, shellfish, and winter flounder time-of-year restrictions: To protect the spawning period, larval settlement, and juvenile development of winter flounder as well as adult horseshoe crabs staging to spawn, implement time of year restriction on all in-water work within Lewis Bay from January 15 to June 30. BOEM could require additional time of year restrictions to protect shellfish spawning and settlement within Lewis Bay. Combined shellfish time of years covering all identified species would extend the time of year restriction for the Lewis Bay portion of the project to September 30 to protect bay scallops from spawning through larval settlement phases.
- Covell's Beach horseshoe crab time-of-year restriction: If Covell's Beach is selected for cable landfall, avoidance of nearshore area work on the shoreline during horseshoe crab spawning season to protect adults staging to spawn as well as eggs, larvae, and newly settled juveniles. This time of year restriction period would be from May 1 to July 31.
- Regional monitoring initiative for fishery impacts: Contribute funds to a long-term regional environmental monitoring program as directed by BOEM. The regional collaborative monitoring program will monitor the long-term health of the offshore continental shelf environment within the MA WEA. Funds toward the regional collaborative monitoring program would not exceed $500,000 per year.
- Cable burial to avoid hangs: Require that cables be buried 6.5 feet (2 meters) at a minimum between the WDA and Muskeget Channel to help avoid trawl hangs. Where cable burial is not technically feasible due to bottom geology or topography, or due to the need to cross other infrastructure, concrete mattresses or rock placement would be permissible to secure and protect cables.
- Long-term monitoring of cable placements: Perform remote survey of cable placements to confirm cables remain buried and rock placement/concrete mattresses remain secured and undamaged. Survey annually along all cable placements for the first 3 years and biennially thereafter. Carry out remedial action as required to re-secure cables. The lessee must provide BOEM with the inter-array and export cable-monitoring reports within 45 calendar days following the inspections schedule for the benthic monitoring plan and after major storm events.
- Compensation for lost income due to offshore wind energy facility operations and maintenance: Implement a financial compensation program for documented loss of income due to inability of fishing vessels to access previously fished locations within the WDA during the operational phase. Compensation could include direct payments to fishermen and/or funding of fishery directed projects (e.g., research; infrastructure improvements).
- Annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear clean up around WTG foundations: Perform annual ROV surveys and cleanup around the WTG foundations to reduce entanglement and entrapment of finfish or invertebrates in lost fishing gear.

With mitigation, BOEM expects the proposed-Project activities would have a **minor** to **moderate** effect on commercial fisheries and for-hire recreational fishing. If BOEM selected a less impactful alternative and included additional mitigation measures, then impacts would be **minor** to **moderate** depending on the level and efficacy of the mitigation provided. As discussed in the following sections, some elements of Alternatives B, D1, D2, and E could result in lesser impacts; however, other aspects of these alternatives, such as larger area of seabed disturbance, for example, could result in incrementally greater impacts as described below. As a result, the overall impact ratings of these alternatives are the same as the Proposed Action.

3.4.5.4. Impacts of Alternative B on Commercial Fisheries and For Hire Recreational Fishing

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Under Alternative B, Vineyard Wind would not use the New Hampshire Avenue cable landfall through Lewis Bay and would select the Covell's Beach landfall. The Covell's Beach landfall option has lower fishing vessel traffic (nearshore) as compared to the New Hampshire option (see Figure 3.4.5-1). Lewis Bay (New Hampshire Avenue) has populations of winter flounder and shellfish (soft shell clam, American oyster, and quahog). Also, as shown on Figures 3.4.5-2, 3.4.5-5 and 3.4.5-6 the New Hampshire landing site has high to very high density of fishing vessels targeting squid, medium high density of vessels targeting surfclam and ocean quahog, medium-high to high density of vessels targeting sea scallop, and typically a higher number of vessel transit counts (Figures 3.4.5-8 and 3.4.5-9). However, at the Covell's Beach site, those densities are very low. Further, no important fishing spots have been identified on Covell's Beach or in Centerville Harbor (Town of Barnstable 2009). In general, Vineyard Wind's Supplemental Draft Environmental Impact Report (Epsilon 2018c) identifies the New Hampshire Avenue landing site as having more impacts on commercially important shellfish than Covell's Beach. The Commonwealth of Massachusetts may require time of year restrictions at either location, but for different species—Winter Flounder for New Hampshire Avenue, horseshoe crab for Covell's Beach.

Overall, although localized impacts on nearshore, state-management fisheries are expected to be less under Alternative B, the selection of the Covell's Beach landfall option does not affect the assessment conclusions and ratings with respect to the commercial fisheries and for-hire recreational fishing. Alternative B would have a similar impact on commercial fisheries as the Proposed Action and less of an impact on for-hire recreational fishing than the Proposed Action.

Direct and Indirect Effects of Non-Routine Activities

Alternative B would not have an effect on any of the identified impacts of non-routine activities as assessed under the Proposed Action. Effects of non-routine activities associated with Alternative B would be similar to those for the Proposed Action, with **moderate** impacts.

Conclusion

Based on the analysis above, construction and operations of Alternative B would have fewer impacts on fishing in state waters, but overall still have the same **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing as the Proposed Action. This results from the fact that the Covell's Beach option would not alter the overall assessment conclusions and ratings regarding impacts identified for commercial fisheries and for hire-recreational fishing. With mitigation implemented (see Appendix D), the impacts of this alternative would decrease from **moderate** to **major** to **minor** to **moderate**.

3.4.5.5. Impacts of Alternative C on Commercial Fisheries and For Hire Recreational Fishing

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Construction and installation, operations and maintenance, and decommissioning of Alternative C would provide more unobstructed space for navigation in the northern portion of the WDA, which is commonly used by commercial and for-hire fisheries. However, the acreage of the WDA would remain unchanged and all WTGs and ESPs would be sited within the same sized footprint as under the Proposed Action (the six northern-most WTGs would be removed and instead placed along the southern portion of the WDA), and there would be no changes to ESPs or the OECC. Moving WTGs away from the northern portion could improve access to the portion of the scallop fishery that has higher vessel density in that portion of the WDA. Further, the surfclam/ocean quahog fishery used to be quite important in the northernmost section of the WDA. However, areas of scallop and surfclam/ocean quahog concentration vary substantially from year to year, meaning the benefits of this alternative would not be consistent from year to year. Therefore, BOEM anticipates Alternative C would have the same impact on commercial fisheries and for-hire recreational fishing as the Proposed Action. Overall, construction and installation, operations and maintenance, and decommissioning of Alternative C would have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing.

Direct and Indirect Effects of Non-Routine Activities

Effects of non-routine activities associated with Alternative C would be similar to those for the Proposed Action, with **moderate** impacts.

Conclusion

Despite the more unobstructed space for navigation in the northern portion of the WDA, the size of the WDA and characteristics of potential Project impacts would remain the same. Overall, this change does not alter the assessment conclusions or ratings and, consequently, Alternative C would have the same **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing as the Proposed Action. With mitigation implemented (see Appendix D), the impacts of this alternative would decrease from **moderate** to **major** to **minor** to **moderate**.

3.4.5.6. *Impacts of Alternative D on Commercial Fisheries and For Hire Recreational Fishing*

Impacts of Alternative D1

Incremental Contribution of Alternative D1

Direct and Indirect Effects of Routine Activities

Alternative D1 would establish a 1 nautical mile minimum spacing between all WTGs, resulting in a 22 percent increase in the area of the WDA. An increase in the WDA would require the completion of additional pre-construction surveys, expanding on those already completed for the WDA. This work would be completed prior to construction activities and would consist of biological, geological, and geotechnical surveys. As the WDA would expand in the southern portion of the Vineyard Wind lease area, additional surveys could result in increased vessel activity in that area prior to construction activities, causing **minor** disruptions to fishing activities. In general, BOEM expects the following as a result of Alternative D1, as compared to the Proposed Action:

- Construction and installation:
  - Increase in temporary disruption to access or restriction in harvesting activities from increased WDA area and lengthier construction and installation time.
- Operations and maintenance:
  - Decrease in accessibility to/availability of fish within the WDA as larger seabed area would be disturbed.
  - Improvement in access to fishing locations and the ability of vessels to deploy fishing gear given the increased spacing between the WTGs. However, during the scoping process, some stakeholders indicated that spacing of more than 1 nautical mile (1.8 kilometers) would be required for safe vessel maneuver and operation of fishing gear in the WDA.
  - Increase in displacement of fishing vessels as a result of now larger WDA, leading to increased conflict over other fishing grounds.

Given that the positive impacts of increased fishing access are at least partly offset by the negative impacts of a larger WDA and a longer construction period, BOEM expects Alternative D1 to also have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing.

Direct and Indirect Effects of Non-Routine Activities

BOEM expects Alternative D1 would reduce the risk of collisions between the proposed Project-related vessels and fishing vessel, given the larger spacing between WTGs. In addition, the likelihood of damage or loss of deployed gear would decrease as compared to the Proposed Action. However, an increase in the WDA would increase the overall area of potential impact. BOEM expects Alternative D1 to also have a **moderate** impact on commercial fisheries and for-hire recreational fishing.

Conclusion

Alternative D1 would require a larger WDA. The increased size of the WDA could incrementally increase effects on vessel traffic, compared to the Proposed Action. However, a beneficial effect would be expected from the increase spacing of WTGs. Therefore, there would be incremental beneficial and negative effects for various users. As a result, Alternative D1 would have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing. With mitigation implemented (see Appendix D), the impacts of this alternative would decrease from **moderate** to **major** to **minor** to **moderate**.

3.4.5.7. *Impacts of Alternative D2*

Incremental Contribution of Alternative D2

Direct and Indirect Effects of Routine Activities

Alternative D2 would result in an east-west WTG orientation with 1 nautical mile spacing between all WTGs, rather than the Proposed Action's northwest-southeast orientation and less than 1 nautical mile spacing. This alternative would require a larger WDA. Similarly, as under Alternative D1, an increase in the WDA under Alternative D2 would require the completion of additional pre-construction surveys, expanding on those already completed for the WDA.

Also, the increased size of the WDA could incrementally increase effects on vessel traffic, compared to the Proposed Action; however, some Rhode Island-based commercial fisheries groups and the Rhode Island Coastal Resources Management Council have asserted that Alternative D2 would improve maritime navigation and facilitate continued fishing operations and practices within the WDA compared to the Proposed Action due to the orientation of the turbines. To the extent to which certain vessels and gear types choose to fish within wind energy arrays that may be built in federal waters offshore Massachusetts and Rhode Island, an East-West turbine orientation may slightly lessen (but not eliminate) impacts to those operators (Annie Hawkins, Pers. Comm., November 16, 2018). While there is a current east-west traffic in the WDA, there is also northwest-southeast traffic in the northern portion of the WDA. Fishermen have stated that there is an unwritten gentlemen's agreement between mobile and fixed gear vessels where fixed gear fishermen deploy their gear in an east-west direction along Loran lines whose numbers end in 0 and 5 and mobile gear fishermen tow in between in an east-west direction.[29] Therefore, construction, operations, maintenance, and decommissioning of Alternative D2 could still have **moderate** to **major** impacts on commercial fisheries. BOEM expects the following as a result of Alternative D2 as compared to the Proposed Action:

- Construction and installation:
  - Increase in temporary disruption to access or restriction in harvesting activities from increased WDA area and potentially lengthier construction and installation time.
- Operations and maintenance:
  - Decrease in accessibility to/availability of fish within the WDA as larger seabed area would be disturbed, at least partially offset by an increase in fish habitat associated with the additional rocky bottom and infrastructure surface area due to placement of the WTGs and ESPs.
  - Improvement in access to fishing locations and the ability of vessels to deploy mobile and fixed fishing gear given the east-west orientation and increased spacing between the WTGs except for some commercial fisheries in the northern portion of the WDA.
  - Increase in displacement of fishing vessels as a result of now larger WDA, leading to increased conflict over other fishing grounds.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative D2 on navigation and vessel traffic would be the same as those of the Proposed Action, **moderate**.

Conclusion

Alternative D2 would require a larger WDA. The increased size of the WDA could incrementally increase effects on vessel traffic, compared to the Proposed Action; however, some commercial fisheries groups have stated that Alternative D2 would improve maritime navigation, leading to improved vessel traffic. Therefore, there would be incremental beneficial and negative effects for various users. As a result, construction, operations, maintenance, and decommissioning of Alternative D2 would still have **moderate** to **major** impacts on navigation and vessel traffic. With mitigation implemented (see Appendix D), the impacts of this alternative would decrease from **moderate** to **major** to **minor** to **moderate**.

3.4.5.8. Impacts of Alternative E on Commercial Fisheries and For Hire Recreational Fishing

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Alternative E would limit the number of WTGs from 100 to 84 (a 16 percent decrease) and the acreage of the WDA would likely decrease as compared to the Proposed Action. There would be no change in the locations of ESPs, the OECC, or transit corridors. The spacing between each of the transit corridors would be at least the same distance as the Proposed Action, but could be greater. Alternative E would likely improve the access to certain fishing locations and the ability of vessels to deploy fishing gear where the 16 WTGs are removed (as compared to the Proposed Action), but only in those locations. BOEM expects Alternative E to have less of an impact than the Proposed Action, but still an overall **moderate** to **major** impact on commercial fisheries and **minor** to **moderate** impact on for-hire recreational fishing.

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[29] Frederick J. Mattera, Affidavit Rational for Commercial Fishing Industries Required East & West Turbine Layout for Wind Energy Areas for Rhode Island and Massachusetts including Bureau of Energy Management OCS Lease Sites A-0486, A-0487, A-0500, A-0501, September 23, 2018.

Direct and Indirect Effects of Non-Routine Activities

BOEM expects Alternative E would reduce the risk of collisions between the proposed Project-related vessels and fishing vessel, given fewer WTGs. In addition, the likelihood of damage or loss of deployed gear would decrease as compared to the Proposed Action. BOEM does not expect any other changes as a result of this alternative. Overall, BOEM expects Alternative E would have a **moderate** impact on commercial fisheries and for-hire recreational fishing.

Conclusion

Alternative E would have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing, similar to those of the Proposed Action. With mitigation implemented (see Appendix D), the impacts of this alternative on commercial fisheries would decrease from **moderate** to **major** to **minor** to **moderate**.

3.4.5.9. Impacts of Alternative F (No Action Alternative) on Commercial Fisheries and For Hire Recreational Fishing

Under the No Action Alternative, BOEM would not approve the proposed Project activities. Any potential impacts on commercial and for-hire recreational fishery of the Proposed Action would not occur. The current trends in commercial fisheries and for-hire recreational fishing would continue.

3.4.5.10. Comparison of Alternatives for Commercial Fisheries and For Hire Recreational Fishing

Table 3.4.5-10 provides a summary of ratings for each identified impact of the proposed Project for all considered alternatives, before mitigation measures are applied. Table 3.4.5-11 provides a summary of ratings for each identified impact of the proposed Project for all considered alternatives with mitigation. Despite the variations in proposed-Project design components, the impact on rating is minimal. There appear to be benefits to commercial fisheries and for-hire recreational fishing from avoiding disruption in Lewis Bay (Alternative B), maintaining a minimum spacing of 1 nautical mile between WTGs (Alternative D1), using an east-west layout orientation (Alternate D2), the removal of surface occupancy in the northern/northeastern-most portion of the WDA (Alternative C) and reduced proposed Project size (Alternative E). However, BOEM expects that the pressure on the seabed and fish resources would increase with the increased size of the WDA (Alternatives D1 and D2). Overall net benefits of the different alternatives over the Proposed Action are limited and if unmitigated would still have **moderate** to **major** impacts on commercial fisheries and for-hire recreational fishing (Table 3.4.5-10). However, if BOEM required additional mitigation measures as a condition of COP approval (see above and Appendix D), and less impactful alternatives described above were implemented, overall impacts could be reduced to **minor** to **moderate** (Table 3.4.5-11).

3.4.5.11. Cumulative Impacts

The geographic area for cumulative impacts assessment includes the boundaries that define the management area of the New England Fishery Management Council and the Mid-Atlantic Fishery Management Council for all federal fisheries within the EEZ (from 3 to 200 nautical miles from the coastline), plus the state waters of the Commonwealth of Massachusetts (from 0 to 3 nautical miles from the coastline). Appendix C provides a description of past, present, and future projects considered in the assessment of cumulative impacts. Present or future offshore wind developments, undersea/submarine cables, transmission lines, and pipelines are relevant to commercial fisheries and for-hire recreational fisheries. BOEM expects marine vessel transportation would also increase, including commercial and recreational vessels. These activities have the potential to cumulatively impact commercial fisheries and for-hire recreational fishing. This is especially true for present and planned developments in proximity to the Proposed Action, including WLAs adjacent to or in proximity to the WDA, specifically the MA WEA or the Deepwater WLA.

Table 3.4.5-10: Comparisons of Alternatives for Commercial Fisheries with No Mitigation

Impacts	A	B	C	D1	D2	E	F
Construction and Installation/Decommissioning							
Increase in vessel traffic in ports or restricted access to the water due to increased use of ports by vessels during construction.	Minor	Minor	Minor	Minor	Minor	Minor	Negligible
Temporary disruption to access or restriction in harvesting activities due to the presence of vessels and construction activities in the WDA and along the OECC.	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible
Changes to the accessibility to/availability of fish within the WDA and along the export OECC due to damage or destruction of fish and fish habitat and/or difficulty deploying fishing gear.	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible
Displacement of fishing vessels, leading to increased conflict over other fishing grounds.	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Negligible
Operations and Maintenance							
Changes to vessel transit corridors and chosen fishing locations due to the presence of proposed-Project infrastructure within the WDA during operations (e.g., affecting travel time and trip costs).	Minor	Minor	Minor	Minor	Minor	Minor	Negligible
Changes to the accessibility to/availability of fish within the WDA and along the export OECC due to damage or destruction of fish and fish habitat and/or difficulty deploying fishing gear.	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible
Displacement of fishing vessels, leading to increased conflict over other fishing grounds.	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible
Non-Routine							
Increased risk of collision between proposed Project-related vessels and fishing vessel (assessed as part of Navigation).	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Negligible
Damage or loss of deployed gear due to mobile gear striking or hooking on proposed Project infrastructure (e.g., unburied or insufficiently buried cables).	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible
Overall Rating	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Moderate to Major	Negligible

OECC = Offshore Export Cable Corridor; WDA = Wind Development Area
Note: Impact rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. Where impacts are presented as a range, the color representing the highest level of impact has been applied.

Table 3.4.5-11: Comparisons of Alternatives for Commercial Fisheries with Mitigation

Impacts	A	B	C	D1	D2	E	F
Construction and Installation/Decommissioning							
Increase in vessel traffic in ports or restricted access to the water due to increased use of ports by vessels during construction.	Minor	Minor	Minor	Minor	Minor	Minor	Negligible
Temporary disruption to access or restriction in harvesting activities due to the presence of vessels and construction activities in the WDA and along the OECC.	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Changes to the accessibility to/availability of fish within the WDA and along the export OECC due to damage or destruction of fish and fish habitat and/or difficulty deploying fishing gear.	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Displacement of fishing vessels, leading to increased conflict over other fishing grounds.	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Operations and Maintenance							
Changes to vessel transit corridors and chosen fishing locations due to the presence of proposed-Project infrastructure within the WDA during operations (e.g., affecting travel time and trip costs).	Minor	Minor	Minor	Minor	Minor	Minor	Negligible
Changes to the accessibility to/availability of fish within the WDA and along the export OECC due to damage or destruction of fish and fish habitat and/or difficulty deploying fishing gear.	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Displacement of fishing vessels, leading to increased conflict over other fishing grounds.	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Non-Routine							
Increased risk of collision between proposed Project-related vessels and fishing vessel (assessed as part of Navigation).	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Damage or loss of deployed gear due to mobile gear striking or hooking on proposed Project infrastructure (e.g., unburied or insufficiently buried cables).	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Overall Rating	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible

OECC = Offshore Export Cable Corridor; WDA = Wind Development Area

Notes: Table assumes financial compensation mitigation for gear loss, construction, and operations. Impact rating colors are as follows: orange = major; yellow = moderate; green = minor; light green = negligible. Where impacts are presented as a range, the color representing the highest level of impact has been applied.

Activities associated with offshore wind energy facilities can increase the area of disturbed seabed affecting fish habitat, decrease the access to fishing grounds, and increase competition over other fishing locations. Specifically, BOEM only considers Tier 1 and Tier 2 activities to be reasonably foreseeable future actions under 40 CFR § 1508.7. Tier 1 includes the CVOW project and the proposed Atlantic City Wind Farm (also called the Nautilus Offshore Wind Project). These projects could potentially include the addition of eight WTGs to the analysis area. Tier 2 includes the South Fork Wind Farm Project, which could potentially contribute an additional 15 WTGs (see Table C.1-3 in Appendix C). Four other Tier 3 offshore wind energy projects are not reasonably foreseeable based on the assumptions outlined in Appendix C; however, any future development of these projects could contribute to cumulative effects if they are developed. In total, Tier 3 projects could potentially include the addition of 232 WTGs. Based on proximity to the WDA, the BSW and Revolution Wind projects would likely have the greatest contribution to cumulative effects if they come to fruition. Potential effects associated with these projects may be similar to the Proposed Action and would likely include seafloor-disturbing activities and impediments to fishing access. However, the extent of these effects would depend on project-specific information that is unknown at this time, such as the location of offshore activities and the arrangement of WTGs.

The following describes specific effects of past, present, and reasonably foreseeable future actions:

- The construction and installation of the Proposed Action, in addition to past, present, and reasonably foreseeable future construction activities of other offshore developments in the geographic area, can increase vessel traffic and result in delays or restrictions in access to ports for fishing vessels due to increased use of ports by the Proposed Action vessels.
- The construction and installation of the Proposed Action, in addition to past, present, and reasonably foreseeable future construction activities of other offshore developments, can limit the access to fish or restrict harvesting activities due to the presence of construction activities and non-fishing vessels.
- Construction and installation and operations and maintenance of the Proposed Action, as well construction and operations of other past, present, and reasonably foreseeable future offshore activities, can reduce access to and availability of fish within the WDA and other WLAs/WDAs. This can result in damage or destruction of fish and fish habitat. In addition, it would make it more challenging to deploy mobile gear for a larger number of fishing vessels.
- Construction and installation and operations and maintenance of the Proposed Action, as well construction and operations of other past, present, and reasonably foreseeable future offshore activities, could create a larger displacement of fishing vessels from affected areas, leading to increased conflict over other fishing grounds.
- Construction and installation of the Proposed Action, as well as past, present, and reasonably foreseeable future construction activities of other offshore developments, can notably increase vessel traffic and result in delays or restrictions in access to ports for fishing vessels due to increased use of ports by the Proposed Action vessels.
- There would be an increased risk of collision between fishing and Proposed Action vessels, based on the increased traffic the proposed Project would bring to the area, particularly during the construction and installation period.
- There would be an increased risk of collision for all fishing vessels navigating within or near the WDA, including collision with fishing or other vessel types. For further discussion, see Section 3.4.7.
- There would be an increased risk of allision for fishing vessels with WTGs or ESPs, including powered and drift allision, during all Proposed Action phases.
- An increased number of vessels would experience damage or loss of deployed gear due to mobile gear striking or hooking on offshore infrastructure (e.g., insufficiently buried cables, foundations).

In particular, similar projects in proximity or adjacent to the WDA may cumulatively impact fishing revenue landed in local ports. The recently published COP by Deepwater Wind South Fork LLC (Ch2m 2018) provides information on impacts to commercial and recreational fisheries in the Deepwater WLA (the South Fork Wind Farm project is located in the southern part of OCS-A0496; see Figure 1.1-1). As indicated in the technical report, fishing vessels from Massachusetts, Rhode Island, Connecticut, and New York conduct most of their fishing activities in the Deepwater WLA, with some vessels also operating from New Jersey, Virginia, and North Carolina. The largest annual revenue (based on 2006 to 2015 data) was landed in New Bedford ($407,000), Point Judith ($391,100), Newport and Little Compton ($188,000 each). Ports of Little Compton (8.5 percent), and Chilmark and Westport (5.4 and 5.1 percent, respectively) had the greatest percentage of revenue sourced from within the Deepwater WLA. Fishing vessels in the Deepwater WLA typically target monkfish, lobster, skates, sea scallops, and surfclam-ocean quahog WEA, where by FMP, the largest annual revenue comes from monkfish ($247,300), sea scallop ($193,300) and surfclam/ocean quahog ($98,700). Together with other proposed projects, such as an offshore wind power project off Virginia Beach (to be located in OCS-A 0497), the South Fork Wind Farm would cumulatively interact with potential impacts of the Proposed Action and other adjacent projects cumulatively reducing fishing revenue for affected commercial fishery and for-hire recreational fishing (see Section 3.4.5.1).

Additional impacts on commercial fisheries and for-hire recreational fishing can result from climate change events such as increased magnitude or frequency of storms, shoreline changes, and water temperature changes. FMPs are established to manage fisheries to avoid overfishing through the use of catch quota, special management areas and closed area regulations; these can further reduce (or increase) the size of available landings to commercial fisheries.

All of the above activities and events can cumulatively reduce the availability of fish stock to commercial fisheries and for-hire recreational fisheries or increase the costs of fishing, decreasing the volume of landed catch, revenues, and profits. The magnitude of this effect is difficult to predict, as it would depend on the total area being developed, the species frequently harvested in those areas, and the size of fishing fleets affected. There is also limited information on impacts of reasonably foreseeable future projects that are mostly in early design stages. However, in the context of the larger region defined by the cumulative impacts assessment boundaries and the FMP fisheries potentially affected, a reasonable prediction is that the effects on commercial fisheries and for-hire recreational fishing as a result of the Proposed Action and other potential developments would be **moderate to major**.

The cumulative impacts of Alternatives B, C, D1, D2, and E on commercial fisheries and for-hire recreational fishing would be the same as for the Proposed Action: **moderate to major**.

3.4.5.12. Incomplete or Unavailable Information for Commercial Fisheries and For Hire Recreational Fishing

Fisheries are managed in the context of an incomplete understanding of fish stock dynamics and effects of environmental factors on fish populations. Although the fisheries information used in this assessment has limitations (e.g., vessel trip report data is an imprecise measurement of where fishing occurred; available historical data lacks consistency making comparisons challenging), it does represent the best available data and sufficient information exists to support the findings presented herein. Any detailed interpretation should be treated with caution as it may not fully or correctly represent the value of fisheries.

3.4.6. Land Use and Coastal Infrastructure

This section examines existing land use in the vicinity of the proposed Project's onshore facilities.

3.4.6.1. Description of the Affected Environment for Land Use

Regional Setting

Proposed onshore facilities would be located along the southern coast of Cape Cod, Massachusetts. The cable landfall sites, cable route, and substation would be within the towns of Barnstable and Yarmouth in Barnstable County. Construction as well as operations and maintenance of the proposed Project would use port facilities in New Bedford and Martha's Vineyard. Proposed Project construction, operations and maintenance could also require use of other Massachusetts ports, as well as ports in Rhode Island and Connecticut, and one or more Canadian ports.

The Town of Barnstable is the largest community on Cape Cod in both land area and population, and serves as the county seat. Most of the town's residential development has occurred in the last 40 years. The Hyannis area, west of the proposed Project facilities, contains important assets, including two ferry terminals, the region's largest commercial airport, and the Cape Cod Hospital. Barnstable has large areas of wetlands, forest, and freshwater ponds (Town of Barnstable 2010). Of the town's 38,500 acres (155.8 km^2), 28 percent (10,799 acres [43.7 km^2]) is protected open space and 11 percent (4,070 acres [16.5 km^2]) is committed to recreation, public use (including the airport), or private agriculture/forest lands (Ridley 2010). Low- to medium-density residential development surrounds commercial and industrial uses along major roads. Working waterfronts are a long-established feature of Barnstable County's deep-water harbors, which support traditional fishing activities and recreational boating (Epsilon 2018a).

The Town of Yarmouth is characterized by low- to medium-density residential development, with commercial corridors along Route 6 and Route 28. Of the approximately 4,600 acres (18.6 km^2) of land in the Town of Yarmouth, 1,700 acres (6.9 km^2) are devoted to conservation, including land for the protection of public water supplies. Various ownership and conservation restrictions protect an additional 1,500 acres (6.1 km^2) from development (Epsilon 2018a).

Martha's Vineyard is the largest island in Dukes County, and lies southwest of the cable landfall sites. About 2 percent of the island is zoned for commercial or industrial use, 40 percent is preserved from development, and nearly all of the remaining land area is developed for residential uses (Martha's Vineyard Commission 2010). Commercial activity centers on the traditional village centers, while residential development is more dispersed. Waterfront communities focus on tourism-oriented businesses and seasonal residences. Industrial activities cluster at the Airport Business Park alongside other commercial activities (Epsilon 2018a).

Project Area

At the landfall sites, the proposed Project would make the physical connection between the proposed OECC and the proposed onshore export cables in one or more underground concrete transition vaults. From the surface, the only visible components of the cable system would be the manhole covers (Epsilon 2018a). In addition to the landfall sites, the proposed Project would utilize various ports for construction and installation as well as for operations and maintenance.

Landfall Site 1: Covell's Beach Parking Lot, Town of Barnstable

The Covell's Beach landfall site is located on Craigville Beach Road near the paved parking lot entrance to a public beach owned by the Town of Barnstable. Residences and a building associated with the public beach are west of the potential landfall site, between Craigville Beach Road and the beach. Residential neighborhoods (single-family homes and one multifamily community) are located on both sides of the road to the north and northeast.

Landfall Site 2: New Hampshire Avenue/Lewis Bay, Town of Yarmouth

The New Hampshire Avenue landfall site is located where New Hampshire Avenue ends at the Lewis Bay coastline. The shoreline near the landfall site has been entirely altered with roads, sea wall, riprap, and other manmade features. The surrounding area consists of seasonal residences (Epsilon 2018a). The Yarmouth Recreation Sailing Center is 200 feet (61 meters) north of the proposed landfall site along New Hampshire Avenue; the public parking lot for Englewood Beach and a public boat ramp are 300 feet (91.4 meters) north. Seasonal housing structures are located on the properties adjacent to the landfall site; the residences are 30 to 40 feet (9.1 to 12.2 meters) from the end of New Hampshire Avenue.

Onshore Export Cable Routes

Vineyard Wind would install onshore cables entirely underground, with access points via manholes every 1,500 to 2,000 feet (457.2 to 609.6 meters) (Epsilon 2018a). Table 3.4.6-1 summarizes the land uses along the eastern and western OECRs connecting the landfall site to the proposed onshore substation. The eastern OECR would extend from the New Hampshire Avenue landfall site to the proposed new substation site, while the western OECR would connect the Covell's Beach landfall site to the proposed new substation site. Cable routes would generally follow or be under or adjacent to existing roads or utility ROWs (Epsilon 2018a).

Table 3.4.6-1: Potential Onshore Cable Routes

Road or ROW [a] Used	Distance (miles)	Primary Adjoining Land Uses
Eastern Onshore Export Cable Route [b]		
Berry Avenue	0.7	Residential
Higgens Crowell Road	2.6	Residential, commercial, industrial, and institutional near major roads
Utility ROW	1.7	Residential, wooded, office
Mary Dunn Road	0.4	Wooded, residential and industrial along U.S. 6
Eastern Variant 1: Willow Street	0.5	Wooded, office
Eastern Variant 2: Utility ROW	0.7	Wooded, residential, industrial south of U.S. 6
Eastern Variant 3: Utility ROW south of U.S. 6	1.2	Wooded, no existing utility ROW
Eastern Variant 5: Independence Drive	0.5	Wooded, institutional
Western Onshore Export Cable Route		
Craigville Beach Road	0.6	Residential
Strawberry Hill Road	1.4	Residential; commercial and institutional near major roads
Wequaquet Lane	0.4	Residential; commercial and institutional near major roads
Phinneys Lane	1.3	Residential; institutional and industrial near major roads
Utility ROW/Industrial Sites	1.8	Industrial, wooded
Western Variant 1: Attucks Lane	0.7	Industrial

Source: Epsilon 2018a
[a] ROW = right-of-way
[b] Vineyard Wind eliminated the Eastern Route Variant 4 from the proposed Project; however, variant numbering has been maintained to avoid confusion with previous versions of the COP.

Onshore Substation

The proposed Project substation would be adjacent to the existing Barnstable Switching Station, on approximately 7 acres (28,328.1 m^2) of mostly wooded land. The proposed substation site could also use an existing parking area and small building (Epsilon 2018a). The site is within an existing industrial area, adjacent to an electric transmission corridor (see Figure 2.1-1).

Ports

Marine Commerce Terminal, New Bedford

Vineyard Wind has signed a letter of intent to use the MCT to support proposed Project construction. This facility, in the City of (and part of the Port of) New Bedford in Bristol County, is within New Bedford's extensive industrial waterfront, adjacent to the Acushnet River estuary, which empties into Buzzard Bay. The MCT is surrounded by primarily marine-related industrial uses. Development at the MCT, with support from the Commonwealth of Massachusetts, has targeted the offshore wind energy industry in general (Sasaki et al. 2016). Potential impacts of development and activity at the MCT on land use and coastal infrastructure is discussed under cumulative impacts in Section 3.4.6.3.

Vineyard Haven Harbor, Martha's Vineyard

Vineyard Wind would use Vineyard Haven Harbor in Tisbury as the location of the proposed Project's Operations and Maintenance Facility. Vineyard Haven Harbor is the island's year-round working port, and is home to most of the Martha's Vineyard boatyards. Small coastal tankers and ferries regularly use Vineyard Haven Harbor to transport freight, vehicles, and passengers (Epsilon 2018a). The areas of Tisbury near the Vineyard Haven Harbor are a mix of marine-related, commercial, and residential uses.

Other Ports

Depending on demands and activities at the, the proposed Project may conduct construction staging activities in other areas at the Port of New Bedford, or at one or more ports in Massachusetts, Rhode Island, or Connecticut (see Section 2.1.1.1), as well as one or more Canadian ports. These ports are generally industrial in character, and are typically adjacent to other industrial or commercial land uses and major transportation corridors. Potential impacts of development and activity at these ports is discussed under cumulative impacts in Section 3.4.6.3. See Sections 3.4.4 and 3.4.5 for discussions of recreational vessel and commercial fishing activity in these ports.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the following aspects of land use:

- Residential, recreational, commercial, industrial, and institutional land uses adjacent to landfall sites and OECRs;
- Industrial land (including an existing substation) adjacent to the proposed substation; and
- Existing marine, commercial, and industrial uses near proposed construction staging, operations, and maintenance facilities.

Condition and Trend

The towns of Barnstable, Yarmouth, and Tisbury are long-established communities with a mix of low- to medium-density residential development, business areas, extensive recreation or tourist-oriented commercial and public uses, open space, and smaller areas of industrial land use. Historic homes and town centers exist in close proximity to more recent development. Beaches and waterfront areas are important features to all three towns. Barnstable and Tisbury both have harbors (Hyannis and Vineyard Haven, respectively) important to local marine traffic, including ferry passenger services, fishing, charter, and recreational vessels. Barnstable is the county seat and has multifamily housing, an airport, hospital, industrial areas, and major government buildings.

The town or community plans for Barnstable, Yarmouth, and Martha's Vineyard place priority on protection of community character and conservation of natural resources, and recommend no substantial changes in land uses near proposed Project onshore facilities (Town of Barnstable 2010; Yarmouth Department of Community Development 1998; Martha's Vineyard Commission 2010). New Bedford actively promotes economic development in its port area, including support of the offshore wind energy industry (Sasaki et al. 2016). The Martha's Vineyard plan notes a decline in the commercial fishing industry and calls for protecting harbor facilities for commercial fishing, including harbors in Tisbury and other towns on the island (Martha's Vineyard Commission 2010).

The city of New Bedford is a densely developed, historic manufacturing town and port. The city's Master Plan establishes numerous goals, which include developing emerging technology industry sectors, linking brownfields and historic mills with new development opportunities, diversifying the industries in the Port of New Bedford while supporting traditional harbor industries, and promoting sustainable, mixed-use development in neighborhoods (Vanasse Hangen Brustlin, Inc. 2010).

3.4.6.2. Environmental Consequences

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of impacts on land use and coastal infrastructure include the following elements of the maximum-case scenarios as described in Appendix G:

- The onshore cable landfall site chosen and the selected OECR.
- The time of year during which construction occurs. Onshore construction would take place from September through May, with installation of cables continuing through June 15 with permission from the towns of Barnstable or Yarmouth (COP Volume III; Epsilon 2018a).
- The ports chosen for construction support in addition to the MCT, and improvements (if any) needed at those ports specifically to support the Project.

Potential Variances in Impacts

Aspects of the proposed Project design subject to variation include the OECRs. Each cable landfall site is within or adjacent to a public beach and each OECR follows public roads and utility ROW. The magnitude of impacts would be similar for each route.

Vineyard Wind would schedule onshore construction to occur after Labor Day and before Memorial Day, outside of the busiest tourist season. If Project delays were to change this schedule, the impacts discussed in Sections 3.4.6.3 through 3.4.6.6 would be exacerbated.

3.4.6.3. Impacts of Alternative A (Proposed Action) on Land Use and Coastal Infrastructure

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations and maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct impacts would include a change in land use type or intensity caused by the Proposed Action, temporary or permanent loss of access to land areas due to construction activity (such as noise or visual impacts) or onshore components of the Proposed Action, or alterations to coastal infrastructure (port facilities, public access areas such as beaches and parks) that change or intensify the coastal land uses.[30] Indirect impacts would include the economic consequences of land use changes, such as reduced property value and property tax revenue (see Section 3.4.1.3).

The sections below summarize the potential direct and indirect impacts of the Proposed Action on land use and coastal infrastructure.

Construction and Installation of Offshore Components

Land uses impacted by construction of offshore components would include the MCT and other port facilities used for shipping, storing, and fabricating Proposed Action components. Vineyard Wind would use the MCT to offload shipments of components, prepare them for installation, and load components onto vessels for delivery to the WDA for installation. The Proposed Action would support the City of New Bedford's land use planning goals (as stated in the Waterfront Framework Plan [Sasaki et al. 2016]) and the state's investment in the MCT by enabling the MCT to better fulfil its purpose of supporting the wind energy industry. Therefore, the Proposed Action's use of the MCT would have **minor beneficial** impacts on land use and coastal infrastructure.

In addition, Vineyard Wind has stated that it may use other ports in Massachusetts, Rhode Island, and Connecticut[31] for potential offloading, storage, and staging of Proposed Action components for delivery to the WDA. As stated in

[30] Information related to potential sedimentation and vegetation loss impacts can be found in Sections 3.2.2 and 3.3.1.

[31] Potential ports in Canada, identified in Section 2.1.1, are outside of the scope of this analysis.

Section 3.4.6.1, these other ports are industrial in character, designated by local zoning and land use plans for heavy industrial activity, and typically adjacent to other industrial or commercial land uses and major transportation corridors. The Proposed Action's potential activities at these ports would support designated uses would have a **negligible beneficial** impact on the land uses and coastal infrastructure in each of these ports.

Activities associated with Proposed Action construction would generate noise, vibration, and vehicular traffic at the MCT and, to a lesser extent, any of the other ports described above. These impacts are typical for industrial ports; the Proposed Action would not increase above the levels typically experienced or expected at these facilities, and would not hinder other nearby land use or use of coastal infrastructure.

Overall, construction and installation of offshore components would have **minor beneficial** impacts on land use and coastal infrastructure by supporting designated uses at ports. Section 3.4.1.2 discusses the economic impacts of the Proposed Action's use of the MCT and other ports.

Construction and Installation of Onshore Components

Construction of the cable landfall sites and underground cable routes would temporarily disturb neighboring land uses through construction noise, vibration and dust, and delays in travel along the impacted roads listed above (Section 3.4.4.1). Construction and installation of the Proposed Action's onshore components would also require construction staging in parking lots adjacent to or near the landfall sites. This would reduce the public parking available for Covell's Beach and for Edgewood Beach and the adjacent boat ramp. These disturbances would be temporary, lasting 1 year (excluding the June through August peak tourist season). Vineyard Wind would complete construction at any one location along a public road in a matter of days or weeks.

Vineyard Wind would work with the Town of Barnstable and/or Yarmouth (depending on the cable landfall site and OECR chosen) to develop a Traffic Management Plan to "minimize disruptions to residences and commercial establishments in the vicinity of construction and installation activities" (COP Volume III, Section 4.2, Table 4.2-1; Epsilon 2018a). Vineyard Wind would also fund a construction monitor (to be hired by the effected towns) to ensure compliance with the Traffic Management Plan and communicate with the appropriate stakeholders (COP Volume III, Section 7.2.2.1.2; Epsilon 2018a).

Vineyard Wind would install the OECR in an underground duct bank, primarily underneath existing public roads (COP Volume III, Section 2.2.2.1; Epsilon 2018a). BOEM assumes that the Proposed Action would avoid permanent disruption to existing underground utilities, such as water, sewer, and electrical lines; however, depending on the exact placement of the duct bank, installation of the OECR could hamper future installation of public utilities. As a result, and considering the traffic and access effects described above, construction and installation of the Proposed Action would have a **moderate impact** on land use and coastal infrastructure. These impacts would be greater if Vineyard Wind selects the New Hampshire Avenue landfall site due to the disruption of a public parking lot, beach, and boat ramp; however, based on the impact definitions in Section 3.1, these impacts would remain **moderate**.

Vineyard Wind would construct the Proposed Action's substation adjacent to an existing substation, in an industrially zoned area of Barnstable. Accordingly, the Proposed Action's substation would have **negligible** impacts on land use and no impacts on coastal infrastructure

Vineyard Wind would locate the Project's Operations and Maintenance Facilities at Vineyard Haven Harbor in Tisbury. The Operations and Maintenance Facilities could use existing buildings or require renovation or new construction, and would likely require improvements to existing piers (COP Volume I, Section 3.2.6; Epsilon 2018a). At the time of preparation of this Draft EIS, information was lacking to perform a detailed indirect impact assessment of the necessary modifications at Vineyard Haven; however, **moderate** land use and coastal infrastructure impacts are anticipated during construction, due to disruption of access, noise, and dust typically associated with construction projects.

Operations and Maintenance

Operations and maintenance of the Proposed Action's offshore components would require daily activity at the Operations and Maintenance Facilities and periodic activity at the MCT and other ports, if needed. The Operations and Maintenance Facilities would include offices, a warehouse, training, repair facilities, and docks, all of which are consistent with the range of land uses permitted by the Town of Tisbury in this area. The increased activity within the town's port and areas zoned for business and industrial uses would reinforce the land use character of Tisbury's harbor, town center, and business areas, and provide a source of investment in the coastal infrastructure. Activities at other ports, as described for the construction and installation phase, would be consistent with the existing and designated uses at other ports. Accordingly, operations and maintenance of offshore components would have **minor beneficial** impacts on land use and coastal infrastructure.

Once installed, the onshore cables and landfall ducts would be underground and would not change adjacent land uses or affect coastal infrastructure. Periodic maintenance and repairs would have minor, temporary impacts on access to adjacent land uses. The cables and ducts would therefore have **negligible** impacts on land use and coastal infrastructure.

Decommissioning

Impacts during decommissioning would be similar to the impacts during construction and installation. The activity generated at the MCT and other ports would continue to be consistent with existing and designated port uses.

If Vineyard Wind removes the underground, onshore cables and cable ducts, temporary construction disturbances would result along the affected roads and in the vicinity of the landfall sites. The length and extent of these delays would be similar to those experienced during installation. As with construction, decommissioning activities would have larger impacts if conducted during the summer season.

Provided that the removal of cables and landfall sites occurs outside of the June to August peak tourist season, decommissioning of the onshore components of the Proposed Action would have **negligible** impacts on land use, while decommissioning of the offshore components would have **beneficial** impacts on port land use.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. Non-routine activities that could impact land use and coastal infrastructure include collisions or allisions (including resultant spills or releases) at Vineyard Haven or the MCT, or non-routine maintenance of the OECR. These activities would generally require intense, temporary activity to address emergency or urgent conditions. The temporary presence of onshore construction equipment, as well as the unexpectedly frequent vessel activity in Vineyard Haven Harbor, would have **minor** impacts on land use and coastal infrastructure.

Conclusion

Construction and installation and decommissioning of the offshore components of the Proposed Action would have **minor beneficial** impacts on land use due to increased compatible uses at ports, while construction or decommissioning of onshore components would have **moderate**, temporary impacts on land use and coastal infrastructure, due to disturbance associated with onshore construction.

Operation and maintenance of the Proposed Action would have **minor beneficial** impacts on land use due to compatible activity at ports, and **negligible** impacts due to occasional routine maintenance activity along the OECR and substation.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.6.4. Impacts of Alternative B on Land Use and Coastal Infrastructure

Alternative B is the same as the Proposed Action, except that the only OECC landfall site that Vineyard Wind would consider is the Covell's Beach landfall site, with the corresponding OECC route.

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Construction and installation of Alternative B would avoid impacts on Englewood Beach, the public boat ramp and parking lot, and nearby residences. Other construction, operations and maintenance, and decommissioning impacts of Alternative B would be the same as the Proposed Action. The overall impact of Alternative B on land use and coastal infrastructure would be the same as the Proposed Action: during construction, **minor beneficial** impacts at ports, and **moderate** impacts for the onshore infrastructure (the cable route and substation and indirect impacts at Vineyard Haven), and during operations, **minor beneficial** impacts at ports and **negligible** impacts for onshore infrastructure.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative B on land use and coastal infrastructure would be the same as the Proposed Action: **minor**.

Conclusion

Alternative B would have the following impacts:

- **Minor beneficial** impacts at ports, and **moderate** impacts for onshore land use and marine infrastructure at Vineyard Haven during construction and installation and decommissioning; and
- **Minor beneficial** impacts at ports and **negligible** impacts for onshore infrastructure during operations and maintenance.

3.4.6.5. Impacts of Alternatives C, D, and E on Land Use and Coastal Infrastructure

The impacts of Alternatives C, D (including Alternatives D1 and D2), and E on land use and coastal infrastructure would be the same as the Proposed Action: during construction, **minor beneficial** impacts at ports, and **moderate** impacts for the onshore infrastructure (the cable route and substation and indirect impacts at Vineyard Haven), and during operations, **minor beneficial** impacts at ports and **negligible** impacts for onshore infrastructure. The impacts of non-routine activities associated with Alternatives C, D, and E on land use and coastal infrastructure would be the same as the Proposed Action: **minor**.

3.4.6.6. Impacts of the No Action Alternative on Land Use and Coastal Infrastructure

The land areas within or adjacent to the onshore facilities of the proposed Project are within developed communities. If BOEM does not approve the proposed Project, these communities would experience continued activity in accordance with established land use patterns and regulations. The **minor beneficial** impacts from the proposed Project on land uses and coastal infrastructure at certain ports would not occur.

The harbors proposed for construction support or operations and maintenance would continue to serve marine traffic and industries, without the new business that the proposed Project would provide.

3.4.6.7. Comparison of Alternatives for Land Use and Coastal Infrastructure

In comparison to the Proposed Action, the other alternatives would not have a meaningfully different impact on land use and coastal infrastructure. Alternative B would avoid potential impacts on Englewood Beach (including the beach, boat ramp, and parking lot), and thus would be marginally less impactful than the Proposed Action; however, both the Proposed Action and Alternatives B, C, D1 and D2 would have **minor beneficial** impacts and **negligible to moderate** impacts on land use and coastal infrastructure. As discussed in Section 3.4.6.2, the analysis of impacts is based on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.6.3 through 3.4.6.5.

3.4.6.8. Cumulative Impacts

The areas of analysis for cumulative impacts on land use and coastal infrastructure are the Towns of Barnstable and Yarmouth, and the ports potentially used for Project construction, operations and maintenance, and decommissioning (see Appendix C, Figure C.1-14). Appendix C describes projects that could generate cumulative impacts on land use and coastal infrastructure. These include:

- Approved onshore development projects, such as the Village at Barnstable (Hyannis, Massachusetts) and manufacturing, commercial, and retail development projects within approximately 1 mile or less from the onshore facilities; and
- Cable landfall sites and OECRs associated with other offshore wind energy projects (if those landfall sites and OECRs would be within 1 mile of the Proposed Action); none are reasonably foreseeable at this time.
- Past, present, and reasonably foreseeable future improvements to the MCT and the surrounding area. The Draft New Bedford Port Authority Strategic Plan does not identify specific future improvements at the MCT expansion (Port of New Bedford 2018); however, the MCT and surrounding parcels have substantial growth potential for large land uses and job training to support the wind sector, advanced manufacturing, and research (Sasaki et al. 2016). New Bedford's land use goals include expansion and improvement of waterfront facilities to support commercial fishing, the shipping industry, and recreational boating, providing for a full range of port users (Sasaki et. al. 2016). The MCT is separated from urban residential neighborhoods by other, less intensive industrial and commercial sites and major roads. The New Bedford Waterfront Framework Plan recommends adaptive reuse of brick mill buildings south of the MCT, to further insulate adjacent residential neighborhood to the south from the heavy industry of the port (Sasaki et. al. 2016).

- Redevelopment of the Connecticut State Pier, located in New London's historic downtown and identified by Vineyard Wind as possibly supporting Proposed Action construction and/or operations and maintenance. The Connecticut Port Authority seeks to manage and redevelop the Connecticut State Pier partially to support the offshore wind industry, which could increase the port activity (City of New London 2017).
- Improvements to the ProvPort and Port of Davisville at Quonset Point, identified by Vineyard Wind as possibly supporting construction of the Proposed Action. Deepwater Wind has committed to substantial improvements to Rhode Island Ports in support of the Revolution Wind Project (Kuffner 2018). The Quonset-Davisville Port is within a developing commerce/industrial park, buffered from nearby residential communities by the surrounding business park. The ProvPort is within downtown Providence. Like the MCT, the ProvPort is in a heavy industrial area, adjacent to older residential and commercial neighborhoods.
- Improvements to other Massachusetts ports. The Massachusetts Clean Energy Center has identified eighteen waterfront sites in Massachusetts that may be available and suitable for use by the offshore wind industry (MassCEC 2017a). The eighteen sites include two identified by Vineyard Wind as potential facilities to support construction or operations and maintenance: the Brayton Point and Montaup Power Plant sites (MassCEC 2017a and b; only the Brayton Point site is considered reasonably foreseeable (see Appendix C). Both are retired waterfront power plant sites with a long history of industrial (power production) use. Neighboring land uses for Brayton Point include a town-owned wetland and a residential neighborhood (MassCEC 2017b). Reuse of the Brayton Point for port and industrial activities (consistent with the Proposed Action's needs) would potentially increase the marine and road traffic, noise, and air pollution in the area.

Construction of the proposed or reasonably foreseeable onshore projects would temporarily disturb neighboring land uses due to noise, vibration, and dust, as well as travel delays along impacted roads. Simultaneous construction of two or more onshore development projects and/or cable landfall sites and OECRs would, when combined with the Proposed Action, generate cumulative impacts on land use, especially in the area near Barnstable Municipal Airport (i.e., within 1 mile of the proposed substation). None of the onshore development projects would be adjacent to (and none would use roads impacted by) the Proposed Action's cable landfall sites and OECRs. The disturbance associated with construction of the OECR would be temporary and confined to a limited geographic area at any given time.

Construction of the MCT is complete, with no reasonably foreseeable expansion. The initiation of offshore wind-related activity at the MCT would be within the boundary of the established terminal and in accordance with the City of New Bedford's land use goals and plans. Similarly, reasonably foreseeable construction and operation of improvements at other ports to support offshore wind projects would occur within the boundaries of existing port facilities or re-purposed industrial facilities, would be similar to existing activities at the existing ports, and would support state strategic plans and local land use goals for development of waterfront infrastructure. State and local agencies would be responsible for minimizing the impacts of these future development plans by ensuring continued access to ports and adjacent land uses, and minimization or avoidance of noise, air quality, and other impacts on nearby neighborhoods.

Based on the discussion above, the Proposed Action's cable landfall sites, OECR, and substation, when combined with past, present, and reasonably foreseeable future projects would result in **negligible** cumulative impacts on land use and coastal infrastructure. The Proposed Action, when combined with past, present, and reasonably foreseeable future development and use of other port facilities to support offshore wind energy projects, would have **minor** adverse impacts on land use and coastal infrastructure, due to impacts on residential neighborhoods near existing and proposed port facilities. State and local plan review, as described above, would be required to ensure that adverse impacts remain minor. The Proposed Action, when combined with past, present, and reasonably foreseeable future development and use of other port facilities to support offshore wind energy projects, would have **minor beneficial** impacts on land use and coastal infrastructure due to the investment and economic activity at port facilities and underused industrial sites consistent with established state and local land use goals**.**

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **negligible** impacts on for onshore activities, **minor** impacts on residential neighborhoods near ports, and **minor beneficial** impacts at ports themselves.

3.4.6.9. Incomplete or Unavailable Information for Land Use and Coastal Infrastructure

Other than the MCT and Vineyard Haven, Vineyard Wind has not stated which ports they would use for proposed Project construction or operations and maintenance. This information would enable a more detailed description of potential land use and coastal infrastructure impacts at other designated ports, comparable to the discussion of the MCT in Section 3.4.6.3; however, sufficient information was available for the evaluation of land use and coastal infrastructure.

3.4.7. Navigation and Vessel Traffic

This section discusses navigation and vessel traffic characteristics, and potential impacts on the waterways and adjacent water approaches for the area specified within the WDA, the MCT, and other port and Operations and Maintenance Facilities. Information presented in this section draws upon the COP (Epsilon 2018a), including the Revised NRA for the Project (COP Appendix III-I; Epsilon 2018a), which was prepared to comply with guidelines in the USCG's Navigation and Vessel Inspection Circular 02-07 (USCG 2007).

3.4.7.1. Description of the Affected Environment for Navigation and Vessel Traffic

Regional Setting

Proposed Project facilities would be located within and off the coast of Massachusetts, supported by ports in Massachusetts and potentially in Connecticut and Rhode Island.[32] The coastal areas of these states support high volumes of vessel traffic. This includes cargo, tanker, and other heavy vessel traffic to and from major ports in Boston and New York (NOAA 2018l), as well as commercial and recreational fishing, ferries, and other recreational vessel activity (see Sections 3.4.4 and 3.4.5). Figure 3.4.7-1 presents regional vessel traffic.

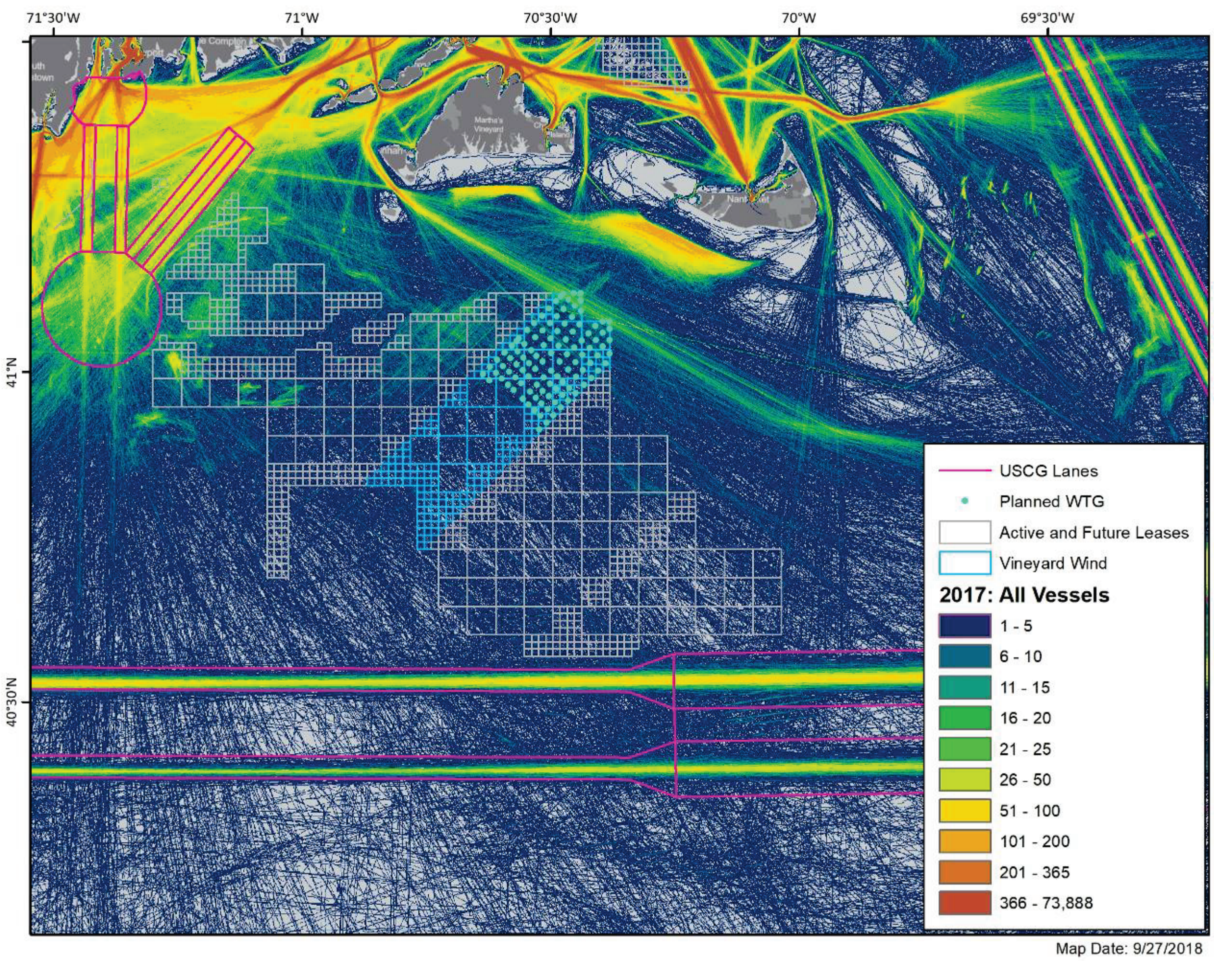


Figure 3.4.7-1: Vessel Traffic, 2017

"The area off of the southern coast of Massachusetts includes several precautionary areas, which are defined areas within which ships must use caution and should follow the recommended direction of traffic flow" (COP Section 3.5 and Figure 3.5, Appendix III-I; Epsilon 2018a). Traffic separation schemes exist in precautionary areas to facilitate safe

[32] Vineyard Wind could use ports in New Jersey or Canada; however, these areas are outside of the scope of this analysis and this section does not further discuss them.

navigation by creating traffic lanes reserved for unidirectional traffic, typically for deep-draft vessels. The study area includes portions of the Nantucket to Boston traffic separation scheme and the Nantucket to Ambrose traffic separation scheme, while the areas off the coast of Massachusetts, Rhode Island, and Connecticut include traffic separation scheme lanes for the approaches to Narraganset Bay (Providence, Rhode Island), Buzzards Bay, and the Ports of Boston and New York (COP Figure 3-5, Appendix III-I; Epsilon 2018a).

Project Area

Vessel Traffic

Table 3.4.7-1 summarizes the number and type of vessels recorded within 10 miles (16 kilometers) of the WDA. Commercial fishing vessels and recreational vessels comprised more than 70 percent all of the AIS tracks recorded in 2016 and 2017. While the area north of the WDA is highly frequented by commercial fishermen, data analysis shows that the WDA itself is also utilized by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling (COP Section 4.1.7, Appendix III-I; Epsilon 2018a).

Table 3.4.7-1: 2016 and 2017 AIS Vessel Traffic Data

	Vessel Dimensions (maximum-minimum)					Vessel Traffic	
Vessel Type [a]	**Length**	**Beam**	**Draft**	**DWT [b]**	**Speed (knots)**	**2016**	**2017**
Research Vessels	108–236 ft (33–72 m)	23–46 ft (7–14 m)	7–20 ft (2–6 m)	97–2328 t (88–2,112 MT)	<1–19	1	1
Passenger Cruise Ships/Ferries	na	na	na	na	na	1	9
Commercial Fishing	36–197 ft (11–60 m)	13–49 ft (4–15 m)	13–16 ft (4–5 m)	453 t (411 MT)	<1–18	198	314
Dredging/Underwater/ Diving Operations	112–341 ft (34–104 m)	39–66 ft (12–20 m)	9–22 ft (3–7 m)	4,400 t (3,992 MT)	<1–22	2	1
Military or Military Training	141–269 ft (43–82 m)	39–43 ft (12–13 m)	11 ft (3 m)	1,820–2,250 t (1,651–2,041 MT)	3–9	4	8
Recreational (Pleasure, Sailing, Charter Fishing, etc.)	36–184 ft (11–56 m)	13–33 ft (4–10 m)	7–38 ft (2–12 m)	499 t (452 MT)	<1–58	142	176
Cargo	551–656 ft (168–200 m)	56–108 ft (17–33 m)	23–36 ft (7–11 m)	22,563 t 20,469 MT	2–8	5	13
Tug-and-barge	118–492 ft (36–150 m)	36–76 ft (11–23 m)	17–23 ft (5–7 m)	637 t (578 MT)	10–21	2	14
Other/Unspecified	na	na	na	na	na	76	147
Total						431	683

Source: COP Table 4.0-2 and Table 4.3-6, Appendix III I; Epsilon 2018a
AIS = Automatic Identification System; DWT = deadweight tons; t = tons; MT = metric tons; ft = feet; m = meter; na = data not available
[a] Includes only vessels equipped with AIS (required for commercial vessels >65 ft in length)
[b] Displacement based on example vessels

The NRA study only recorded vessels using an AIS, which is only required on commercial vessels with a length of 65 feet (19.8 meters) or longer. As shown in Table 3.4.7-1, some smaller recreational and fishing vessels carry an AIS; however, the NRA data likely excludes most vessels less than 65 feet (19.8 meters) long that traverse the WDA (COP Section 2.2, Appendix III-I; Epsilon 2018a). It is likely that non-AIS commercial and recreational vessels navigate through the WDA and across the OECC.

The NRA did not provide data for AIS crossings of the OECC (including Lewis Bay); however Figure 4.0-4 in the NRA shows AIS vessel tracks across the OECC. The OECC route alternative through Lewis Bay would cross major ferry routes (shown in NRA Figure 4.0-4 as “passenger vessels” and “high speed vessels”). About 15 nautical miles offshore, the OECC route would cross a navigation route for tug-and-barge (shown as “towing”), tanker, and fishing vessels. Recreational vessels have also been commonly recorded throughout this area (COP Figure 4.0-4, Appendix III-I; Epsilon 2018a).

It is likely that non-AIS commercial fishing and recreational vessels navigate across the OECC. In 2016 and 2017, a daily average of 150 vessels crossed or came within 0.3 miles (0.5 kilometers) of the OECC (COP Section 4.3, Appendix III-I; Epsilon 2018a). Section 3.4.4 discusses recreation while Section 3.4.5 discusses commercial fisheries.

The heaviest vessel traffic in the vicinity of the WDA occurs in four primary areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. Additionally, high-volume passenger ferry traffic occurs between Hyannis and Nantucket and Martha's Vineyard. Additional information and datasets, tables, and figures related to vessel traffic can be found in COP Section 7.8 (Volume III; Epsilon 2018a) and in the NRA (COP Section 4.0, Appendix III-I; Epsilon 2018a). Section 3.4.1 provides information about passenger ferries and Section 3.4.5 provides economic information related to commercial fisheries.

Aids to Navigation

PATON and federal aids to navigation (ATON), including radar transponders, lights, sound signals, buoys, and lighthouses are located throughout the Project area. These aids serve as a visual reference to support safe maritime navigation. USCG operates and maintains the ATONs. The closest buoys to the WDA include a red and white bell buoy[33] near the southern entrance to Muskeget Channel and one green can buoy[34] that indicates the narrow channel clearance where Muskeget Channel narrows before leading into Nantucket Sound from the south. These ATONs are located approximately 4.6 nautical miles from the northern edge of the WDA. The USCG administers the permits for PATONs located on structures positioned in or near navigable waters of the United States.

Ports, Harbors, and Navigation Channels

The major ports in the vicinity of the proposed Project area include the Ports of Providence (ProvPort), Fall River, New Bedford, and Davisville. These ports serve the commercial fishing industry (see Section 3.4.5), passenger cruise lines, cargo, and other maritime activities. Of these, the largest deep draft port by volume is the ProvPort (COP Section 4.1, Appendix III-I; Epsilon 2018a). The primary vessel traffic and shipping lanes to these ports are outside of the WDA (COP Section 5.5.1, Appendix III-I; Epsilon 2018a). Section 3.4.1 discusses economic activity at these ports.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the following navigation resources:

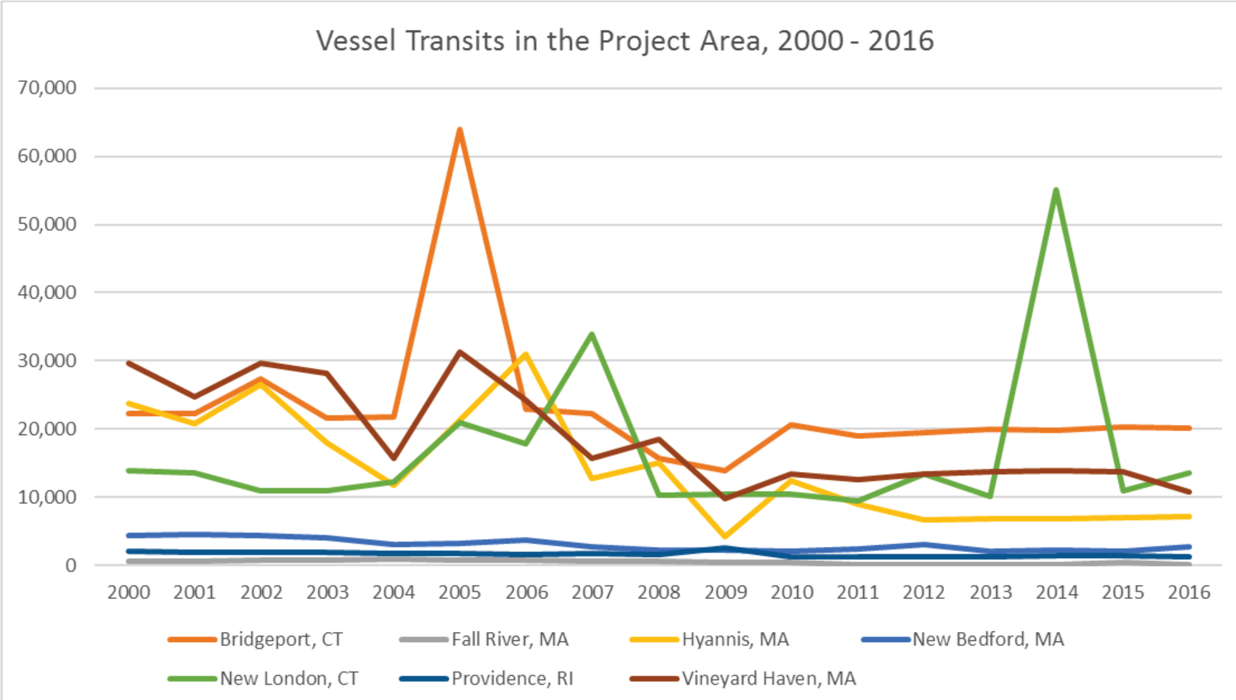
- Port activity: The Project would generate vessel activity at ports used for the Project. The most intensive activity would occur during construction and decommissioning. Proposed-Project activities in or near the Vineyard Haven, Hyannis (Lewis Bay), New Bedford (including the MCT), or other ports could cause delays or difficulty using these ports for recreational, commercial fishing, ferry, or other vessels.
- Navigation Channels: Increased Project vessel traffic could cause delays or increased density for other vessels in Nantucket Sound, the Muskeget Channel, and the Atlantic Ocean south of Nantucket.
- Safety: The addition of WTGs and ESPs in the WDA present potential obstructions to navigation, increased risk of collision and allision, and could affect marine radars. Project-related vessel traffic could also increase the risk of incidents such as collision and allision.

Condition and Trend

Between 1980 and 2010, total vessel transits in the Project area steadily decreased (Rhode Island Coastal Resources Management Council 2010; USACE 2018b), and has remained relatively stable since 2010 (USACE 2018b). Figure 3.4.7-2 presents vessel traffic in ports that would be affected by the Proposed Action. Cargo tonnage at area ports increased by 21.7 percent, while cargo vessel transits decreased by over 60 percent, reflecting increasing cargo vessel capacities. Within the WDA and the surrounding area, vessel traffic is primarily seasonal: in 2016 and 2017, 73 percent and 78 percent (respectively) of all annual WDA area traffic occurred between Memorial Day and Labor Day. This is primarily due to high seasonal activity by recreational vessels and commercial fishing vessels: up to 94 percent of annual recreational vessel trips in the WDA and surrounding area occurred during the Memorial Day to Labor Day period in 2016 and 2017, while up to 82 percent of the annual commercial fishing vessel trips occurred during the same time period. Cargo vessel traffic is less seasonal: Memorial Day to Labor Day activity comprised 60 percent (2016) and 38 percent (2017) of total annual cargo vessel trips in the WDA and surrounding area (COP Section 4.1, Appendix III-I; Epsilon 2018a).

[33] Red and white buoys mark the center of channel, fairways, and offshore approach points, and indicate unobstructed water on all sides.

[34] A green can buoy marks the right (starboard) side of the channel when leaving a harbor toward open waters.



Source: USACE 2018b

Figure 3.4.7-2: Vessel Traffic in the Project Area, 2010-2016

Traffic patterns in the vessel traffic routes within the proposed Project area are relatively stable (Northeast Regional Ocean Council 2018); however, vessel size, and vessel traffic volume and density in the proposed Project area could be affected by coastal developments, market demands, and other factors, such as dredging the main Boston Harbor shipping channels to accept larger container vessels (Northeast Regional Planning Body 2016). Tankers, tug/tow, cargo, and passenger vessels generally stay within fairways and designated traffic lanes and do not usually traverse the proposed WDA. However, 2015-2017 AIS maps show that a large volume of sailing, fishing, and other unspecified vessels traverse this area (Northeast Regional Ocean Council 2018).

3.4.7.2. Environmental Consequences

Relevant Design Parameters

Proposed-Project design parameters that would influence the magnitude of impact on the study area's navigation and vessel traffic characteristics include the following elements of the maximum-case scenario (as described in Appendix G):

- The port(s) selected to support construction and installation, in addition to the MCT;
- The number of vessels utilized for construction and installation;
- The number, type, and placement of the WTGs, including the location, width, and orientation of transit corridors through the WDA;
- The OECC route option selected; and
- Time of year of construction.

Potential Variances in Impacts

Variability of the proposed-Project design within the PDE that could affect navigation and vessel traffic includes the OECC route and landfall site selected, the ports used to support Project construction and installation and decommissioning, the WTG design selected (e.g., 8 MW, 10 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule. Variances in these factors could affect vessel navigation choices. This section has assessed the maximum-impact scenario, so variances from this scenario should lead to similar or reduced impacts.

3.4.7.3. Impacts of Alternative A (Proposed Action) on Navigation and Vessel Traffic

Incremental Contribution of the Proposed Action

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations and maintenance, and decommissioning of the Proposed Action, as described in Chapter 2. Section 3.1 defines direct and indirect impacts. Direct effects on navigation and vessel traffic would include increased vessel traffic in and near the WDA and ports used by the Proposed Action, as well as obstructions to navigation caused by Proposed Action activities. Table 3.4.7-2 summarizes the anticipated Project-related vessel traffic during Proposed Action construction. Nearly all construction vessel trips would originate or terminate at the MCT; however, occasional trips could use the secondary ports in the United States or Canada, listed in Table 2.1-2.

Table 3.4.7-2: Project-Related Vessel Traffic during Proposed Action Construction

	Maximum Single-Day	Average, Peak Construction Period	Average, Entire Construction Period
Daily Trips	46 [a]	18	7
Vessels in WDA or OECC	46	46	25

Source: Vineyard Wind, 2018d
OECC = Offshore Export Cable Corridor; WDA = Wind Development Area
[a] During maximum single day, Proposed Action construction could generate up to a total of 46 trips from the New Bedford Marine Commerce Terminal (MCT) or secondary ports in the United States or Canada, as defined in Table 2.1-2.

Direct impacts on navigation and vessel traffic would also include changes to navigation patterns. Indirect impacts would include changes in navigation patterns and the effectiveness of marine radar and other navigation tools. This could result in indirect effects, including delays within or approaching ports, increased navigational complexity, detours to offshore travel or port approaches, or increased risk of incidents such as collision and allision. Section 3.4.4 addresses the Proposed Action's impacts on recreation, while Section 3.4.5 addresses the Proposed Action's impacts on commercial fisheries and for-hire recreational fishing.

Offshore Construction and Installation

To address the impacts from construction and installation, Vineyard Wind would self-implement the following measures:

- Establish a Marine Coordinator to "manage all construction vessel logistics and act as a liaison with the USCG, pilots, port authorities, state and local law enforcement, volunteer marine patrols, and commercial operators during construction" (COP Appendix III-I, Section 8.1.2; Epsilon 2018a);
- Develop and frequently update a Mariner Communications Plan, which would include Notice To Mariners, a Fisheries Communications Plan (tailored to the commercial fishing industry), media announcements, inclusion of individual WTGs and ESPs on navigational charts, a website, and other methods (COP Appendix III-I, Section 8.1.2; Epsilon 2018a);
- Work with the USCG to establish variable-size temporary safety zones in active construction areas (depending on the nature and extent of construction activity), and to appropriately communicate those zones to mariners (COP Appendix III-I, Section 8.1.2; Epsilon 2018a);
- Develop and maintain a radio communications plan, coordinated with the USCG (COP Appendix III-I, Section 8.1.2; Epsilon 2018a);
- Consider locating an offshore cell network or marine radio repeater stations to improve radio communications (COP Appendix III-I, Section 8.1.2; Epsilon 2018a)—BOEM assumes that this measure would be in place for the life of the Project;
- Engage with stakeholders, including local marinas, to facilitate communication of the proposed-Project's construction schedule (COP Appendix III-I, Section 5.2.2; Epsilon 2018a);
- Work with the marine event and sailing regatta organizers to ensure safe navigation in the vicinity of the WDA (COP Appendix III-I, Section 5.2.2; Epsilon 2018a);
- Employ additional safety measures in consultation with the USCG, such as the placement of temporary PATONs to minimize the risk of allision and ensure safe routes during temporary events (COP Appendix III-I, Section 5.2.2; Epsilon 2018a).

In addition to the measures listed above, BOEM would require that all construction vessels are equipped with AIS, regardless of vessel length, and all vessels comply with U.S. and/or SOLAS standards with regards to vessel construction, vessel safety equipment, and crewing practices.

Impacts on Non-Project Vessels

Offshore construction and installation of the Proposed Action would temporarily restrict access to portions of the OECC route and WDA during construction. Construction support vessels, including vessels carrying assembled WTGs or WTG components, would be present in the waterways between the WDA and the ports used during Proposed Action construction and installation. The Proposed Action would result in an average of 25 vessels operating in the WDA or OECC at any given time, with a maximum of 46 vessels (COP Volume I, Section 4.2.4; Epsilon 2018a). "On average, four cable-laying, support, and crew vessels may be deployed along sections of the OECC during the construction and installation phase" (COP Volume III, Section 7.8.2.1.2; Epsilon 2018a).

Non-Project vessels (vessels not associated with the Proposed Action) operating in the waters between the Proposed Action ports and the WDA would be able to avoid Proposed Action vessels, components, and access restrictions though small, routine adjustments to navigation. For the OECC, non-Project vessels required to travel a more restricted (narrow) lane near the OECC could potentially experience greater delays waiting for cable-laying vessels to pass. With implementation of the mitigation measures by Vineyard Wind described above, non-Project vessels transiting between the Proposed Action ports and the WDA would be able to avoid Proposed Action vessels and restricted safety zones though routine adjustments to navigation. Although fishing vessels may experience increased transit times in some situations, these situations are spatially and temporally limited. Overall, BOEM anticipates that Proposed Action vessel activities in the open waters in the WDA and between the WDA and ports would have **minor** impacts on non-Project vessels, while Proposed Action vessel activities in restricted lanes near the OECC would have **moderate** impacts on non-Project vessels.

Impacts on Port Activities

Increased Proposed Action vessel traffic in ports (including the MCT and other ports identified in Section 2.1.1.1) would result in vessel traffic congestion, limited maneuver space in navigation channels, and delay in ports, and could increase the risk of incidents such as collision and allision in or near ports. Vessel traffic generated by Proposed Action construction would constitute less than 10 percent of typical daily vessel transits into and out of the Port of New Bedford (COP Appendix III-I; Epsilon 2018a). This finding notwithstanding, broad-beamed transfer barges or installation vessels could take up as much as one-third of the width of the entry channel for the Port of New Bedford, leaving little room for other vessels to maneuver. The presence of these vessels could cause delays for non-Proposed Action vessels, and could cause some fishing or recreational vessel operators to change routes or use an alternative port. If Vineyard Wind implements the mitigation measures described above, and if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route, construction and installation of the Proposed Action would have **moderate** impacts on port activities.

Vineyard Wind's selection of the New Hampshire Avenue landfall site would result in an OECC route through Lewis Bay, one of the densest marine traffic areas in the study area (USCG 2016). Lewis Bay is part of the USACE-managed Hyannis Harbor federal navigation project, which includes:

- A breakwater extension and 15.5-foot (4.7-meter) deep anchorage area west of the Lewis Bay entrance, comprising about 55 acres in area;
- A 150-foot (45.7-meter) wide, 7,200-foot (2,194.5-meter) long, 12-foot (3.7-meter) deep navigation channel extending from the outer harbor (i.e., west of the Lewis Bay entrance) to Lewis Bay;
- A 100-foot (30.5-meter) wide, 6,000-foot (1,828.8-meter) long, 12-foot (3.7-meter) deep channel extending from Lewis Bay to the Hyannis town wharf; and
- A 12-foot (3.7-meter) deep anchorage across from the town wharf (USACE 2018a).

USACE considers the installation of cables within the federal navigation project or any areas within 40 feet (12.2 meters) of the channel edge to pose significant risks to navigation. The USACE may require a Section 408 review to determine if the proposed structure is a risk to the continued maintenance of the channel. Improper installation of the cable could pose significant risk to navigation in Lewis Bay if improper cable depths result in a hindrance to USACE dredging.

Construction activities in Lewis Bay may cause delays and vessel operators to change routes or use an alternative port, especially if the existing navigation channel is obstructed by the inability to dredge due to the presence of the OECC. Hy-Line Cruises, which operates one of the ferry services from Hyannis to Martha's Vineyard, Nantucket, and other destinations, does not anticipate disruptive impacts on their ferry routes during the cable-laying process (COP Appendix III-I, Section 4.1.3, Epsilon 2018a). Vineyard Wind's self-implemented measures described above, as well as the BOEM-required use of AIS, would not prevent disruptions in Lewis Bay; therefore, construction and installation of the Proposed Action with the New Hampshire Avenue cable landfall site and OECC route would result in potentially **major** impacts to navigation and vessel traffic. If BOEM were to require OECC burial at a depth sufficient to allow unencumbered USACE dredging of the Lewis Bay channel, and if USACE were to accept this mitigation measure as less than significant, construction and installation of the Proposed Action with the New Hampshire Avenue cable landfall site and OECC route would result in **moderate** impacts on navigation and vessel traffic.

Impacts on Sailing Competitions

Long-distance sailing races occasionally traverse the WDA and OECC route. During construction and installation of the Proposed Action, these racing routes would need to be adjusted to avoid installation activities, either by traversing an unoccupied portion of the WDA or OECC route, or a portion of the WDA or OECC route where construction and installation activities are already complete, or by avoiding the WDA entirely. Avoidance of the entire OECC route may not be possible, depending on each race's homeport. With implementation of the mitigation measures described above, the Proposed Action would have **minor** impacts on sailing competitions during construction and installation.

Onshore Construction and Installation

Construction and installation of onshore components of the Proposed Action associated with the Covell's Beach cable landfall site would have **negligible** on navigation and vessel traffic. Selection of the New Hampshire Avenue cable landfall site would disrupt access to the public boat ramp at Englewood Beach. Therefore, the Proposed Action, with the New Hampshire Avenue cable landfall site, would have **minor** impacts on navigation and vessel traffic.

Operations and Maintenance

Impacts on Non-Project Vessels

During operations and maintenance of the Proposed Action, the permanent presence of WTGs and ESPs would create new obstacles for vessels that traverse the area. WTGs could also serve as additional aids to navigation with lighting and marking. Many vessels that currently navigate that area would continue to be able to navigate through the WDA between the WTGs and ESPs. Vessels that exceed a height of 82 feet (25 meters) would be at risk of alliding with WTG blades (85 to 98.4 feet [26 to 30 meters] at mean higher high water), and would need to navigate around the WDA. Some deep draft or tug and tow vessels would also need to make relatively minor deviations further south to avoid the array. Vessels that could continue to navigate within the WDA would still need to navigate with caution to avoid WTGs and ESPs. Accordingly, the presence of WTGs and ESPs would increase the risk of allision (COP Appendix III-I, Section 5.5; Epsilon 2018a).

Operations and maintenance of the Proposed Action would likely impact marine radar on vessels near or within the WDA. The grid-array of regularly spaced WTGs could produce false and multiple radar echoes for vessels in or approaching the WDA (COP Appendix III-I, Section 7.2.2.1; Epsilon 2018a; USDOI 2009; de la Vega et al. 2013; Ling et al. 2013). While radar is one of several navigational tools available to vessel captains, including navigational charts, Global Positioning System, and navigation lights mounted on the WTGs (COP Appendix III-I, Section 5.4; Epsilon 2018a); radar is the main tool used to help locate other nearby vessels that are not otherwise visible. The navigational complexity of transiting through the WDA, including the potential effects of WTGs and ESPs on marine radars, would increase risk of collision with other vessels (including non-Project vessels and Proposed Action vessels). Further, the presence of the WTGs could complicate offshore search and rescue operations or surveillance missions within the WDA.

To address the operations and maintenance impacts described above, a marine coordinator would remain on duty for the life of the Proposed Action. Vineyard Wind would also continue to implement the Mariner Communication Plan, and would continue to coordinate with the USCG and other authorities. In addition:

- Vineyard Wind would provide lighting, high-visibility paint, AIS transponders, reflecting panels, unique identifiers, and foghorns with a 2.3 mile (3.7 km) effective radius for WTGs and ESPs. Fog horns would not be audible on land (COP Appendix III-I; Section 8.2.2);
- Vineyard Wind would investigate providing incentives for radar software and hardware updates for non-Project vessels, as well as consultations or other training for vessel crews to help adjust radar settings and interpret radar signals (COP Appendix III-I; Section 8.2.2);
- WTGs would be in a grid pattern, spaced 0.75 to 1 nautical mile apart, with northeast-southwest and northwest-southeast corridors through the WDA. In addition, Vineyard Wind would adopt a 2 nautical mile wide northwest-southeast oriented transit lane (developed through discussion among fishing stakeholders and state agencies) south of the WDA; and
- BOEM would require that all vessels comply with U.S. and/or SOLAS standards with regards to vessel construction, vessel safety equipment, and crewing practices.

Considering the impacts and measures described above, operations and maintenance of the Proposed Action would have **moderate** impacts on non-Project vessels operating near or within the WDA.

Impacts on Port Activities

The Proposed Action would generate trips by crew transport vessels (about 75 feet [22.3 meters] in length), multipurpose vessels, and service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length), with larger vessels based at the MCT and smaller vessels based at Vineyard Haven. At the time of preparation of this Draft EIS, insufficient information was available to perform a detailed indirect impact assessment of the modifications to and potential operations out of the Vineyard Haven port. In a typical year, the Proposed Action would generate 256 crew transfer vessel trips, 110 multipurpose vessel trips, and 26 service operation vessel trips, some of which would originate from Vineyard Haven (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2018a). On average, the Proposed Action would generate approximately one to three vessel trips per day during regular operations; therefore, operations and maintenance of the Proposed Action would have a **minor** impact on port activities.

Impacts on Navigation and Vessel Traffic near Landfall Sites

Typical operations and maintenance of the Proposed Action with the Covell's Beach cable landfall site would not involve in-water activity and would have no impact on vessel traffic near the landfall site.

If Vineyard Wind selects the New Hampshire Avenue cable landfall site, the burial depth of the OECC (5 to 8 feet [1.5 to 2.4 meters] below navigation channel component of the Hyannis Harbor federal navigation project would be insufficient to safely allow maintenance dredging of the channel (see Section 3.4.7.1). As stated in the discussion of construction impacts above, the USACE would consider the presence of the OECC within the Hyannis Harbor federal navigation project to be a significant impact on navigation. Without maintenance dredging, vessel transit in and out of Hyannis and other areas of Lewis Bay could be obstructed, and some vessels may eventually be unable to enter or exit Lewis Bay. Operation of the OECC with the New Hampshire Avenue cable landfall site would therefore have potentially **major** impacts on navigation and vessel traffic in Lewis Bay. As discussed above, if BOEM were to require OECC burial at a depth sufficient to allow unencumbered USACE dredging of the Lewis Bay channel, and if USACE were to accept this mitigation measure as less than significant, construction and installation of the Proposed Action with the New Hampshire Avenue cable landfall site and OECC route would result in **moderate** impacts to navigation and vessel traffic.

Decommissioning

Impacts during decommissioning would be similar to the impacts described for construction and installation. Temporary disruptions of vessel traffic would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles WTGs and ships them to ports for further disposal. Removal of the OECC, if required, would also generate temporary disruptions of vessel traffic. During decommissioning, the Proposed Action's impacts on marine radar would decline from **moderate** to **negligible**, due to the removal of WTGs and ESPs that cause radar disruptions. As with construction, decommissioning activities would have larger impacts if conducted during the summer season.

If decommissioning of the Proposed Action employs the mitigation measures described for construction and installation, decommissioning of the Proposed Action with the Covell's Beach cable landfall site would have **minor** impacts on navigation and vessel traffic. BOEM anticipates decommissioning of the Proposed Action with the New Hampshire Avenue cable landfall site would have potentially **major** impacts on navigation and vessel traffic in Lewis Bay, due to disruptions to the navigation channel.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. Examples of such activities or events that could impact navigation and vessel traffic include non-routine corrective maintenance activities; collisions or allisions between vessels or vessels and WTGs or ESPs; cable displacement or damage by anchors or fishing gear; chemical spills or releases; and severe weather and other natural events. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. The occasional increased vessel activity in Vineyard Haven Harbor and in offshore locations above the OECC or within the WDA working on individual WTGs or ESPs could temporarily prevent or deter navigation and vessel traffic near the site of a given non-routine event. Impacts on navigation and vessel traffic would be **moderate**, lasting only as long as repair or remediation activities necessary to address these non-routine events.

Conclusion

Overall, construction and installation, operation and maintenance, and decommissioning of the Proposed Action would have **minor** to **moderate** impacts on navigation and vessel traffic if the Covell's Beach landfall site and OECC route are selected and potentially **major** impacts if the New Hampshire Avenue cable landfall site and OECC route through Lewis Bay are selected. Impacts to non-Proposed Action vessels would include changes in navigation routes, delays in ports, and degraded communication and radar signals, and increased difficulty of offshore search and rescue or surveillance missions within the WDA, all of which would increase navigational safety risks. Some commercial fishing, recreational, and other vessels would choose to avoid the WDA altogether, leading to some potential funneling of vessel traffic along the WDA borders. Generally, fewer turbines (i.e. implementation of the larger 10-MW turbines) in the WDA would reduce potential impacts on navigation and vessel traffic.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.7.4. Impacts of Alternative B on Navigation and Vessel Traffic

Alternative B would narrow the PDE to use the Covell's Beach landfall site in Barnstable, and would not allow the flexibility to use the New Hampshire Avenue landfall site in Yarmouth.

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Implementation of Alternative B would avoid the potential major impacts associated with construction activity in Lewis Bay or obstruction of the designated navigation channel for Lewis Bay. Other construction, operations and maintenance, and decommissioning impacts of Alternative B would be the same as the Proposed Action. Thus, BOEM anticipates Alternative B would have **minor to moderate** impacts on navigation and vessel traffic.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities associated with Alternative B would have the same impacts on navigation and vessel traffic as the Proposed Action: **moderate**.

Conclusion

Alternative B would limit Vineyard Wind's landfall site to Covell's Beach and would avoid the potential **major** impacts associated with construction activity in Lewis Bay or obstruction of the designated navigation channel for Lewis Bay. All other activities associated with Alternative B would be the same as the Proposed Action; thus, BOEM anticipates this alternative would have **minor** to **moderate** impacts on navigation and vessel traffic.

3.4.7.5. Impacts of Alternative C on Navigation and Vessel Traffic

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Alternative C would move the six northern-most WTG locations to the southern portion of the WDA, resulting in an unobstructed area in the northern portion of the WDA, which is closer to ports and other shore facilities. The acreage and footprint of the WDA, location of ESPs and other WTGs, and OECC route would remain the same as he Proposed Action. The WTG location in Alternative C would incrementally decrease effects on vessel traffic, compared to the Proposed Action. All other impacts of Alternative C would be the same as the Proposed Action. Based on the impact definitions in Section 3.1, BOEM finds that Alternative C would have the same impacts on navigation as the Proposed Action:

- **Minor to moderate** impacts if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route; and
- Potentially **major** impacts if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route through Lewis Bay.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities associated with Alternative C would have the same impacts on navigation and vessel traffic as the Proposed Action: **moderate**.

Conclusion

Alternative C would have the same impacts on navigation and vessel traffic as the Proposed Action: **minor to moderate** impacts on navigation and vessel traffic if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route, and potentially **major** impacts on navigation and vessel traffic if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route. Mitigation measures identified above would also be applicable to this alternative.

3.4.7.6. Impacts of Alternative D on Navigation and Vessel Traffic

Incremental Contribution of Alternative D1 and D2

Direct and Indirect Effects of Routine Activities

Alternative D (including Alternatives D1 and D2) would result in different WTG configurations, each of which would require different navigation routes. Alternative D would also require a larger WDA, and may require additional preconstruction survey activity. As a result, Alternative D could incrementally increase effects on vessel traffic, compared to the Proposed Action, although this would be offset by the increased spacing of the WTGs in the WDA, which could incrementally decrease effects on navigation and vessel traffic safety, compared to the Proposed Action. In addition, some commercial fisheries groups have stated that Alternative D2 would improve maritime navigation, leading to an incremental reduction in navigational complexity for vessel traffic. Based on these considerations, BOEM finds that Alternative D (including Alternatives D1 and D2) would have the same impacts on navigation as the Proposed Action:

- **Minor to moderate** impacts if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route; and
- Potentially **major** impacts if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route through Lewis Bay.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities associated with Alternative D would have the same impacts on navigation and vessel traffic as the Proposed Action: **moderate**.

Conclusion

Alternative D would have the same impacts on navigation and vessel traffic as the Proposed Action: **minor to moderate** impacts on navigation and vessel traffic if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route, and potentially **major** impacts on navigation and vessel traffic if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route. Mitigation measures identified above would also be applicable to this alternative.

3.4.7.7. Impacts of Alternative E on Navigation and Vessel Traffic

Alternative E would involve construction of up to 84 WTGs, each of which would likely have a generation capacity of approximately 9.5 MW. The location of transit corridors would be the same as in the Proposed Action.

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

The impacts of construction, installation, and decommissioning of Alternative E would be the same as for the Proposed Action. During operations and maintenance, vessel operators in the WDA would still need to navigate around WTGs and ESPs. The distance between these structures could be larger and/or the size of the WDA could be smaller than under the Proposed Action, depending on ultimate siting locations. The increased spacing of the WTGs and/or potentially smaller footprint of the WDA could incrementally decrease effects on navigation and vessel traffic safety, compared to the Proposed Action. All other impacts of Alternative E would be the same as the Proposed Action. Based on the impact definitions in Section 3.1, BOEM finds that Alternative E would have the same impacts on navigation as the Proposed Action:

- **Minor to moderate** impacts if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route; and
- Potentially **major** impacts if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route through Lewis Bay.

Direct and Indirect Effects of Non-Routine Activities

Non-routine activities associated with Alternative E would have the same impacts on navigation and vessel traffic as the Proposed Action: **moderate**.

Conclusion

Alternative E would have the same impacts on navigation and vessel traffic as the Proposed Action: **minor to moderate** impacts on navigation and vessel traffic if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route, and potentially **major** impacts on navigation and vessel traffic if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route. Mitigation measures identified above would also be applicable to this alternative.

3.4.7.8. Impacts of Alternative F (No Action Alternative) on Navigation and Vessel Traffic

If the proposed Project is not approved, existing navigation and vessel traffic would continue to occur within the WDA, OECC route, and near the ports to be used for Project construction, operations and maintenance, and decommissioning. Seafloor areas within the WDA and OECC route would remain available for future marine minerals leasing, location of future offshore energy projects, siting of future submarine cables and pipelines, and surface or submarine military vessel activity. The harbors proposed for construction or decommissioning support or operations and maintenance would continue current operations. Alternative F would have no impact on navigation and vessel traffic.

3.4.7.9. Comparison of Alternatives for Navigation and Vessel Traffic

All alternatives would have **minor to moderate** impacts on navigation and vessel traffic if Vineyard Wind selects the Covell's Beach cable landfall site and OECC route, and potentially **major** impacts on navigation and vessel traffic if Vineyard Wind selects the New Hampshire Avenue cable landfall site and OECC route. The presence of more unobstructed space for navigation in parts of the WDA under Alternatives C and E would slightly decrease the severity of the impacts, but would not result in a different impact magnitude, based on the definitions in Section 3.1. All other impacts of Alternatives C and E would be the same as the Proposed Action. Alternative B would avoid potential major impacts associated with Project construction, operations and maintenance, and decommissioning in Lewis Bay. As discussed in Section 3.4.7.2, the analysis of impacts is based on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.7.3 through 3.4.7.7.

3.4.7.10. Cumulative Impacts

The analysis area for navigation and vessel traffic is a 10-mile (16-kilometer) radius around the WDA, the OECC, and vessel approach routes to port facilities that may be used by the proposed Project (see Appendix C, Figure C.1-2). Appendix C describes projects that could generate cumulative impacts on navigation and vessel traffic. These projects include:

- The proposed South Fork offshore wind energy Tier 2 project[35];
- Dredging disposal sites, including the Rhode Island Sound Disposal Site located approximately 13 miles (21 kilometers) south of the entrance to Narragansett Bay, Rhode Island, and BOEM-identified future sand resources;
- The new barge service (Davisville/Brooklyn/Newark container-on-Barge Service) proposes to run twice each week in state waters between Brooklyn (New York), Newark (New Jersey), and the Port of Davisville (Rhode Island), which is located on Quonset Point, one of the potential construction ports;
- Port (MCT) upgrades to support the development of the offshore wind energy industry; and
- Undersea transmission lines, gas pipelines, and other submarine cables, such as the Block Island Transmission Cable and proposed South Fork Export Cable, located within vessel approach routes to port facilities.

The four Tier 3 offshore wind energy projects are not reasonably foreseeable based on the assumptions outlined in Appendix C; however, any future development of these projects could contribute to cumulative effects. These effects may be similar to the Proposed Action and would likely include increased vessel traffic and obstructions to navigations. In total, Tier 3 projects could potentially include the addition of 232 WTGs. Based on proximity to the WDA, the BSW (up to approximately 110 WTGs) and Revolution Wind (up to approximately 75 WTGs) projects would likely have the greatest contribution to cumulative effects if they come to fruition. The extent of the effects would ultimately depend on project-specific information that is unknown at this time.

[35] The two Tier 1 projects described in Appendix C are outside of the geographic analysis area.

The proposed or reasonably foreseeable projects listed above would produce additional vessel traffic during construction and create additional areas where vessels must navigate within or avoid WTGs and related structures. If two or more projects were under construction at the same time, the marine traffic at New Bedford and other ports would experience cumulative impacts that could result in additional delays for vessels using those ports. Sand borrow areas for beach replenishment and dredging disposal sites would also contribute to increased vessel traffic and create areas that vessels must navigate around during extraction or disposal. The new barge service would also contribute to increased vessel traffic, resulting in potential increased risk of incidents such as collision and allision within the analysis area. Large vessels headed to or from Boston or New York that occasionally transit through the WDA (see Section 3.4.7.1) would also need to adjust course to avoid the Proposed Action and other proposed or reasonably foreseeable projects. Cumulative impacts on recreational boaters or fishing could also occur as a result of increased vessel traffic during construction, as evaluated in Sections 3.4.4 and 3.4.5.

The presence of neighboring wind energy leases would further increase the navigational complexity in the region, resulting in a proportionately increased cumulative risk of collisions and allisions The proposed 2 nautical mile wide navigation corridor south of the WDA (as discussed above under operations and maintenance) would ensure a single continuous path through adjacent wind energy project areas.

Based on the information presented above, the Proposed Action when combined with the past, present, and reasonably foreseeable future activities would have **moderate** impacts to navigation and vessel traffic.

The cumulative impacts of Alternatives B, C, D1, D2, and E on navigation and vessel traffic would be the same as the Proposed Action with the following exception. Under Alternative B navigation into and out of Lewis Bay would be unchanged. However, the overall cumulative impacts of the Alternatives on navigation and vessel traffic, when combined with past, present, and reasonably foreseeable future activities, would be **moderate**.

3.4.7.11. Incomplete or Unavailable Information for Navigation and Vessel Traffic

This impact analysis is based on best available data (largely AIS), which has only been required on vessels 65 feet (19.8 meters) or greater since March 2015. While other data sources, particularly vessel monitoring system, were not available for analysis, the AIS data, combined with the other sources of navigation data cited throughout this section, are sufficient to support the impact findings herein.

3.4.8. Other Uses

This section describes the affected environment and environmental consequences for other uses of the OCS not addressed in other portions of Section 3.4. In the context of this Draft EIS, “other uses” includes marine mineral resources, military and national security uses, aviation and air traffic, offshore energy uses (aside from the proposed Project), land-based radar systems, and scientific research and surveys.

3.4.8.1. Description of the Affected Environment for Other Uses

Regional Setting

The sections below describe the regionally important resources located in Barnstable, Bristol, Dukes, and Nantucket counties in Massachusetts; Providence and Washington counties in Rhode Island; and the surrounding region that the proposed Project could affect.

Marine Mineral Extraction

BOEM’s Marine Minerals Program leases sand and gravel resources from federal waters on the OCS to address shoreline erosion, beach nourishment, and wetlands restoration. Through the Atlantic Sand Assessment Project, BOEM funded geophysical surveys in 2015 through 2017 to identify new sources of sand, including in waters offshore Massachusetts and Rhode Island (BOEM 2017a). Surveys were conducted from 3 to 8 nautical miles offshore and are typically in waters less than 98 feet (30 meters) deep. Based on the geological surveys, sediment samples were collected in key areas offshore of New York, New Jersey and Delaware. The Atlantic Sand Assessment Project identified potential volumes and the extent of potential new sand resources for BOEM’s National Offshore Sand Inventory. Currently there are no active or requested leases offshore Massachusetts and Rhode Island, and the closest active lease is offshore New Jersey, approximately 170 miles (273.6 kilometers) east of the MA WEA (BOEM 2018d).

National Security and Military Uses

The United States Navy (Navy), the USCG, and other military entities have numerous facilities in the region (see Figure 3.4.8-1). Major onshore regional facilities include Naval Station Newport, the Naval Submarine Base New London, the Northeast Range Complex/Narragansett Bay Operation Area, Joint Base Cape Cod, and numerous USCG stations (Epsilon 2018a). Onshore and offshore military use areas may have designated surface and subsurface boundaries and special use airspace.

Aviation and Air Traffic

There are numerous public and private-use airports in the region (see Figure 3.4.8-1). Major airports serving the region include Boston Logan International Airport, located approximately 90 miles (145 kilometers) north of the WDA, and T.F. Green Airport in Providence, Rhode Island located approximately 65 miles (105 kilometers) northwest of the WDA. The closest public airports to the WDA are Nantucket Memorial Airport on Nantucket and Katama Airpark and Martha’s Vineyard Airport, both located on Martha’s Vineyard. Private airports or airstrips proximate to the proposed Project area are located on Tuckernuck Island and Martha’s Vineyard (Trade Wind Airport). Other public and private airports and heliports are located on the mainland. Military air traffic use the area, and government and other private aircraft may occasionally fly over the WDA for data collection and search and rescue operations (BOEM 2014).

Offshore Energy

The proposed Project is located in the MA WEA, and adjacent to the Deepwater WLA. Vineyard Wind anticipates that offshore wind energy projects will be constructed by other developers in both the MA WEA and the Deepwater WLA (see Appendix C, Section C.1.2). The only active offshore wind energy facility in the region is the Block Island Wind Farm, comprised of five offshore WTGs approximately 45 nautical miles west-northwest of the proposed Project area. Two projects proposed by Deepwater Wind are in pre-development stages in the Deepwater WLA: OCS-A 0487 (South Fork Project) and OCS-A 0486 (Revolution Wind Project), as shown in Figure 1.1-1. The proposed South Fork Wind Project is considered a Tier 2 offshore wind project (see Appendix C, Table C.1-3), and would supply 200 MW of offshore wind power and would begin construction in 2021 (see Appendix C, Table C.1-4). The proposed Revolution Wind Project is considered a Tier 3 offshore wind project for this analysis, and would supply 600 MW of power to Rhode Island and Connecticut and would begin construction in 2022. This project is not considered reasonably foreseeable.

Cable and Pipelines

The coastal region of Massachusetts and Rhode Island is served by the onshore electrical grid and a network of pipelines. Islands in the region, including Block Island, Martha’s Vineyard, and Nantucket, are served by submarine power cables as shown in Figure 3.4.8-1. Several transatlantic cables make landfall in the region, although none make landfall near the proposed Project’s cable landfall sites. No offshore pipelines are located in the region immediately surrounding the proposed Project.

Radar Systems

Commercial air traffic control radar systems, national defense radar systems, and weather radar systems operate in the Proposed Project region (COP Appendix III-J, Volume III; Epsilon 2018a). National defense radar systems operating within the proposed Project region include the Precision Acquisition Vehicle Entry/Phased Array Warning System installation at Joint Base Cape Cod (COP Appendix III-1, Volume III; Epsilon 2018a). Regional navigation radar systems typically include Air Route Traffic Control Centers and Terminal Radar Approach Control centers. The closest such facilities are located near Boston, more than 90 miles (145 kilometers) from the WDA.

The nearest Next-Generation Radar weather system radar is located approximately 60 miles (97 kilometers) to the north of the proposed Project. The FAA operates a Terminal Doppler Weather Radar installation at the Boston Logan International Airport approximately 90 miles (145 kilometers) to the north of the WDA.

Scientific Research and Surveys

A number of federal agencies, state agencies, educational institutions, and environmental non-governmental organizations participate in ongoing research offshore in the MA WEA, Deepwater WLA, and surrounding waters. Aerial and ship-based research includes oceanographic, biological, geophysical, and archaeological surveys.

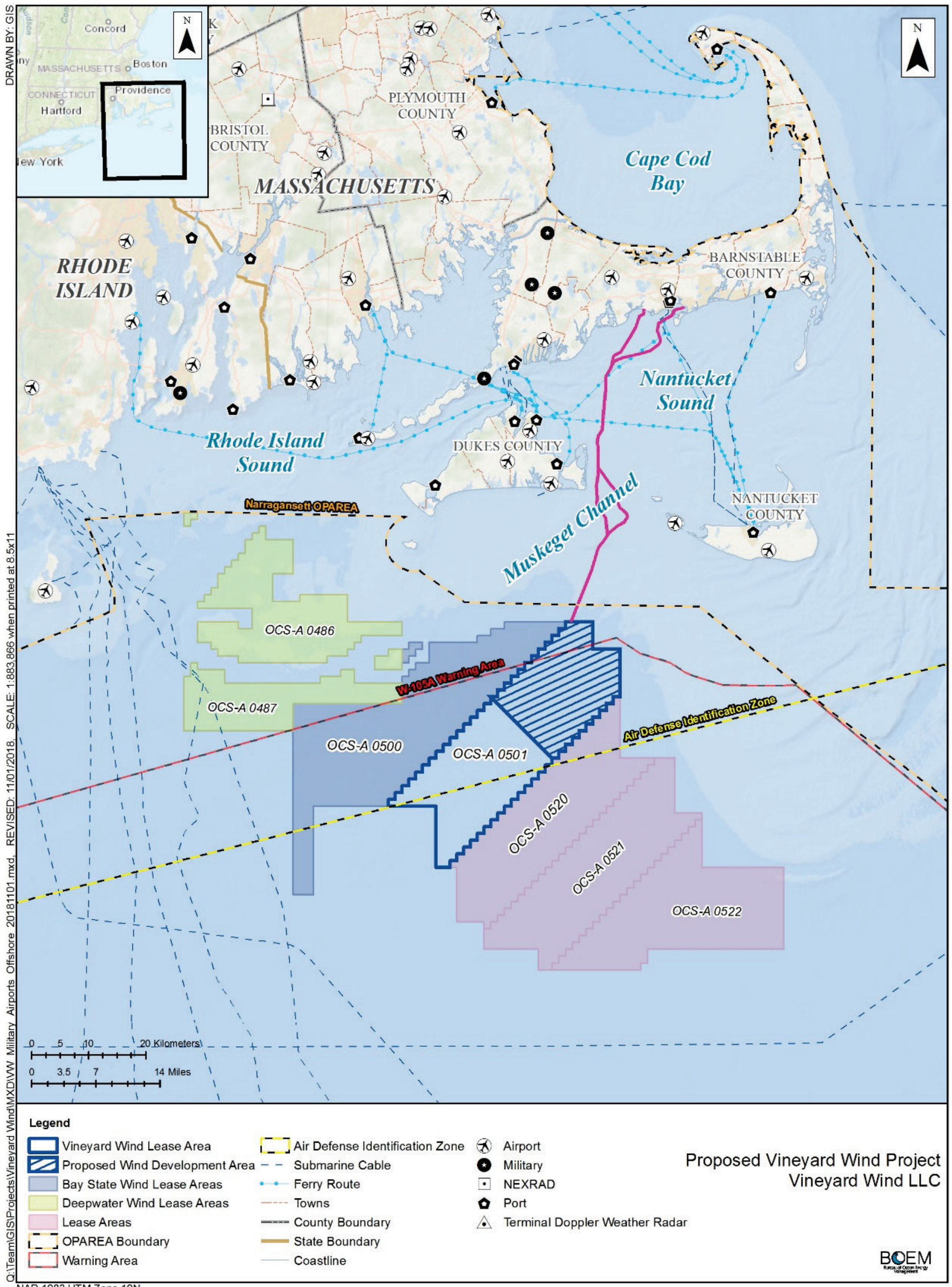


Figure 3.4.8-1: Military, Airspace, and Other Uses

Project Area

Marine Mineral Extraction

The proposed Project area is further offshore and in deeper waters than BOEM's marine mineral leases typically occur. Most sand re-nourishment projects in the northeast are for smaller beach areas and take sand from nearshore areas. Re-nourishment projects that occur in OCS waters tend to be farther south, where beaches are larger and require more sand volume. Nearshore areas are often a less expensive alternative for re-nourishment projects, and are therefore usually preferred; however, as the demand for more sand resources increases, some states are looking farther offshore.

There are no active or requested OCS sand and mineral leases within the proposed Project area (BOEM 2018d). The COP did not identify any significant sand resource blocks in the proposed Project area (Epsilon 2018a).

National Security and Military Uses

Vineyard Wind has been working with the USCG and the Navy regarding identification of potential concerns related to Project-related activities (e.g., navigation). Since the WDA is located within the Narragansett Bay Operation Area. Typically, military training exercises occur in deeper offshore waters southeast of the WDA, though transit of military vessels may occur throughout the area (Epsilon 2018a).

Aviation and Air Traffic

General aviation traffic in and near WDA is highest during the summer tourism season on Martha's Vineyard and Nantucket. Martha's Vineyard Airport hosted more than 46,500 aircraft operations in 2013 (Jacobs 2016), while Nantucket Memorial Airport hosted nearly 105,000 operations in 2017 (Nantucket 2018). Commercial and long-distance flights typically occur at or above 18,000 feet (5,486 meters) AMSL. High-performance jet and turbo prop aircraft generally follow Instrument Flight Rules routes between 3,000 and 7,000 feet (914 and 2,134 meters) AMSL. Other aircraft operate using Visual Flight Rules (VFR), which do not require designated routes or altitudes. VFR pilots are required to maintain a minimum 500 feet AMSL (152.5 meters) clearance from any structure or vessel (14 CFR § 91.119). There are no minimum altitude restrictions over water in the absence of any structures or vessels (BOEM 2014).

A small portion of the northwestern most section of the WDA is located within U.S. territorial waters and airspace. The Navy and other Department of Defense branches use the airspace over and adjacent to the WDA. A portion of the WDA is within Warning Area W-105A, a block of airspace ranging from 0 to 50,000 feet (15,240 meters) AMSL, part of the Navy-managed Narragansett Bay Complex (COP Appendix III-J, Volume III; Epsilon 2018a; GlobalSecurity.org, 2018).

The FAA has authority to review proposed structures greater than 200 feet (61 meters) tall and within 12 nautical miles of the shoreline, to determine whether the activity would impact safe and efficient use of navigable airspace or air navigation and communication facilities. Because a portion of northwest section of the WDA is within FAA jurisdiction, and because WTGs would be in excess of 200 feet (61 meters) high, the proposed Project is subject to FAA review. Construction of turbines onshore and transport of constructed turbines to the WDA could also necessitate FAA aeronautical studies of turbines in transit to the WDA (Epsilon 2018a). The COP Aviation Impact Assessment found that more than 90 percent of existing air traffic over the WDA occurred at altitudes that would not be impacted by the WTG placements (COP Appendix III-J; Epsilon 2018a).

Offshore Energy

Ørsted and Eversource have proposed the BSW Project for Massachusetts Lease OCS-A 0500, which is located in the MA WEA and is immediately west of the proposed Project (see Figure 3.4.8-1). BSW is currently in the planning and development stage, and is considered a Tier 3 offshore wind project, which is not considered reasonably foreseeable at this time. BSW has indicated that they will submit their COP to BOEM in 2019 and plan to begin construction in 2022. In October 2018, BOEM announced a final sale notice for Massachusetts lease areas OCS-A 0520, OCS-A 0521, and OCS-A 0522 located immediately east-southeast of the proposed Project (see Figure 1.1-1).[36] These lease areas are designated Tier 5 offshore wind projects, because they are highly speculative at this time. Due to their speculative nature, the BSW Project and development of lease areas OCS-A 0520, OCS-A 0521, and OCS-A 0522 are not further considered in this analysis.

[36] Atlantic Wind Lease Sale 4A (ATLW-4A) Commercial Leasing for Wind Power on the Outer Continental Shelf Offshore Massachusetts—Proposed Sale Notice, 83 Fed. Reg. 70 (April 11, 2018)

The town of Edgartown in partnership with the UMass has proposed a tidal energy project, the Muskeget Channel Tidal Test Site/Edgartown-Nantucket Tidal Energy Power Plant Project, in Muskeget Channel between Martha's Vineyard and Nantucket, which could overlap with the OECC. Because the tidal energy project has not received permits, it is considered speculative and is addressed in the cumulative analysis (see Appendix C) as not reasonably foreseeable.

Cable and Pipelines

Four submarine transmission cable systems are located in Nantucket Sound that service Nantucket and Martha's Vineyard. There are no offshore pipelines that service Martha's Vineyard or Nantucket. Service to Martha's Vineyard is provided by two cables interconnecting the Town of Falmouth with Vineyard Haven and Tisbury through Vineyard Sound. Two cables also service Nantucket through Nantucket Sound, from Dennis Port and Hyannis Port to landfall at Jetties Beach. If Vineyard Wind selects the New Hampshire Avenue landfall site option, the proposed cable would cross over the National Grid Hyannis Port-Jettis Beach submarine power cable off of Dunbar Point, just outside the mouth of Lewis Bay (see Figure 3.4.8-1).

Radar Systems

There are no Next Generation Weather Radar (NEXRAD) radar systems located within the WDA or immediately adjacent to the WDA. Aircraft in the proposed Project area use regional radar systems described in the Regional Setting section.

Scientific Research and Surveys

Scientific research and surveys occur in the proposed Project area. Vineyard Wind has committed resources for ongoing monitoring in the operations phase of the Proposed Action. Because offshore wind farms on the scale of the Proposed Action do not currently existing in the United States, the construction and installation, operations and maintenance, and decommissioning phases all present unique opportunities to conduct scientific research focused on the impacts of offshore wind farms on various resources.

Aspects of Resource Potentially Affected

The proposed Project could potentially affect the uses described in this section if the following occur:

- Proposed Project facilities or vessel traffic affect military activities by limiting maneuverability or affecting the scope of operations;
- Proposed Project facilities affect aviation and air traffic by introducing obstructions to air space and altering navigational routes;
- Proposed Project facilities affect the siting, construction, or operation of other offshore energy facilities through conflict with available port space, vessel traffic, or spatial/temporal overlap between the WDA and other offshore energy uses;
- Construction or operation activities damage or cause service outages to existing offshore power cables or affect the siting of future cables;
- Construction or operational activities cause interference with weather and aviation radar signals; and/or
- Proposed Project facilities affect scientific research and surveys by increasing or decreasing opportunities for research or by impeding research by navigational obstructions.

There are no federal OCS sand and mineral lease areas and no identified significant sand resource blocks within the proposed Project area; therefore, the Proposed Action would have no impacts on marine mineral resources, and this section does not further discuss these resources.

Section 3.4.7 discusses marine vessel navigation impacts.

Condition and Trend

This section summarizes the conditions and trends within the proposed Project area relevant to the resources described above:

- Although there are no marine mineral leases in the proposed Project area, the demand for sand resources in federal waters has increased in recent years, due to shoreline erosion and coastal damage from storms, and this trend is expected to continue. Following Hurricane Sandy, BOEM's Marine Minerals Program signed cooperative agreements with both Massachusetts and Rhode Island to assess sand resources at critical beaches in each state (as well as other states along the eastern seaboard). While this would likely lead to leases along the east coast (as described in Appendix C), BOEM does not anticipate overlap between marine mineral leases and the proposed Project.

- National security and military interests will continue to use the onshore and offshore areas in the vicinity of the WDA.
- Air traffic is expected to continue at current levels in and around the WDA.
- BOEM anticipates that developers may continue to propose offshore energy projects in the vicinity of the proposed Project, although the foreseeability of future impacts is analyzed in accordance with the framework set forth in Appendix C, Section C.1.2.
- Other than the proposed Project's OECC, BOEM has not identified any publicly noticed plans for additional submarine cables or pipelines; therefore, no new cable installation is expected.
- Existing radar systems will continue to provide weather, navigational, and national security support to the region.
- Scientific research activities would continue into the foreseeable future at similar or potentially greater levels in the MA WEA, due to research opportunities associated with construction and operation of offshore wind facilities such as the Proposed Action. Vineyard Wind has committed resources for ongoing monitoring in the operations phase of the proposed Project.

3.4.8.2. Environmental Consequences for Other Uses

Relevant Design Parameters

The primary proposed-Project design parameters that would influence the magnitude of the impact on other uses include the following elements of the maximum-case scenarios as described in Appendix G:

- Route and timing of the OECC construction, which could affect military vessel activity (surface or submarine) during typical operations and/or training exercises;
- Design, height, number, and arrangement of WTGs and ESPs, which could affect marine radar systems, movement of civilian and military aircraft, and military vessels (surface or submarine) (vessels impact discussed in Section 3.4.7);
- Construction port locations and construction vessel routes, as they relate to the movement of civilian and military aircraft and military vessel activity (surface or submarine) during typical operations and/or training exercises; and
- Configuration of FAA-required aviation obstruction lighting on the WTGs, which would affect civilian and military aircraft navigation.

Potential Variances in Impacts

The impact assessment provided below evaluates the potential effects of an array of 100 of the 8-MW WTGs, laid out in a grid-like pattern, with spacing between WTGs of 0.76 to 1 nautical mile, and clear corridors running northwest/southeast and northeast/southwest.[37] Different WTG layouts or selection of the 10-MW WTGs could result in different impact characteristics and magnitudes, but BOEM anticipates similar impacts based due to the minimum and maximum number of turbines as identified in Chapter 2 and Appendix G. Construction of the proposed Project may slightly overlap with the proposed start of South Fork Wind Farm construction, if that project is approved. If the Proposed project's schedule were to be delayed, a greater overlap would occur, along with potential impacts to other potential projects.

3.4.8.3. Impacts of Alternative A (Proposed Action) on Other Uses

Incremental Contribution of the Proposed Action

This section discusses the direct and indirect impacts of routine and non-routine activities associated with Proposed Action construction, operations, and decommissioning.

Direct and Indirect Effects of Routine Activities

Routine activities would include construction, operations, and decommissioning of the Proposed Action, as described in Chapter 2, Alternatives Including the Proposed Action. Section 3.1 defines direct and indirect impacts. The potential direct and indirect impacts of the Proposed Action on other uses include:

- Temporary or permanent loss of access to offshore airspace or sea surface, including military surface or submarine vessel routes;
- Temporary or permanent airspace hazards;
- Temporary or permanent loss of access to offshore resources;

[37] Although Vineyard Wind proposes 106 WTG placement locations as part of the PDE, no more than 100 total WTGs would be installed as part of the proposed Project.

- Damage to, or disruption of, service provided by cables and pipelines; Disruption of regional or vessel radar systems.; and
- Disruption or increase in scientific research and surveys.

Construction and Installation of Offshore Components

Offshore construction and installation of the Proposed Action would have the following impacts on other uses:

- Military and National Security Uses: During construction, large vessels with limited maneuverability would deliver WTGs, ESPs, and associated equipment to one or more port facilities and to the WDA. These vessels would operate within restricted navigation channels or be on station during construction and installation activities. Vineyard Wind would continue coordination with the Navy and USCG to minimize conflicts in the proposed Project area. The Department of Defense concluded that the Proposed Action would have minor but acceptable impacts on their operations (Frederick Engel, Pers. Comm., September 13, 2018). Therefore, BOEM anticipates that the Proposed Action would have **minor** impacts on military operations and national security.
- Aviation and Air Traffic: WTG towers under construction would exceed the FAA's 200-foot (61-meter) threshold for notification. Vineyard Wind would notify the FAA of construction activities, and the FAA would issue notices to airmen for WTGs under construction in the WDA or in transit between ports and the WDA (COP Volume III, Section 7.9.2.1.2; Epsilon 2018a). Construction of the Proposed Action could cause some aircraft to alter navigation plans to avoid WTGs and construction cranes; however, based on the volume of other airspace available and the low percentage of aircraft using this airspace (see Section 3.4.8.1), construction and installation of the offshore components of the Proposed Action would have **negligible** impacts on aviation and air traffic.
- Offshore Energy Uses: Construction and installation of the offshore components of the Proposed Action, including vessel and port activity, and installation activities in the WDA, would not impact any currently approved offshore energy projects due to timing of those projects and their locations in different lease areas. See Appendix C for a list of potential projects and anticipated construction timelines based on timely state and federal approvals. With the exception of South Fork Wind Farm and its potential use of the same construction port, there appears to be no spatial and temporal overlap between the WDA and other offshore wind, oil and gas, or tidal energy projects during construction; therefore, impacts would be **negligible**.
- Cables and Pipelines: If Vineyard Wind selects the New Hampshire Avenue landfall site, the proposed offshore cable would cross over the National Grid Hyannis Port-Jettis Beach submarine power cable off of Dunbar Point, just outside the mouth of Lewis Bay (see Figure 3.4.8-1). BOEM expects direct impacts on this submarine cable to be **minor** because Vineyard Wind would use standard techniques for the crossing to prevent damage to either cable.
- Radar Systems: A U.S. Department of Energy screening tool for WTG siting did not identify any potential conflicts between the Proposed Action and ground-based NEXRAD radars (COP Volume III, Section 7.9.2.1.6; Epsilon 2018a). Construction and installation of the offshore components would therefore have **negligible** impacts on ground-based radar systems of all types.
- Scientific Research and Surveys: Research activities may continue within the proposed Project area during construction and installation; however, in some cases, research vessels may need to alter transit routes to avoid WTGs or cable routes. Low altitude aerial surveys may also need to alter routes to avoid WTGs. BOEM expects direct and indirect adverse impacts to be **minor**, due to potential temporary avoidance measures. Construction and installation of the Proposed Action would also have **minor beneficial** impacts, due to increased opportunities to study impacts of construction and operation of the offshore components.

Construction and Installation of Onshore Project Components

Onshore construction and installation of the Proposed Action would have **negligible**, if any, impacts on other uses due to the absence of spatial overlap with marine minerals activities, military and national security uses, aviation and air traffic, offshore energy uses, radar systems, and scientific research and surveys.

Operations and Maintenance of Offshore Components

Operations and maintenance of offshore components would have the following impacts on other uses:

- Military and National Security Uses: The offshore components of the Proposed Action would be monitored and controlled remotely from the Proposed Action's Operations and Maintenance Facilities. Planned maintenance activities would involve dispatching a crew transport vessel to complete repairs and restore normal operations. These activities would be similar to existing civilian vessel activity in and near the WDA and Vineyard Wind would comply with coordination requirements. Operations and maintenance of the offshore components of the Proposed Action would have **minor** impacts on military operations and national security (see Section 3.4.7).

- Aviation and Air Traffic: The WTGs could necessitate changes in the minimum altitudes of some designated instrument flight routes for Nantucket Memorial Airport and other airports in the region. Because more than 90 percent of existing air traffic over the WDA occurred at altitudes that would not be impacted by the presence of WTGs (COP Appendix III-J; Epsilon 2018a), and based on the low volumes of air traffic in the WDA, operations and maintenance of the Proposed Action would have **minor** impacts on air traffic and aviation.
- Offshore Energy Uses: The WDA would not overlap with other offshore wind, oil and gas, or tidal energy project areas. While final routes for offshore cables for other proposed wind projects within the surrounding lease areas are not known, cables for these projects would be able to avoid or cross the Vineyard Wind OECC using standard techniques. Maintenance vessels for other projects could use the same ports as Vineyard Wind; however, BOEM does not anticipate conflicts with vessels associated with other offshore energy projects. Potential future offshore wind construction and operations and maintenance vessels could use the vessel transit lanes within the regional area, as needed, to navigate from one side of the WDA to the other. Overall, the operations and maintenance of the offshore components of the Proposed Action would have **minor** impact on future offshore energy projects.
- Cables and Pipelines: If Vineyard Wind selects the New Hampshire Avenue landfall site, maintenance activities during operations could have a **minor** impact on the National Grid Hyannis Port-Jettis Beach submarine cable, if maintenance is required near the cable crossing. BOEM expects direct impacts on this submarine power cable to be **minor** because Vineyard Wind would use standard techniques during maintenance to prevent damage to either cable (see Figure 3.4.8-1). Cables installed in the future would be able to cross the OECC using standard protection techniques; therefore, impacts on future cables would be **negligible**.
- Radar Systems: Operations and maintenance of WTGs in the WDA would have **negligible** impacts on military or civilian radar systems, as described for the Proposed Action, Construction and Installation phase (COP Appendix III-I; Epsilon 2018a). While wind developments in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference (DOE 2016; COP Volume III, Section 7.9.2.1.6; Epsilon 2018a), ground-based radar systems are located a sufficient distance from the WDA that radar interference is not anticipated and mitigation would not be required. A U.S. Department of Energy screening tool for WTG siting did not identify any potential conflicts between the Proposed Action and ground-based NEXRAD radars (COP Volume III, Section 7.9.2.1.6; Epsilon 2018a). Section 3.4.7 discusses potential impacts on marine vessel radar communication systems.
- Scientific Research and Surveys: Research activities may continue within the proposed Project area during operations and maintenance, and Vineyard Wind has committed resources for ongoing monitoring in the operations phase of the Proposed Action. In some cases, research vessels and any low-altitude aerial surveys may need to alter travel routes to avoid WTGs. BOEM expects direct and indirect adverse impacts to be **minor**, due to avoidance measures. In addition, operations and maintenance of the Proposed Action may have **minor beneficial** impacts on scientific research and surveys, due to increased opportunities to study impacts of operation and maintenance of the offshore components.

Operations and Maintenance of Onshore Project Components

BOEM has not identified any conflicts between the onshore Project components and military interests or OECRs, facilities associated with other offshore energy projects, offshore cables and pipelines, radar systems, or scientific research and surveys. None of the onshore components of the Proposed Action would exceed the 200-foot (61-meter) FAA notification threshold. Accordingly, operations and maintenance of the onshore components of the Proposed Action would have no impacts on marine minerals activities, military and national security, aviation and air traffic, offshore energy, radar systems, and scientific research and surveys.

Decommissioning

The impacts of decommissioning the Proposed Action would be similar to those described for construction and installation, including:

- Military and National Security Uses: **Minor** impacts associated with vessel traffic necessary to remove offshore components of the Proposed Action.
- Aviation and Air Traffic: **Minor** impacts due to the presence of WTGs and cranes in the WDA or in transit to ports during the removal process, which would constitute an obstruction under 14 CFR § 77.17(a)(1) and would necessitate modification of instrument flight routes for Nantucket Memorial Airport and other airports in the region. These obstructions would remain in place until the end of the decommissioning phase.
- Offshore Energy Uses: **Minor** impacts associated with vessel traffic necessary to remove offshore components of the Proposed Action.
- Cables and Pipelines: Assuming the use of standard techniques to prevent damage to the National Grid Hyannis Port-Jettis Beach submarine cable or other cables, decommissioning would have **minor**, temporary impacts at existing cable crossings. BOEM expects **negligible** impacts if Vineyard Wind is permitted to retire the OECC in place.

- Radar Systems: As is the case for construction, decommissioning of Proposed Action components would have **negligible** impacts on radar systems.
- Scientific Research and Surveys: As is the case for construction, decommissioning of Proposed Action components are anticipated to have **minor** adverse impacts on scientific research and surveys, as well as **minor beneficial** impacts associated with increased opportunities to study offshore wind facility impacts during the decommissioning phase.

Direct and Indirect Effects of Non-Routine Activities

Section 2.3 describes the non-routine activities associated with the Proposed Action. Examples of such activities or events that could impact other uses include non-routine corrective maintenance activities; collisions or allisions between military and Project vessels or military vessels and WTGs or ESPs; cable displacement or damage by anchors or fishing gear; chemical spills or releases; and severe weather and other natural events. These activities would generally require intense, temporary activity to address emergency conditions. For open-ocean areas, response to non-routine events would typically involve dispatch of a crew transport vessel to the identified location to complete repairs and restore normal operations. These vessels would have minimal interaction with military and national security activities, and no interaction with air traffic or other offshore energy projects. Impacts on cables or pipelines would only occur where those pipelines overlap with the OECC. Assuming appropriate crossing or avoidance measures, there would be no impact on cables or pipelines. Overall, BOEM anticipates non-routine activities associated with the Proposed Action would have **negligible** impacts on other uses.

Conclusion

Based on the analysis above, construction, operations, and decommissioning of the Proposed Action would have overall **negligible** to **minor** impacts on other uses in the proposed Project area. These include:

- Military and National Security Uses: **Minor** impacts associated with vessel traffic necessary to install, maintain, or remove offshore components of the Proposed Action.
- Aviation and Air Traffic: **Minor** impacts due to the presence of WTGs throughout the duration of the decommissioning phase. The conclusion of the decommissioning phase would remove these obstructions and resulting impacts would be **negligible**.
- Offshore Energy Uses: **Minor** impacts associated with vessel traffic necessary to install, maintain, or remove offshore components of the Proposed Action.
- Cables and Pipelines: **Minor** impacts, due to the use of standard cable crossing techniques.
- Radar Systems: **Negligible** impacts on military or civilian radar systems. Section 3.4.7 discusses potential impacts on marine vessel radar communication systems.
- Scientific Research and Surveys: **Minor** adverse impacts on scientific research and surveys due to potential alteration of transit, as well as **minor beneficial** impacts due to increased opportunities to study impacts of offshore wind development on a variety of resources.

The analysis of impacts is based on a maximum-case scenario and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

3.4.8.4. Impacts of Alternative B on Other Uses

Incremental Contribution of Alternative B

Direct and Indirect Effects of Routine Activities

Alternative B is the same as the Proposed Action, except that only the Covell's Beach OECC route and landfall site would be considered. The impacts of construction, operations, maintenance, and decommissioning of Alternative B on other uses would be the same as the Proposed Action for military operations and national security (**minor**), aviation and air traffic (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), offshore energy uses (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), radar systems (**negligible**), and scientific research and surveys (**minor**). For cables and pipeline, the Covell's Beach OECC route would not cross the National Grid Hyannis Port-Jettis Beach submarine cable route. As a result, BOEM anticipates Alternative B would have **negligible** impacts on cables and pipelines.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative B on other uses would be the same as for the Proposed Action: **negligible**.

3.4.8.5. Impacts of Alternative C on Other Uses

Incremental Contribution of Alternative C

Direct and Indirect Effects of Routine Activities

Alternative C would move the six northern-most WTG locations to the southern portion of the WDA, resulting in the exclusion of some of the northern-most WTG locations. The acreage and footprint of the WDA, location of ESPs and other WTGs, and OECC route would remain the same as described for the Proposed Action.

The impacts of construction, operations, maintenance, and decommissioning of Alternative C on other uses would be the same as the Proposed Action for military operations and national security (**minor**), aviation and air traffic (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), offshore energy uses (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), cables and pipelines (**minor**) radar systems (**negligible**), and scientific research and surveys (**minor**), although Alternative C would provide more unobstructed space for navigation in the northern portion of the WDA, which is closer to ports and other shore facilities. Under Alternative C, three fewer turbines would be located in U.S. territorial waters, and only five turbines would be subject to FAA jurisdiction, compared to eight in the Proposed Action (COP Volume III, Appendix III-J; Epsilon 2018a). While this difference would incrementally decrease effects on military and national security vessel traffic, as well as air traffic, BOEM anticipates Alternative C would still have **minor** impacts on military and national security uses, aviation, and air traffic.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative C on other uses would be the same as the Proposed Action: **negligible**

3.4.8.6. Impacts of Alternative D on Other Uses

Impacts of Alternative D1 and D2

Incremental Contribution of Alternative D1 and D2

Direct and Indirect Effects of Routine Activities

Alternatives D1 and D2 would result in different WTG configurations, each of which would increase the size of the WDA and require different navigation routes for vessels in the WDA, neither of which would result in meaningfully different types or magnitudes of impacts on other uses compared to the Proposed Action. Accordingly, the impact levels for Alternatives D1 and D2 are anticipated to be the same as the Proposed Action:

- **Minor** for military operations and national security uses in all Project phases;
- **Negligible** impacts on aviation and air traffic during construction and installation and decommissioning, and **minor** impacts during operations and maintenance;
- **Negligible** impacts on offshore energy uses during construction and installation and **minor** impacts during operations and maintenance and decommissioning;
- **Minor** impacts on cables and pipelines in all Project phases;
- **Negligible** impacts on ground-based radar systems in all Project phases; and
- **Minor** impacts on scientific research and surveys in all Project phases.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternatives D1 and D2 on other uses would be the same as the Proposed Action: **negligible**

3.4.8.7. Impacts of Alternative E on Other Uses

Incremental Contribution of Alternative E

Direct and Indirect Effects of Routine Activities

Alternative E would involve construction of up to 84 WTGs, each of which would likely have a generation capacity of approximately 9.5 MW. The location of transit corridors would be the same as in the Proposed Action.

The impacts of construction, operations, maintenance, and decommissioning of Alternative E on other uses would be the same as the Proposed Action for military operations and national security (**minor**), aviation and air traffic (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), offshore energy uses (**negligible** for construction and installation, **minor** for operations and maintenance and decommissioning), cables and pipelines (**minor**), radar systems (**negligible**), and scientific research and surveys (**minor**). The increased height of the WTGs would incrementally increase effects on aviation and air traffic; however, BOEM anticipates Alternative E would still require alterations to instrument flight routes for Nantucket Memorial Airport and other regional airports, and the magnitude of these impacts would remain **minor during operations and maintenance**.

Direct and Indirect Effects of Non-Routine Activities

The impacts of non-routine activities associated with Alternative E on other uses would be the same as the Proposed Action: **negligible**

3.4.8.8. Impacts of Alternative F (No Action Alternative) on Other Uses

If the proposed Project is not approved, existing other uses would continue to occur within the WDA, OECC route, and near the ports to be used for Project construction and installation, operations and maintenance, and decommissioning. Seafloor areas within the WDA and OECC route would remain available for future marine minerals leasing, location of future offshore energy projects, siting of future submarine cables and pipelines, and surface or submarine military vessel activity.

The harbors proposed for construction or decommissioning support or operations and maintenance would continue to serve civilian and military vessel activity, and would continue typical operations. Scientific research and surveys could continue in the WDA and OECC unimpeded, but beneficial impacts associated with increased opportunities to study the impact of offshore wind on various resources would not be realized.

3.4.8.9. Comparison of Alternatives for Other Uses

The Proposed Action and Alternatives B through F would have **negligible** to **minor** impacts on other uses. Alternatives C and D1 would marginally decrease conflicts with other uses by leaving more ocean floor available for potential marine mineral activities and more ocean available for military surface and submarine vessel activity. The increased size of the WDA in Alternative D (including Alternatives D1 and D2) would marginally increase conflicts military vessels, and Alternative E would marginally increase effects on aviation and air traffic due to the increased height of wind turbines. Alternative E would increase conflicts with aviation and air traffic due to increased WTG height. Based on the impact definitions in Section 3.1, these marginal increases would change overall impact ratings. Under Alternative F, the beneficial impacts associated with increased opportunities to study the impact of offshore wind on various resources would not be realized. As discussed in Section 3.4.8.2, the analysis of impacts is based on a maximum-case scenario. Scenarios that involve smaller amounts of construction or infrastructure development would result in lower impacts, but would not result in different impact ratings than those described in Sections 3.4.8.3 through 3.4.8.7.

3.4.8.10. Cumulative Impacts

The following sections provide the analysis of cumulative impacts associated with other uses. Appendix C describes projects that could generate cumulative impacts on other uses. Figure C.1-15 provides additional information on the geographic analysis area for other uses.

Military and National Security Uses

The geographic study area for cumulative impacts on national security/military use includes airspace, surface, and subsea areas that are utilized by regional military entities in an area roughly bounded by Montauk, New York; Providence Rhode Island; Provincetown, Massachusetts; and within a 10-mile (16-kilometer) buffer from wind lease areas in the MA WEA and Deepwater WLA. Branches of the military, as well as civilian air and vessel traffic (commercial and recreational), currently use and will continue to utilize the airspace and waters in this area for operations and training. The cumulative projects described in Appendix C would introduce additional navigational obstructions (for example, in the case of offshore wind facilities and tidal energy projects) and vessel traffic to the military use cumulative study area. The Project proponents have coordinated with potentially affected military agencies to identify and address potential impacts, and other proposed offshore wind energy projects are required to conduct similar coordination. Onshore or offshore construction projects that exceed 200 feet (61 meters) in height (such as wind turbines and communication towers) are required to screen for potential military impacts through the FAA review process. BOEM anticipates the Proposed Action, when combined with past, present, and reasonably foreseeable activities, would have **minor** impacts on military and national security uses.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **minor**. Alternative C would provide more unobstructed space for navigation for military aviation traffic in the northern portion of the WDA, which is closer to ports and other shore facilities, while adding WTGs in the southern portion of the WDA. This would displace the cumulative impacts on military uses, but would not result in a different impact magnitude, compared to the Proposed Action. The increased height of the WTGs under Alternative E would increase cumulative impacts on military use, but would not change the impact rating listed above, based on the definitions in Section 3.1.

Aviation and Air Traffic

The geographic study area for cumulative impacts on aviation and air traffic is the airspace and airports used by regional air traffic, generally an area roughly bounded by Montauk, New York; Providence Rhode Island; Provincetown, Massachusetts; and within a 10-mile (16-kilometer) buffer from wind lease areas in the MA WEA and Deepwater WLA. Commercial and recreational civilian aircraft currently use and will continue to utilize the airspace in this area. Reasonably foreseeable cumulative projects described in Appendix C would result in the construction of additional aviation obstructions in the geographic study area, such as existing and proposed onshore and offshore wind turbines (in transit between port and installation sites when under construction at staging areas, and installed), communication towers, meteorological towers, and construction cranes. If developers construct the proposed South Fork wind facilities, some aircraft may alter navigation plans to avoid the combined offshore wind development areas. Based on the volume of other airspace available around the reasonably foreseeable development areas and FAA requirements to identify and record potential obstructions to aviation, BOEM anticipates that the Proposed Action, when combined with past, present, and reasonably foreseeable activities, would have **minor** impacts on aviation and air traffic.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **minor**. Alternative C would provide more unobstructed space for navigation for commercial aviation traffic in the northern portion of the WDA, which is closer to ports and other shore facilities, while adding WTGs in the southern portion of the WDA. This would displace the cumulative impacts on aviation, but would not result in a different impact magnitude, compared to the Proposed Action. The increased height of the WTGs under Alternative E would increase cumulative impacts on aviation use, but would not change the impact rating listed above, based on the definitions in Section 3.1.

Offshore Energy

The proposed South Fork Tier 2 project is the only reasonably foreseeable offshore wind energy project with the potential to generate cumulative impacts on other uses. The four Tier 3 offshore wind energy projects are not reasonably foreseeable based on the assumptions outlined in Appendix C; however, development of these projects is possible and could contribute to cumulative effects in the future. If these projects come to fruition, potential effects may be similar to the Proposed Action.

The development areas for reasonably foreseeable offshore wind energy projects do not overlap each other, and submarine cables associated with the South Fork project or other energy projects could cross each other without impact using standard techniques. The ports described in Appendix C (including the MCT and other ports used for construction and installation, operations and maintenance, and decommissioning of the Proposed Action) could accommodate activities for multiple offshore energy projects. Conflicts with vessels associated with other offshore energy projects are not anticipated, with the implementation (by project developers) of standard scheduling and coordination efforts. Therefore, the offshore components of the Proposed Action, when combined with other past, present and reasonably foreseeable activities, would have **minor** impact on other offshore energy projects.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **minor**.

Cables and Pipelines

The geographic study area for cumulative impacts is within 1 mile (1.6 kilometers) of the OECC and WDA, and other undersea facilities and wind lease areas in the MA WEA and Deepwater WLA that could affect future siting or operation of cables and pipelines. While the locations of existing and proposed projects listed in Appendix C, including offshore energy facilities and offshore cables, may impact the siting of future cables and pipelines, they would not preclude future offshore energy facilities. Therefore, BOEM anticipates the cumulative impacts of the Proposed Action, when combined with other past, present, and reasonably foreseeable activities, would have **minor** impacts on offshore cables and pipelines in the region.

Under Alternative B, the Covell's Beach OECC route would not cross the National Grid Hyannis Port-Jetties Beach submarine cable route, and the identified Tier 1 or Tier 2 wind energy projects would not site submarine cable corridors in the area around the OECC. Accordingly, the cumulative impacts of Alternative B, when combined with other past, present, and reasonably foreseeable future projects would have **negligible** impacts on cables and pipelines. BOEM anticipates the cumulative impacts under Alternatives C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **minor**.

Radar Systems

The geographic study area for cumulative impacts on NEXRAD radar systems is the same as the study area for aviation. Because BOEM anticipates the proposed Project to have negligible impacts on military and civilian radar systems, and because other reasonably foreseeable projects with the potential to affect radar systems (reasonably foreseeable offshore wind facilities) are sited a similar distance from radar systems, potential cumulative impacts of past, present, and reasonably foreseeable activities plus the incremental contribution of the Proposed Action would be **negligible**.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **negligible**.

Scientific Research and Surveys

The geographic study area for cumulative impacts on scientific research and surveys is the same as for aviation and land-based radar uses, and encompasses the likely locations of research similar what is expected to occur within the WDA and OECC route. These areas include the footprint of the Proposed Action, the Deepwater WEA, the Block Island Wind Farm, and all of Cape Cod. BOEM assumes that research in this area would include oceanographic, biological, geophysical, and archaeological surveys focused on the OCS and nearshore environments, and/or resources that may be impacted by offshore wind development. While other activities, such as construction of reasonably foreseeable offshore wind farms, associated cable systems, and vessel activity may present additional navigational obstructions for sea and air-based surveys, these developments will not collectively prevent scientific research and surveys in the cumulative study area, and would likely require only minor re-routing or temporary avoidance of active construction areas. In addition, the development of other offshore wind facilities in the cumulative study area would provide additional opportunities to study the potential impacts of offshore wind farms. Accordingly, BOEM anticipates that the Proposed Action, when combined with other past, present, and reasonably foreseeable activities would have **minor** adverse impacts and **minor beneficial** impacts on scientific research and surveys.

BOEM anticipates the cumulative impacts under Alternatives B, C, D1, D2, and E when combined with the past, present, and reasonably foreseeable future activities, to be the same as the Proposed Action: **minor** adverse impacts, as well as **minor beneficial** impacts on scientific research and surveys.

3.4.8.11. Incomplete or Unavailable Information for Other Uses

There is no incomplete or unavailable information related to the analysis of impacts on other uses.

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4. CONSULTATION AND COORDINATION

4.1. INTRODUCTION

This chapter discusses public and agency involvement in the preparation of this Draft EIS, including formal consultations, cooperating agency exchanges, the public scoping comment period and correspondence. Consultation, coordination, and correspondence throughout the development of this Draft EIS occurred primarily through in-person meetings and teleconferences. BOEM coordinated with numerous agencies throughout the development of this document, as listed in Section 4.3.2.

4.2. CONSULTATIONS

The following section provides a summary and status of each consultation (ongoing, complete, and the opinion or finding of each consultation). The Bureau of Environmental Safety and Enforcement, USACE, and USEPA are cooperating agencies for the development of the Draft EIS for the proposed Project under NEPA, and are also co-action agencies for the ESA consultation.

4.2.1. Coastal Zone Management Act

The Coastal Zone Management Act requires that federal actions within and outside the coastal zone that have reasonably foreseeable effects on any coastal use or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program. On April 6, 2018, Vineyard Wind voluntarily submitted a federal consistency certification with the Massachusetts Office of Coastal Zone Management and the Rhode Island Costal Resources Management Council per 15 CFR § 930.76 Subpart E. Vineyard Wind's COP (Epsilon 2018a) provided the necessary data and information under 15 CFR § 930.58. The States' concurrence is required before BOEM may approve or approve with conditions the Vineyard Wind COP per 30 CFR § 585.628(f) and 15 CFR § 930.130(1).

4.2.2. Endangered Species Act

Section 7(a)(2) of the ESA of 1973, as amended (16 USC § 1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either NMFS or USFWS, depending upon the jurisdiction of the Services. Pursuant to 50 CFR § 402.07, BOEM has accepted designation as the lead federal agency for the purposes of fulfilling interagency consultation under Section 7 of the ESA for listed species under the jurisdiction of NOAA Fisheries Services and USFWS. BOEM will consult on the proposed activities considered in this Draft EIS with both NMFS and USFWS for listed species under their respective jurisdictions. NMFS and USFWS have not designated any critical habitat in the WDA; thus, none will be affected. The sections below describe the status of consultations for each of the services.

4.2.2.1. National Marine Fisheries Service

BOEM has prepared and submitted a BA to NMFS (BOEM 2018b). The Vineyard BA assesses impacts from all aspects of the proposed Project, including construction, operation, maintenance, and decommissioning on NMFS listed species. BOEM transmitted this BA to NMFS and requested formal consultation under Section 7 of the ESA on December 7, 2018. The scope of the BA covers the entirety of potential effects on NMFS-listed species and designated critical habitat associated with the proposed Project. The analysis of effects and conclusions of the BA are incorporated by reference, summarized in this Draft EIS, and found here: https://www.boem.gov/Vineyard-Wind/. NMFS anticipates initiating formal consultation on the Vineyard Wind project by January 24, 2019, assuming NMFS determines that all necessary information has been received from BOEM. Formal consultation will be completed and a Biological Opinion issued by NMFS prior to the publication of the ROD for the proposed Project.

An existing 2013 Biological Opinion (NMFS 2013) that covers data collection activities including high-resolution geophysical surveys, geotechnical surveys, biological surveys, and other related data collection activities associated with the proposed Project. NMFS concluded that the above actions may adversely affect, but are not likely to jeopardize, the continued existence of Kemp's ridley, green, or leatherback sea turtles; the Northwest Atlantic DPS of loggerhead sea turtles; NARW, fin, sei, or sperm whales; or the Gulf of Maine, New York Bight, Chesapeake Bay, or South Atlantic DPS of Atlantic sturgeon. Since the 2013 Biological Opinion, new information has become available, such as new NOAA sound exposure guidelines (NMFS 2016), new information on the sound sources (Crocker and Fratantonio 2016), and changes in the listing status of humpback whales and green sea turtles. This new information warrants the re-evaluation of the effects of data collection activities. BOEM expects the completion of Section 7 consultation associated with this Data Collection BA to supersede and replace the 2013 Biological Opinion. However, the April 10, 2013, Biological Opinion will remain in effect until it is replaced.

4.2.2.2. U.S. Fish and Wildlife Service

On July 13, 2018, in preparation of this Draft EIS and the BA for non-marine species such as birds and bats, BOEM used USFWS's Information for Planning and Consultation system[1] to determine if any ESA-listed, proposed, or candidate species may be present in the proposed Project area. The report identified five ESA-listed species with potential to occur in the proposed Project area: northern long-eared bat (*Myotis septentrionalis*), Piping Plover (*Charadrius melodus*), Rufa Red Knot (*Calidris canutus rufa*), Roseate Tern (*Sterna dougallii dougallii*), and American chaffseed (*Schwalbea americana*) (USFWS 2018).

On December 7, 2018, BOEM submitted a BA to USFWS (BOEM 2018b). The Vineyard Wind BA assesses all aspects of the proposed Project, including construction, operation, maintenance, and decommissioning on USFWS listed species. The analysis of effects and conclusions of the BA are incorporated by reference, are summarized in this Draft EIS, and can be found here: https://www.boem.gov/Vineyard-Wind/. BOEM requested concurrence (within 30 days) on its conclusions of the following: (1) that the impacts of the proposed activities are expected to be discountable and insignificant, and thus not likely to adversely affect ESA-listed bird species; (2) the determination of no effect to ESA-listed bats; (3) that no critical habitat designated for listed bird species would be adversely affected by the proposed Project activities; and (4) that the proposed Project activities are expected to be discountable and insignificant, and thus not likely to adversely affect the American chaffseed, and no critical habitat has been designated for this species.

4.2.3. Government-to-Government Tribal Consultation

EO 13175 commits federal agencies to engage in government-to-government consultation with Tribes, while Secretarial Order No. 3317 requires U.S. Department of the Interior agencies to develop and participate in meaningful consultation with federally recognized tribes where a tribal implication may arise. A June 29, 2018 memorandum outlines BOEM's current tribal consultation policy. This memorandum states that "consultation is a deliberative process that aims to create effective collaboration and informed Federal decision-making" and is in keeping with the spirit and intent of the NHPA and NEPA, Executive and Secretarial Orders, and Department of the Interior Policy. BOEM implements tribal consultation policies through formal government-to-government consultation, informal dialogue, collaboration, and engagement.

BOEM provided individual invitations via e-mail to the Tribal Historic Preservation Officers (THPOs) for the NEPA/NPHA scoping meetings scheduled for April 16-20, 2018. BOEM initiated formal consultation for Section 106 consultation through individual letters mailed to THPOs and Tribal leaders on April 24, 2018. BOEM then sent individual invitations via e-mail to tribal THPOs and Deputy THPOs to participate in a June 26, 2018 NHPA webinar.

Finally, on July 30, 2018, BOEM sent another set of individual emails to Tribal leaders and THPOs again requesting government-to-government consultation. The Narragansett Indian Tribe and the Mohegan and Mashantucket Pequot Tribes responded to this request. BOEM held government-to-government meetings with the Narragansett at Tribal offices in Charlestown, Rhode Island, and jointly with the Mohegan and Pequot at Mashantucket, Connecticut on August 21 and 22, 2018. All three tribes expressed interest in continuing consultation with offshore wind, and all emphasized the importance of early consultation in project development; participation in field evaluation for both marine and terrestrial archaeological survey was also requested in future projects.

4.2.4. National Historic Preservation Act

Section 106 of the NHPA (54 USC § 306108 et seq.) and its implementing regulations (36 CFR part 800) require federal agencies to consider the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment. BOEM has determined that the proposed Project is an undertaking subject to Section 106 review. The construction of WTGs, ESPs, installation of electrical support cables, and development of staging areas are ground or seabed disturbing activities that may directly affect archaeological resources. The presence of WTGs may also introduce visual elements out of character with the historic setting of historic structures or landscapes; in cases where historic setting is a contributing element of historic properties' eligibility for the NRHP, the Project may indirectly affect those historic properties.

BOEM incorporated the Section 106 process into the NEPA public scoping process, pursuant to 36 CFR § 800.2(d)(3). The Scoping Summary Report (BOEM 2018g), available on BOEM's project-specific website, summarizes comments

[1] https://tinyurl.com/0501-ipac

on historic preservation issues.[2] On April 24, 2018, BOEM initiated consultation with six federally recognized tribes: the Mashantucket (Western) Pequot Tribal Nation, the Mashpee Wampanoag Tribe, the Mohegan Tribe of Indians of Connecticut, the Narraganset Indian Tribe, the Shinnecock Indian Nation, and the Wampanoag Tribe of Gay Head (Aquinnah). BOEM requested information on properties of historic/cultural significance that the proposed Project could affect, and offered BOEM's assistance in providing additional details and information on the proposed Project to the tribes. At their request, BOEM met in government-to-government consultation on August 21 and 22, 2018 with the Mashantucket (Western) Pequot Tribal Nation, the Mohegan Tribe of Indians of Connecticut, and the Narragansett Indian Tribe to further describe the scope and scale, and assess the potential impact, of the proposed undertaking. On June 7, 2018, BOEM contacted representatives of local governments, state and local historical societies, economic development commissions, and other Federal agencies to solicit information on historic properties and determine their interest in participating as consulting parties. On June 26, 2018, BOEM conducted a webinar for potential consulting parties, with the goals of discussing the undertaking, defining the area of potential effect, and discussing BOEM's guidance for what constitutes a good faith effort to identify historic properties within the APE (BOEM 2017b). Vineyard Wind finalized its visual impact assessment historic resources report on September 25, 2018; on November 7, 2018, BOEM held a second Section 106 consultation meeting on the island of Nantucket, with the goal of discussing viewshed assessments, visual simulations, and assessing effects to historic properties.

As portions of the APE are surveyed for historic properties, and as assessment reports are made available to BOEM by Vineyard Wind, BOEM will continue the Section 106 review process. The terrestrial and marine archaeological survey and assessment reports are anticipated to be finalized by December 2018. Upon receipt, BOEM will conduct internal sufficiency reviews and then conduct additional consultations on the identification, assessment, and resolution of any adverse effects to historic properties with the consulting parties. If appropriate, BOEM will develop a memorandum of agreement with the consulting parties in early 2019 to resolve adverse effects to NRHP-listed or -eligible properties.

4.2.5. Magnuson-Stevens Fishery Conservation and Management Act

Pursuant to Section 305(b) of the MSA, federal agencies are required to consult with NMFS on any action that may result in adverse effects on EFH. NMFS regulations implementing the EFH provisions of the MSA can be found at 50 CFR § 600. As provided for in 50 CFR § 600.920(b), BOEM has accepted designation as the lead agency for the purposes of fulfilling EFH consultation obligations under Section 305(b) of the MSA. Certain OCS activities authorized by BOEM may result in adverse effects on EFH and, therefore, require consultation with NMFS. BOEM has developed an EFH Assessment (BOEM 2018f) concurrent with this Draft EIS, and transmitted the findings of that EFH Assessment to NMFS on December 7, 2018. BOEM's EFH Assessment determined that the proposed action would adversely affect quality and quantity of EFH for several species of managed fish. BOEM and NMFS anticipate completing the EFH consultation by May 2019.

4.3. Development of the Draft Environmental Impact Statement

This section provides an overview of the development of the Draft EIS, including public scoping, cooperating agency involvement, and distribution of the Draft EIS for public review and comment.

4.3.1. Scoping

On March 30, 2018, BOEM issued a Notice of Intent (NOI) to prepare an EIS consistent with the regulations implementing NEPA (42 USC § 4321 et seq.) to assess the potential impacts of the Proposed Action and Alternatives (Notice of Intent to Prepare an Environmental Impact Statement for Vineyard Wind's Proposed Wind Energy Facility, 83 Fed. Reg. 13777 [March 30, 2018]). The NOI commenced the public scoping process for identifying issues and potential alternatives for consideration in the EIS. BOEM held five public scoping meetings in the vicinity of the proposed Project area to solicit feedback and identify issues and potential alternatives for consideration in the EIS. Throughout the scoping process, federal agencies, state, local, and tribal governments, and the general public had the opportunity to help BOEM identify potential significant resources and issues, impact-producing factors, reasonable alternatives (e.g., size, geographic, seasonal, or other restrictions on construction and siting of facilities and activities), and potential mitigation measures to be analyzed in the EIS, as well as provide additional information. BOEM used the NEPA scoping process to initiate the Section 106 consultation process under the NHPA (54 USC § 300101 et seq.), as permitted by 36 CFR § 800.2(d)(3), and sought public input through the NOI regarding historic properties and potential effects to historic properties from activities associated with the COP (Epsilon 2018a). BOEM also used this scoping process to begin informal ESA consultation. The formal scoping period lasted from March 30 through April 30, 2018.

[2] https://www.boem.gov/Vineyard-Wind/

BOEM accepted comment submissions on the NOI via the following mechanisms:

- Electronic submissions received via www.Regulations.gov on docket number BOEM-2018-0015;
- Electronic submissions received via email to a BOEM representative;
- Hard-copy comment letters submitted to BOEM via traditional mail;
- Hard-copy comment cards and/or letters received during each of the public scoping meetings; and
- Comments submitted verbally at each of the public scoping meetings.

BOEM held five public scoping meetings at the following locations and dates:

- April 16, 2018—Fairfield Inn and Suites, Waypoint Event Center, New Bedford, Massachusetts
- April 17, 2018—Martha's Vineyard Hebrew Center, Vineyard Haven, Massachusetts
- April 18, 2018 (a.m.)—Nantucket Middle School, Nantucket, Massachusetts
- April 18, 2018 (p.m.)—Double Tree Hotel, Hyannis, Massachusetts
- April 19, 2018—University of Rhode Island Ryan Center, Kingston, Rhode Island

BOEM reviewed and considered, as appropriate, all scoping comments in the development of the Draft EIS, and used the comments to identify alternatives for analysis. A Scoping Summary Report (BOEM 2018g) summarizing the submissions received and the methods for analyzing them is available on BOEM's website at https://www.boem.gov/Vineyard-Wind/. In addition, all public scoping submissions received can be viewed online at http://www.regulations.gov by typing "BOEM-2018-0015" in the search field. As detailed in the Scoping Summary Report, the resource areas or NEPA topics most referenced in the scoping comments include commercial fisheries and for-hire recreation fishing, Lewis Bay, the Project description, socioeconomics, alternatives, and others.

4.3.2. Cooperating Agencies

BOEM also used the NEPA scoping process to invite other federal agencies and state, tribal, and local governments to consider becoming cooperating agencies in the preparation of the Draft EIS. According to CEQ guidelines, qualified agencies and governments are those with "jurisdiction by law or special expertise" (CEQ 1981). BOEM asked potential cooperating agencies to consider their authority and capacity to assume the responsibilities of a cooperating agency, and to be aware that an agency's role in the environmental analysis neither enlarges nor diminishes the final decision-making authority of any other agency involved in the NEPA process. BOEM offered to provide potential cooperating agencies with a written summary of expectations for cooperating agencies, including time schedules and critical action dates, milestones, responsibilities, scope, and detail of cooperating agencies' contributions, and availability of pre-decisional information. BOEM also asked agencies to consider the "Factors for Determining Cooperating Agency Status" in Attachment 1 to CEQ's January 30, 2002, Memorandum for the Heads of Federal Agencies (CEQ 2002). BOEM held interagency meetings in 2018 on March 20, June 20, August 2, and October 15 to discuss the environmental review process, schedule, responsibilities, and consultation. See Section 1.3.3 for a discussion of the One Federal Decision process.

The following are supporting preparation of the Draft EIS as cooperating agencies:

- Bureau of Safety and Environmental Enforcement
- USEPA
- NOAA NMFS
- USACE
- USCG
- Massachusetts CZM
- Narragansett Indian Tribe
- Rhode Island Coastal Resource Management Council
- RI DEM

4.3.3. Distribution of the Draft Environmental Impact Statement for Review and Comment

This Draft EIS is available in electronic form for public viewing at https://www.boem.gov/Vineyard-Wind/. BOEM will deliver hard copies and/or DVDs of the Draft EIS to the entities listed in Appendix E. Publication of this Draft EIS initiates a 45-day comment period where government agencies, members of the public, and interested stakeholders can provide comments and input. BOEM will accept comments in any of the following ways:

- In hard-copy form, delivered by hand or by mail, enclosed in an envelope labeled "Vineyard Wind COP EIS" and addressed to Program Manager, Office of Renewable Energy, Bureau of Ocean Energy Management, 45600 Woodland Road, Sterling, Virginia 20166. Comments must be received or postmarked no later than January 22, 2019;

- Through the regulations.gov web portal by navigating to http://www.regulations.gov and searching for docket number “BOEM-2018-0069.” Click the “Comment Now!” button to the right of the document link. Enter your information and comment, then click “Submit”; or
- By attending one of the Draft EIS public meetings at the locations and dates listed in the Notice of Availability and providing written or verbal comments.

BOEM will use comments received during the public comment period to inform its preparation of the Final EIS, as appropriate.

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5. UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTION

The CEQ's NEPA implementing regulations (40 CFR § 1502.16) require that an EIS evaluate the potential unavoidable adverse impacts associated with a proposed action. Adverse impacts that can be reduced by mitigation measures but not eliminated are considered unavoidable. Table 5-1 below provides a listing of such impacts. Most potential unavoidable adverse impacts associated with the Proposed Action would occur during the construction phase and would be temporary. Chapter 3 provides additional information on the impacts listed below.

Table 5-1: Potential Unavoidable Adverse Impacts of the Proposed Action

Resource Area	Potential Unavoidable Adverse Impact of the Proposed Action
Air Quality	• Air quality impacts from emissions from engines associated with vessel traffic, construction activities, and equipment operation
Water Quality	• Increase in suspended sediments due to seafloor disturbance during construction, maintenance, and decommissioning activities
Terrestrial and Coastal Fauna	• Habitat alteration-induced impacts, avoidance behavior, and individual mortality due to clearing and grading activities
Birds and Bats	• Displacement and avoidance behavior due to habitat loss/alteration, equipment noise, and vessel traffic • Individual mortality due to collisions with WTGs
Coastal Habitats	• Increase in suspended sediments and habitat-quality effects due to seafloor disturbance
Benthic Resources	• Increase in suspended sediments and resulting effects due to seafloor disturbance • Habitat quality impacts including reduction in habitat as a result of seafloor surface alternations • Disturbance, displacement, and avoidance behavior due to habitat loss/alteration, equipment noise, and vessel traffic • Individual mortality due to construction activities • Conversion of soft-bottom habitat to new hard-bottom habitat
Finfish, Invertebrates, and Essential Fish Habitat	• Increase in suspended sediments and resulting effects due to seafloor disturbance • Habitat quality alterations or loss of habitat • Displacement, disturbance, and avoidance behavior due to habitat loss/alteration, equipment noise, vessel traffic, increased turbidity, sediment deposition, and electromagnetic fields • Individual mortality due to construction and dredging activities
Marine Mammals	• Displacement, disturbance, and avoidance behavior due to habitat loss/alteration, equipment noise, vessel traffic, increased turbidity, and sediment deposition during construction and operations • Temporary loss of acoustic habitat and increased potential for vessel strikes
Sea Turtles	• Disturbance, displacement, and avoidance behavior due to habitat loss/alteration, equipment noise, vessel traffic, increased turbidity, sediment deposition, and electromagnetic fields
Demographics, Employment, and Economics	• Disruption of marine activities and resulting economic effects in the Lewis Bay area if the New Hampshire Avenue landfall location is implemented as part of the Proposed Action
Environmental Justice	• Disruption of marine activities and resulting economic effects in the Lewis Bay area if the New Hampshire Avenue landfall location is implemented as part of the Proposed Action
Cultural, Historical, and Archaeological Resources	• Impacts on viewsheds of and to historic properties
Recreation and Tourism	• Disruption of coastal recreation activities during onshore construction, such as beach access • Viewshed effects from the WTGs altering enjoyment of marine and coastal recreation and tourism activities • Disruption to access or temporary restriction of in-water recreational activities from construction of offshore project elements
Commercial Fisheries and For-Hire Recreational Fishing	• Disruption to access or temporary restriction in harvesting activities due to construction of offshore project elements • Disruption to harvesting activities during operation of offshore wind facility • Changes in vessel transit and fishing operation patterns
Land Use and Coastal Infrastructure	• Land use disturbance due to construction as well as effects due to noise, vibration, and travel delays

Resource Area	Potential Unavoidable Adverse Impact of the Proposed Action
Navigation and Vessel Traffic	• Changes in vessel transit patterns
Other Uses	• No unavoidable adverse impacts

ESP = electrical service platform; WTG = wind turbine generator

6. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

CEQ's NEPA implementing regulations (40 CFR § 1502.16) require that an EIS review the potential impacts on irreversible or irretrievable commitments of resources resulting from implementation of a proposed action. CEQ considers a commitment of a resource irreversible when the primary or secondary impacts from its use limit the future options for its use. The irreversible commitment of resources occurs due to the use or destruction of a specific resource. An irretrievable commitment refers to the use or consumption or a resource that is neither renewable nor recoverable for use by future generations. In other words, the resource cannot be replaced, recovered, or reversed and results in the loss of production or use of natural or human resources.

Table 6-1 below provides a listing of potential irreversible and irretrievable impacts by resource area. Chapter 3 provides additional information on the impacts summarized below.

Table 6-1: Irreversible and Irretrievable Commitment of Resources by Resource Area

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Air Quality	No	No	BOEM does not expect emissions to exceed air quality standards, and emissions would be temporary during construction activities. If the Proposed Action displaces fossil fuel energy generation, overall improvement of air quality would be expected.
Water Quality	No	No	BOEM does not expect activities to cause loss of or major impacts on existing inland waterbodies or wetlands. Turbidity impacts in the marine and coastal environment would be short term.
Terrestrial and Coastal Fauna	Yes	Yes	Removal or disturbance of habitat associated with clearing and grading activities, as well as construction of the substation, could potentially create minor irreversible and irretrievable impacts.
Birds and Bats	No	No	Based on the healthy populations of bird species likely to collide with WTGs, displacement and avoidance behavior and individual mortality due to collisions with WTGs are not expected to be irreversible or irretrievable. Assuming implementation of time-of-year restrictions for tree clearing, the same is true for bats.
Coastal Habitats	No	No	Vineyard Wind would restore the onshore landfall site selected to original conditions, and turbidity impacts would be short term and not lead to irreversible or irretrievable impacts. Changes in seabed composition/habitat as result of cable protection could result in negligible to minor beneficial impacts.
Benthic Resources	No	No	Although local mortality could occur, BOEM does not anticipate population-level impacts on benthic organisms; habitat could recover after decommissioning activities.
Finfish, Invertebrates, and Essential Fish Habitat	No	No	Although local mortality could occur, BOEM does not anticipate population-level impacts. Vineyard Wind could alter habitat during construction and operations but could restore the habitat after decommissioning.
Marine Mammals	Yes	Yes	Irreversible and irretrievable impacts on marine mammals could occur if one or more individuals of species listed under the ESA were injured or killed. However, consultation with NOAA would identify mitigation measures that would reduce or eliminate the potential for such impacts on listed species.
Sea Turtles	Yes	Yes	Irreversible and irretrievable impacts on sea turtles could occur if one or more individuals of species listed under the ESA were injured or killed. However, consultation with NOAA would identify mitigation measures that would reduce or eliminate the potential for impacts on listed species.
Demographics, Employment, and Economics	No	Yes	A temporary increase of contractor needs, housing needs, and supply requirements could occur during construction activities. This could lead to an irretrievable loss of workers for other projects, and increased housing and supply costs.

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Environmental Justice	No	No	Potential environmental justice impacts, if any, would be short term and localized.
Cultural, Historical, and Archeological Resources	Yes	Yes	Although unlikely, unanticipated removal or disturbance to previously unidentified cultural resources onshore and offshore could result in irreversible and irretrievable impacts.
Recreation and Tourism	No	No	Construction activities near the shore could result in a minor, temporary loss of use of the land for recreation and tourism purposes.
Commercial Fisheries and For-Hire Recreational Fishing	No	Yes	Based on the anticipated duration of construction and operations, BOEM does not anticipate impacts on commercial fisheries to result in irreversible impacts. Irretrievable impacts could occur due to loss of use of fishing areas at an individual permit level.
Land Use and Coastal Infrastructure	Yes	Yes	Land use required for construction and operation activities, such as the land proposed for the substation, could result in a minor irreversible impact. Construction activities could result in a minor irretrievable impact due to temporary loss of use of the land for otherwise typical activities.
Navigation and Vessel Traffic	No	Yes	Based on the anticipated duration of construction and operations, BOEM does not anticipate impacts on vessel traffic to result in irreversible impacts. Irretrievable impacts could occur due to changes in transit routes if vessels are not able to adapt and self-recover.
Other Uses	No	No	BOEM does not anticipate the potential impacts to be irreversible or irretrievable.

ESA = Endangered Species Act; NOAA = National Oceanic and Atmospheric Administration; WTG = wind turbine generator

7. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

CEQ's NEPA implementing regulations (40 CFR § 1502.16) require that an EIS address the relationship between short-term use of the environment and the potential impacts of such use on the maintenance and enhancement of long-term productivity. Such impacts could occur as a result of a reduction in the flexibility to pursue other options in the future, or assignment of a specific area (land or marine) or resource to a certain use that would not allow other uses, particularly beneficial uses, to occur at a later date. An important consideration when analyzing such effects is whether the short-term environmental effects of the action will result in detrimental effects to long-term productivity of the affected areas or resources.

As assessed in Chapter 3, BOEM anticipates that the majority of the potential adverse effects associated with the Proposed Action would occur during construction activities, and would be short term in nature and minor or moderate as defined in Section 3.1. In general, BOEM's implementation of the mitigation measures detailed in Appendix D would minimize the Proposed Action effects that persist throughout operations. These effects would cease after decommissioning activities. In assessing the relationships between short-term use of the environment and the maintenance and enhancement of long-term productivity, it is important to consider the long-term benefits of the Proposed Action, which include:

- Promotion of clean and safe development of domestic energy sources and clean energy job creation;
- Promotion of renewable energy to help ensure geopolitical security, combat climate change, and provide electricity that is affordable, reliable, safe, secure, and clean;
- Delivery of power to the New England energy grid to contribute to Massachusetts's renewable energy requirements, particularly, the commonwealth's mandate that distribution companies jointly and competitively solicit proposals for offshore wind energy generation; and
- Increased habitat for certain fish species.

Based on the anticipated potential impacts evaluated in this document that could occur during Proposed Action construction, operations, maintenance, and decommissioning, and with the exception of some potential impacts associated with onshore components, BOEM anticipates that the Proposed Action would not result in impacts that would significantly narrow the range of future uses of the environment. As assessed in Chapter 3, as well as Chapter 6, removal or disturbance of habitat associated with onshore activities (e.g. construction of the proposed substation) could create long-term irreversible impacts. For purposes of this analysis, BOEM assumes that the irreversible impacts presented in Chapter 6 would be long-term. After completion of the Proposed Action operations and decommissioning phases, however, BOEM expects the majority of marine and onshore environments to return to normal long-term productivity levels.

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APPENDIX A

List of Preparers, References Cited, and Glossary

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APPENDIX A. LIST OF PREPARERS AND REVIEWERS, REFERENCES CITED, AND GLOSSARY

A.1. LIST OF PREPARERS AND REVIEWERS

A.1.1. BOEM Contributors

Name	Role/Resource Area
NEPA Coordinator	
Krevor, Brian	NEPA Compliance; Environmental Justice; CZMA
Resource Scientists and Contributors	
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Baker, Kyle	Marine Mammals; Sea Turtles
Bigger, David	Birds; Bats; Terrestrial and Coastal Fauna; Coastal Habitats
Brune, Genevieve	NEPA Compliance
Carrier, Brandi	Cultural, Historical, and Archaeological Resources
Cody, Mary	NEPA Compliance
Draher, Jennifer	Water Quality
Hoffman, Willie	Cultural, Historical, and Archaeological Resources
Hooker, Brian	Finfish, Invertebrates, and Essential Fish Habitat; Commercial Fisheries and For Hire Recreational Fishing; Benthic Resources
O'Connell, Daniel	Geotechnical Engineer, Technical Design Elements
McCoy, Angel	Meteorologist, Technical Design Elements
Morin, Michelle	Chief, Environment Branch for Renewable Energy; NEPA Compliance
Reeb, Desray	Marine Mammals; Sea Turtles
Stillings, Amy	Demographics, Employment, and Economics; Recreation and Tourism; Land Use and Coastal Infrastructure; Commercial Fisheries and For Hire Recreational Fishing; Navigation and Vessel Traffic; Other Uses
Stromberg, Jessica	Project Coordinator
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Waskes, William	Project Coordinator

A.1.2. Reviewers

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Tuxbury, Susan	Fishery Biologist	NOAA National Marine Fisheries Service
Coit, Janet	Director	Rhode Island Department of Environmental Management

Name	Title	Agency
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LeBlanc, Edward	Chief, Waterways Management Division	US Coast Guard

A.1.3. Consultants

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Project Management/Coordinators	
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DeWitt, Andrew	Deputy Project Manager; All Sections
Graham, James	Partner-in-Charge; All Sections
Heater, Heather	Project Manager; All Sections
Hiatt, Kris	Document Manager/Technical Editor; All Sections
Smith, Emily	Technical Editor; All Sections
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Subject Matter Experts	
Bedard, Justin	Cultural, Historical, and Archeological Resources
Colman, Jim	Meteorology and Climate
Fishman, Michael	Birds; Bats
Guffey, Samuel	Terrestrial and Coastal Faunas other than Birds; Coastal Habitats; Appendix B
Gustavson, Kent	Commercial Fisheries and For Hire Recreational Fishing
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Hamer, Caitlin	Appendix C
Huff, Jenifer	Demographics, Employment, and Economics; Environmental Justice; Recreation and Tourism; Land Use and Coastal Infrastructure
Klausmann, Al	Air Quality
Lockard, Greg	Cultural, Historical, and Archeological Resources
Low, Tara	Other Uses (Marine Minerals, Military Use, Aviation, Offshore Energy); Appendix C
Quinn, Duncan	Appendix C
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Steffen, Bradley	Birds; Bats
Stormer, Amanda	Terrestrial and Coastal Faunas other than Birds; Coastal Habitats
Sussman, Benjamin	Demographics, Employment, and Economics; Environmental Justice; Recreation and Tourism; Land Use and Coastal Infrastructure; Navigation and Vessel Traffic
Todorov, Melinda	Navigation and Vessel Traffic
Normandeau Associates, Inc.	
Hitchcock, Amanda	Water Quality; Benthic Resources
Nestler, Eric	Normandeau Project Manager; Water Quality; Benthic Resources; Finfish, Invertebrates, and Essential Fish Habitat; Marine Mammals; Sea Turtles
Stimmell, Sean	Finfish, Invertebrates, and Essential Fish Habitat
Sweeney, Melinda	Marine Mammals; Sea Turtles

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A.3. GLOSSARY

Term	Definition
affected environment	environment as it exists today that could be potentially impacted by the proposed Project
automatic identification system	automatic tracking system used on vessels to monitor ship movements and avoid collision
algal blooms	rapid growth of the population of algae, also known as algae bloom
allision	a moving ship running into a stationary ship
anthropogenic	generated by human activity
archaeological resource	historical place, site, building, shipwreck, or other archaeological site on the American landscape
ballast	material used to improve stability of a vessel or other vehicle or structure
ballast tank	vessel compartment used to hold water to improve stability
ballast water	water carried by a ship in its ballast tank to improve stability
baleen whale	a cetacean with baleens (whalebones) instead of teeth
below grade	below ground level
benthic	related to the bottom of a body of water
benthic resources	the seafloor surface, the substrate itself, and the communities of bottom-dwelling organisms that live within these habitats
bilge	area where the bottom curve of a ship's hull meets the vertical sides
biogenic structure	structures generated by biological organisms
cetacea	order of aquatic mammals made up of whales, dolphins, porpoises, and related lifeforms
coastal habitat	coastal areas where flora and fauna live, including salt marshes and aquatic habitats
coastal waters	waters in nearshore areas where bottom depth is less than 98.4 feet (30 meters)
coastal zone	the lands and waters starting at 3 nautical miles from the land and ending at the first major land transportation route
commercial fisheries	areas or entities raising and/or catching fish for commercial profit
commercial-scale wind energy facility	wind energy facility usually greater than 1 MW that sells the produced electricity
cultural resource	historical districts, objects, places, sites, buildings, shipwrecks, and archeological sites on the American landscape, as well as sites of traditional, religious, or cultural significance to cultural groups, including Native American tribes
culvert	structure, usually a tunnel, allowing water to flow under an obstruction (e.g., road, trail)
cumulative impacts	impacts that could result from the incremental impact of a specific action, such as the proposed Project, when combined with other past, present, or reasonably foreseeable future actions or other projects; can occur from individually minor, but collectively significant actions that take place over time
criteria pollutant	one of six common air pollutants for which the EPA sets National Ambient Air Quality Standards: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, or sulfur dioxide
critical habitat	geographic area containing features essential to the conservation of threated or endangered species
delphinids	oceanic dolphins
demersal	living close to the ocean floor
design envelope	the range of proposed Project characteristics defined by the applicant and used by BOEM for purposes of environmental review and permitting
direct impact	impacts occurring at the same time and place as the action
dredging	removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies
duct bank	underground structure that houses the onshore export cables, which consists of PVC pipes encased in concrete
ecosystem	community of interacting living organisms and nonliving components (such as air, water, soil)

Term	Definition
electrical service platform	the interconnection point between the wind turbine generators and the export cable; the necessary electrical equipment needed to connect the 66-kV inter-array cable to the 220-kV offshore export cables
electromagnetic field	a field of force produced by electrically charged objects and containing both electric and magnetic components
embayment	recessed part of a shoreline
endangered species	a species that is in danger of extinction in all or a significant portion of its range
ensonification	the process of filling with sound
environmental consequences	the potential direct, indirect, and cumulative impacts that the construction, operations, maintenance, and decommissioning of the proposed Project would have on the environment
environmental justice communities	minority and low-income populations affected by the proposed Project
epifauna	fauna that lives on the surface of a seabed (or riverbed), or is attached to underwater objects or aquatic plants or animals
ESA-listed species	species listed under the Endangered Species Act
essential fish habitat	“those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (50 CFR § 600)
export cables	cables connecting the wind facility to the onshore electrical grid power
export cable corridor	area identified for routing the entire length of the onshore and offshore export cables
federal aids to navigation	visual references operated and maintained by the USCG, including radar transponders, lights, sound signals, buoys, and lighthouses, that support safe maritime navigation
finfish	vertebrate and cartilanginous fishery species, not including crustaceans, cephalopds, or other mollusks
for-hire commercial fishing	commercial fishing on a for-hire vessel, i.e. a vessel on which the passengers make a contribution to a person having an interest in the vessel in exchange for carriage
geomagnetic	relating to the magnetism of the Earth
gillnet	a vertically hanging fishnet that traps fish by their gills
hard-bottom habitat	benthic habitats comprised of hard-bottom (e.g., cobble, rock, and ledge) substrates
historical resource	prehistoric or historic district, site, building, structure, or object that is eligible for or already listed in the National Register of Historic Places. Also includes any artifacts, records, and remains (surface or subsurface) related to and located within such a resource
horizontal directional drilling	trenchless technique for installing underground cables, pipes, and conduits using a surface-launched drilling rig
hull	watertight frame or body of a ship
hypoxic event	event related to a lack of adequate oxygen supply
indirect impacts	effects that could occur later in time or farther removed in distance from Project actions, but are still reasonably foreseeable
infauna	fauna living in the sediments of the ocean floor (or river or lake beds)
inter-array cables	cables connecting the wind turbine generators to the electrical service platforms
inter-link cables	cables connecting the electrical service platforms to one another
invertebrate	animal with no backbone
jacket foundation	latticed steel frame with three or four supporting piles driven into the seabed
jack-up vessel	mobile and self-elevating platform with buoyant hull
jet excavation	process of moving or removing soil with a jet
jet plowing	plowing in which the jet plow, with an adjustable blade, or plow rests on the seafloor and is towed by a surface vessel. The jet plow creates a narrow trench at the designated depth, while water jets fluidize the sediment within the trench. In the case of the proposed Project, the cables would then be feed through the plow and laid into the trench as it moves forward. The fluidized sediments then settle back down into the trench and bury the cable.
knot	unit of speed equaling 1 nautical mile per hour
landfall site	the shoreline landing site at which the offshore cable transitions to onshore
marine mammal	aquatic vertebrate distinguished by the presence of mammary glands, hair, three middle ear bones, and a neocortex (a region of the brain)

Term	Definition
marine waters	waters in offshore areas where bottom depth is more than 98.4 feet (30 meters)
monopile or monopile foundation	a long steel tube driven into the seabed that supports a tower
nautical mile	a unit used to measure sea distances and equivalent to approximately 1.15 miles (1.85 kilometers)
odontocete	a kind of cetacean characterized by the presence of teeth, also called toothed whales
onshore substation	substation connecting the proposed Project to the existing bulk power grid system
operations and maintenance facilities	would include offices, control rooms, warehouses, shop space, and pier space
outer continental shelf	all submerged land, subsoil, and seabed belonging to the U.S. but outside of states' jurisdiction
pile	a type a foundation akin to a pole
pile driving	installing foundation piles by driving them into the seafloor
pinnipeds	carnivorous, semiaquatic marine mammals with fin, also known as seals
pin pile	small-diameter pipe driven into the ground as foundation support
plume	column of fluid moving through another fluid
private aids to navigation	visual references on structures positioned in or near navigable waters of the United States, including radar transponders, lights, sound signals, buoys, and lighthouses, that support safe maritime navigation. Permits for the aids are administered by the USCG.
Project area	the combined onshore and offshore area where proposed Project components would be located
protected species	endangered or threatened species that receive federal protection under the Endangered Species Act of 1973 (As Amended)
scour protection	protection consisting of rock and stone that would be placed around all foundations to stabilize the seabed near the foundations as well as the foundations themselves
scrublands	plant community dominated by shrubs and often also including grasses and herbs
sessile	attached directly by the base
silt substrate	substrate made of a granular material originating from quartz and feldspar, and whose size is between sand and clay
soft-bottom habitat	benthic habitats include soft-bottom (i.e., unconsolidated sediments) and hard-bottom (e.g., cobble, rock, and ledge) substrates, as well as biogenic habitat (e.g., eelgrass, mussel beds, and worm tubes) created by structure-forming species
splice vault	underground concrete transition vault that to be constructed at the landfall site and inside of which the 220-kilovolt (kV) alternating current (AC) offshore export cables would be connected to the 220-kV onshore export cables
substrate	earthy material at the bottom of a marine habitat; the natural environment that an organism lives in
suspended sediments	very fine soil particles that remain in suspension in water for a considerable period of time without contact with the bottom. Such material remains in suspension due to the upward components of turbulence and currents, and/or by suspension.
threatened species	a species that is likely to become endangered within the foreseeable future
tidal energy project	project related to the conversion of the energy of tides into usable energy, usually electricity
tidal flushing	replacement of water in an estuary or bay because of tidal flow
trailing suction hopper dredge	a ship that is used to maintain waterways in navigable condition by virtue of being able to pump sand, clay, silt, and gravel. The ship trails its suction pipe and a pump system sucks up a mixture of sand or soil and water, and discharges it in the 'hopper' or hold of the vessel. Once fully loaded the vessel sails to the unloading site.
trawl	a large fishing net dragged by a vessel at the bottom or in the middle of sea or lake water
turbidity	a measure of water clarity
urban estuary	urban area where salt and fresh water meet
utility right-of-way	registered easement on private land that allows utility companies to access the utilities or services located there
viewshed	area visible from a specific location
visual resource	the visible physical features on a landscape, including natural elements such as topography, landforms, water, vegetation, and manmade structures

Term	Definition
wetland	land saturated with water; marshes; swamps
Wind Development Area	northern portion of the lease area measuring 75,614 acres (306 km^2).
wind energy	electricity from naturally occurring wind
Wind Energy Area	areas with significant wind energy potential and defined by BOEM
Wind Lease Area	the entire area that Vineyard Wind purchased from BOEM, which includes more area than just the WDA
wind turbine generator	component that puts out electricity in a structure that converts kinetic energy from wind into electricity

APPENDIX B

Environmental and Physical Settings

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APPENDIX B. ENVIRONMENTAL AND PHYSICAL SETTINGS

B.1. General Regional Setting

The proposed Project area is located in southern New England and includes land areas in the Commonwealth of Massachusetts and adjacent nearshore and offshore waters. Figure B.1-1 shows the region surrounding the proposed Project area.

The proposed Project offshore cables would make landfall in south-central Cape Cod at one of two proposed locations in Barnstable County. One landfall location, the Cowell's Beach landfall site, would be located within the Town of Barnstable, the largest community on Cape Cod; the Town of Barnstable includes forests, wetlands, ponds, protected open space, public use areas, low- to medium-density residential development, and some commercial and industrial uses along major roads. The Town of Barnstable management plan prioritizes preserving the historic character of the area and preserving natural resources (Town of Barnstable 2010). The second landfall location, the New Hampshire Avenue landfall site, would be located in the Town of Yarmouth, which is east of and adjacent to the Town of Barnstable. The proposed Project area would also include office, storage, and port facilities on Martha's Vineyard. About 2 percent of Martha's Vineyard is zoned for commercial or industrial use, 40 percent is preserved from development, and nearly all of the remaining land area is developed for residential uses (Martha's Vineyard Commission 2010).

From the Cape Cod coast, the proposed Project area would extend south-southwest through Nantucket Sound, pass between Martha's Vineyard and Nantucket via Muskeget Channel, and continue south offshore. Offshore waters in the proposed Project area would be located within the greater Georges Bank area (though not part of the bank itself) of the Northeast U.S. Continental Shelf Ecosystem. This ecosystem extends from the Gulf of Maine to Cape Hatteras, North Carolina (BOEM 2014). The Wind Development Area (WDA) and Offshore Export Cable Corridor (OECC) would be located within the Southern New England sub-region of the Northeast U.S. Continental Shelf Ecosystem, which is distinct from other regions based on differences in productivity, species assemblages and structure, and habitat features (Cook and Auster 2007).

B.2. Climate and Meteorology

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) defines distinct climatological divisions to represent areas that are nearly 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.

B.2.1. Ambient Temperature

According to NCDC data for the Massachusetts coastal division, the average annual temperature is 50.4 degrees Fahrenheit (°F) (10.2 degrees Celsius [°C]), the average winter (December-February) temperature is 31.6 °F (-0.2 °C) and the average summer (June-August) temperature is 69.5 °F (20.8 °C), based on data collected from 1987 through 2017. Table B.2-1 summarizes average temperatures at the individual recording stations within the general area of the proposed Project site. Data for some stations as seen in the table are reflective of different years of weather observations; however, the general pattern shows little difference across the listed locations.

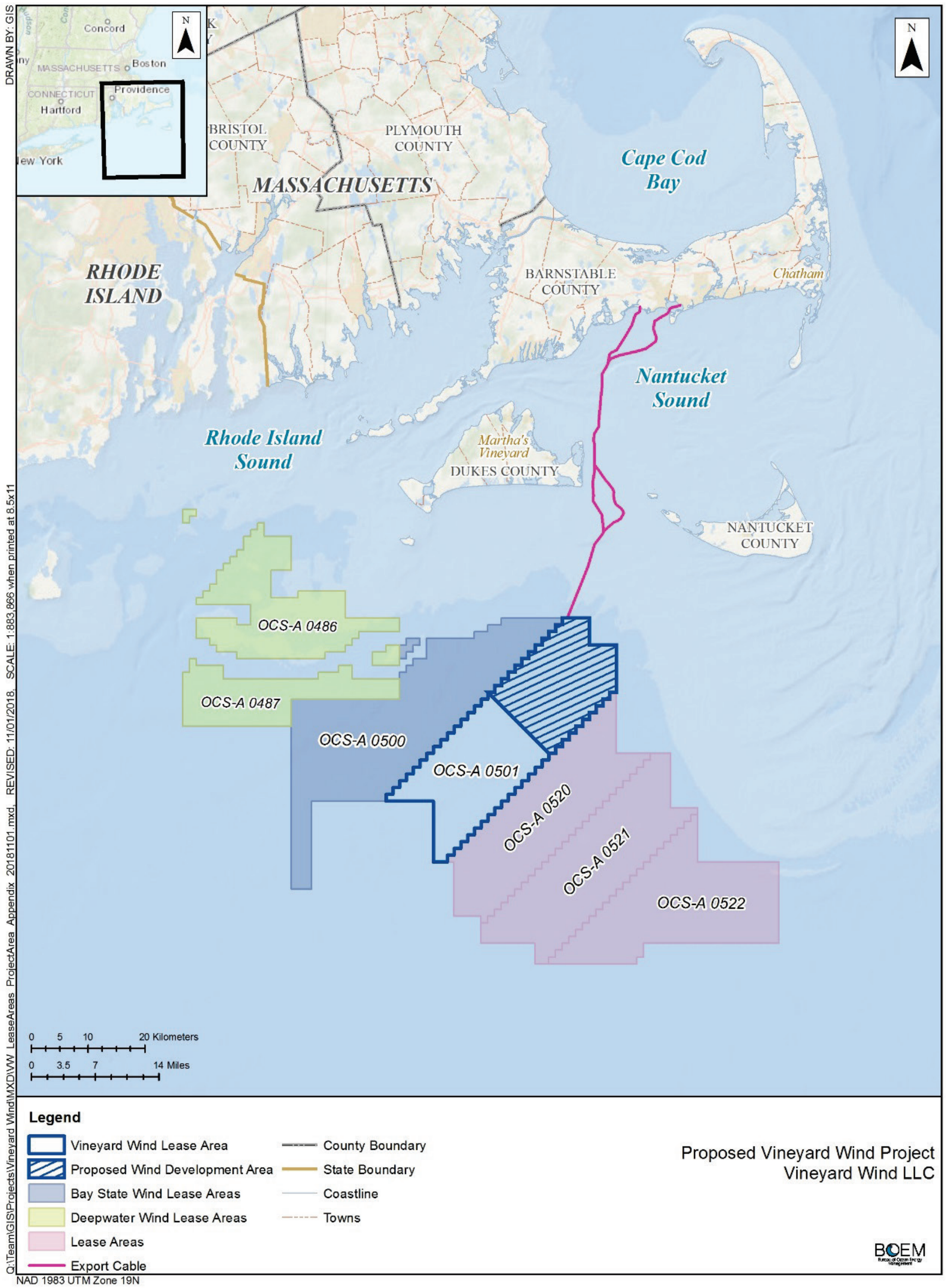


Figure B.1-1: Overall View of the Region Surrounding the Proposed Project Area

Table B.2-1: Representative Temperature Data

Station	Annual Average °F/°C	Annual Maximum °F/°C	Annual Minimum °F/°C
Coastal Division	51.4 / 10.7	60.1 / 15.6	42.6 / 5.8
Nantucket	50.1 / 10.1	57.0 / 13.8	43.2 / 6.2
Martha's Vineyard	51.4 / 10.7	59.8 / 15.4	43.0 / 6.1
Hyannis	52.5 / 11.3	60.2 / 15.6	44.7 / 7.1
Buzzards Bay Buoy	51.4 / 10.8	NA	NA
Nantucket Sound Buoy	52.8 / 11.6	NA	NA

Sources: National Climate Data Center (Coastal Division - NOAA 2017; Nantucket - NOAA 2014; Martha's Vineyard - NOAA 2015; Hyannis - NOAA 2016; Buzzards Bay Buoy - NOAA 2017; Nantucket Sound Buoy - NOAA 2016)

°C = degrees Celsius; °F = degrees Fahrenheit; NA = not applicable

B.2.2. Wind Conditions

Table B.2-2 summarizes wind conditions in the Massachusetts coastal division. This table shows the monthly average wind speeds, monthly average peak wind gusts, and the hourly peak wind gusts for each individual month. Data from 2009 through 2017 show that monthly wind speeds range from a low of 12.2 miles per hour (mph) (19.6 kilometers/hour [km/hr]) in August to a high of 17.2 mph (27.5 km/hr) in January. The monthly wind peak gusts reach a maximum during January at 20.9 mph (33.6 km/hr). The one-hour average wind gusts reach a maximum during March at 64.2 mph (103.3 km/hr).

Table B.2-2: Representative Wind Speed Data

	Monthly Average Gust		Monthly Average Peak Gust		Peak One-Hour Average Gust	
Month	mph	km/hr	mph	km/hr	mph	km/hr
January	17.2	27.5	20.9	33.4	59.1	94.6
February	16.4	26.3	19.9	31.9	63.3	101.3
March	16.6	26.5	20.0	32.0	64.2	102.8
April	14.7	23.6	17.9	28.6	49.1	78.5
May	13.0	20.7	15.4	24.7	47.1	75.3
June	12.6	20.1	15.0	24.0	44.4	71.0
July	12.5	20.0	14.9	23.8	56.9	91.0
August	12.2	19.6	14.6	23.4	59.8	95.6
September	14.0	22.3	16.8	26.9	49.3	78.9
October	16.1	25.8	19.6	31.4	56.6	90.6
November	15.6	25.0	19.5	31.2	57.5	92.1
December	16.6	26.5	20.5	32.7	59.3	94.9

Source: National Data Buoy Center (Nantucket Sound Station 44020) 2009 through 2017

km/hr = kilometer per hour; mph = mile per hour

Throughout the year, wind direction is variable. However, seasonal wind directions are primarily focused from the west/northwest during the winter months (December through February) and from the south/southwest during the summer months (June through August). Figure B.2-1 shows a 5-year wind rose for Buoy Station 44020 (Nantucket Sound). Wind speeds are in meters/second. Percentages indicate how frequently the wind blows from that direction.

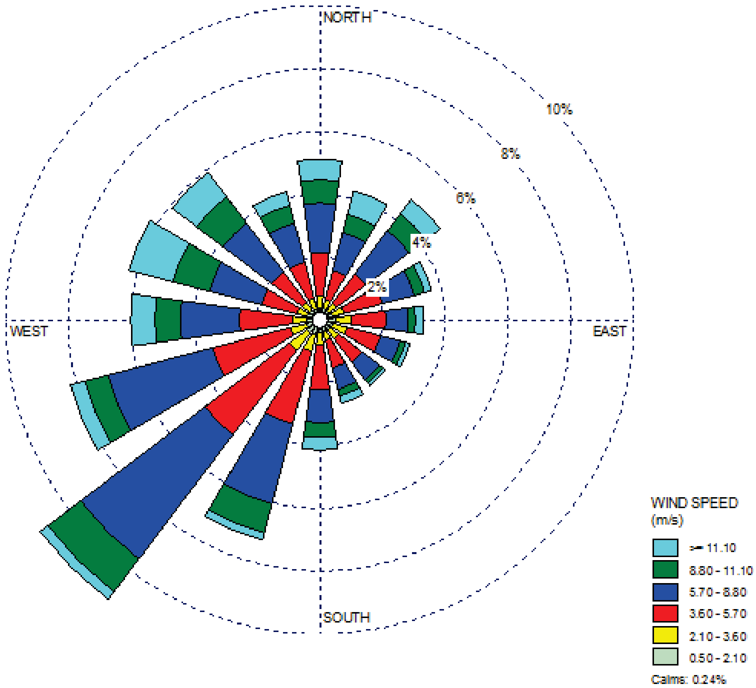


Figure B.2-1: 5-year (2013-2017) Wind Rose for Buoy 44020

B.2.3. Precipitation and Fog

Data from NCDC show that the annual average precipitation is 44.08 inches (112.0 cm) in the Massachusetts coastal division. Table B.2-3 shows monthly variations in average precipitation, which range from a high of 4.08 inches (10.36 centimeters [cm]) for both March and November to a low of 3.13 inches (7.95 cm) in July.

Table B.2-3: Representative Monthly Precipitation Data [a]

Month	Average Precipitation	
	inches	centimeters
January	3.89	9.88
February	3.45	8.76
March	4.08	10.36
April	3.99	10.13
May	3.30	8.38
June	3.24	8.22
July	3.13	7.95
August	3.79	9.62
September	3.55	9.01
October	3.53	8.96
November	4.08	10.36
December	4.05	10.28
Annual Average	44.08	112.0

Source: National Climate Data Center 2017

[a] Precipitation is recorded in melted inches (snow and ice are melted to determine monthly equivalent). Data is representative of the Massachusetts coastal division.

Snowfall amounts can vary quite drastically within small distances. Data from the Martha's Vineyard Station (KMVY) shows that the annual snowfall average is approximately 23 inches (58.4 cm), and the month with the highest snowfall is February, averaging around 8 inches (20.3 cm).

Fog is a common occurrence along coastal Massachusetts. Fog is especially dense across the water south of Cape Cod towards the islands of Martha's Vineyard and Nantucket. Fog data were collected from 1997 to 2009 at the BUZM3 meteorological station located in Buzzard's Bay, approximately 25 miles (40 kilometers) from the project site; and from 2007 to 2009 at the Martha's Vineyard Coastal Observatory (MVCO) meteorological station located 2 miles (3 kilometers) south of Martha's Vineyard (Merrill 2010). The data show that fog is most common in the Project area during the months of June, July, and August, with a typical range of six to eleven days per month with at least 1 hour of fog. In the winter, fog is much less frequent, with three or fewer days with at least 1 hour of fog.

The potential for icing conditions, i.e., atmospheric conditions that can lead to the deposition of ice from the atmosphere onto a structure, was also predicted based on data collected at the BUZM3 tower (Merrill 2010). Icing is rare when the water temperature is greater than 43 °F (6 °C), so in most months of the year, and for many days during the winter months, there is no potential for icing to occur. The data show that moderate icing (defined by the Federal Aviation Administration as a rate of accumulation such that short encounters become potentially hazardous) is unlikely to occur more than 1 day per month, while the potential for light icing is above 5 days per month in December, January, and February. Icing would be unlikely to occur at any time from April through October.

B.2.4. Hurricanes

During the 160 years for which weather records have been kept, ten hurricanes have made landfall in Massachusetts and five others have passed through the WDA without making landfall. The latest hurricane that made a direct landfall was Hurricane Bob in 1991. Out of those ten hurricanes, five ranked as Category 1 on the Saffir-Sampson Scale, two were Category 2 hurricanes, and three were Category 3 hurricanes. Since records have been kept, no Category 4 or 5 hurricanes have made landfall in Massachusetts. Of the hurricanes that passed through the WDA without making landfall in Massachusetts, one was Category 2, one was Category 1, and three were tropical storms when they passed through the WDA. The most recent of these storms was Beryl in 2006. NOAA 2012 defines the winds speeds and typical damage associated with each category of hurricane.

In addition to hurricanes, Nor'easters (cold-core extratropical cyclones) may occur several times per year in the fall and winter months. Wind gusts during the strongest Nor'easters can cause similar damage to a Category 1 hurricane, although Nor'easters typically are larger and last longer than hurricanes.

B.2.5. Mixing Height

Table B.2-4 presents atmospheric mixing height data from two nearby stations. As shown in the table, the minimum average mixing height is 389 meters (1,276 feet), while the maximum average mixing height is 1,421 meters (4,662 feet). The minimum average mixing height is much higher than the height of the top of the proposed rotors (696 feet).

Table B.2-4: Representative Seasonal Mixing Height Data

Season [a]	Data Hours Included [b]	Nantucket Average Mixing Height (meters) [c]	Chatham Average Mixing Height (meters) [d]
Winter	Morning – No Precipitation Hours	780	668
	Morning – All Hours	905	655
	Afternoon – No Precipitation Hours	791	774
	Afternoon – All Hours	890	747
Spring	Morning – No Precipitation Hours	588	681
	Morning – All Hours	734	664
	Afternoon – No Precipitation Hours	746	1218
	Afternoon – All Hours	827	1110

Season [a]	Data Hours Included [b]	Nantucket Average Mixing Height (meters) [c]	Chatham Average Mixing Height (meters) [d]
Summer	Morning – No Precipitation Hours	389	569
	Morning – All Hours	448	568
	Afternoon – No Precipitation Hours	609	1421
	Afternoon – All Hours	667	1295
Fall	Morning – No Precipitation Hours	625	566
	Morning – All Hours	739	583
	Afternoon – No Precipitation Hours	765	1036
	Afternoon – All Hours	831	945
Annual Average	Morning – No Precipitation Hours	595	620
	Morning – All Hours	707	618
	Afternoon – No Precipitation Hours	727	1121
	Afternoon – All Hours	804	1028

Source: Data drawn from Cape Wind Energy Project Final EIS (USDOE and MMS 2012).

[a] Winter = December, January, February; Spring = March, April, May; Summer = June, July, August; Fall = September, October, November

[b] Missing values not included.

[c] Data from EPRI 1984

[d] Data from USEPA 2007

B.3. GEOLOGY AND SEAFLOOR CONDITIONS

The proposed Project area would be located south of Cape Cod in the Atlantic Ocean and Nantucket Sound, where the physiographic regions known as the Seaboard Lowland section of the New England Province and the Atlantic Coastal Plain Province meet. The proposed Project would straddle these two physiographic regions. The Lowland, which includes part of the continental shelf, is a broad belt that extends from south of Rhode Island northeast to central Maine. Erosion and deposition related to glacial processes, produced numerous changes in drainage patterns and observed topography over geologic time. The land formations in the Coastal Plain are low relief and are composed of a wedge of unconsolidated sediments that overlay much older consolidated rock. The north bounds of the Coastal Plain run from the north side of Long Island through Rhode Island Sound to Martha's Vineyard. Offshore water depths generally range from approximately 131 to 262 feet (40 to 80 meters), with some areas as shallow as 65 feet (20 meters). North of Martha's Vineyard, Nantucket Sound exhibits water depths mostly around 40 to 50 feet (12 to 15 meters), with several shallower shoals, and it generally becomes shallower as one approaches Cape Cod. The sea has also influenced landforms in this region, creating barrier spits and longshore accretions of sandy beaches with the prevailing currents (Fenneman 1938; Denny 1982; Oldale 1992).

B.3.1. Historical Formation

Today, the continental shelf off the United States eastern seaboard resides on a passive continental margin with minimal tectonic and seismic activity (COP Section 2.1, Volume II; Epsilon 2018). Hundreds of millions of years ago, prior to this relatively quiescent period, numerous continental plate collisions produced the multiple mountain chains that are prominent on the present landscape, including the Appalachian and Adirondack systems (Denny 1982). Subsequently, weathering and erosion have supplied sediment from the bedrock-based piedmont to the coastal plain regions sloping down toward the Atlantic Ocean. The sediment forms a wedge that thickens toward the sea and is modified by fluvial, estuarine, and coastal processes. Starting approximately 2.6 million years ago, a series of glaciations modified the landscape in the northern latitudes, scouring, transporting, and depositing materials along their path. Glacial periods within the last 500,000 years are believed to be responsible for the geomorphology present on today's landscape (Denny 1982).

B.3.2. Current Seafloor Conditions

The current range of seabed conditions is a result of historical geologic events. Little to no terrigenous sediment supply exists in the region, so the surficial sediment layer comes mostly from glacial deposits (Baldwin et al. 2016). A direct correlation between grain size and bottom current velocities is evident from the strong tidal currents in and around Nantucket Sound to the open water, general shelf circulation south of the islands (COP Section 2.1, Volume II; Epsilon 2018). Where high current conditions exist, the coarsest material persists (gravel, cobbles, boulders), often with large ripples and waves in the sandy surficial layer (Poppe et al. 2012; Baldwin et al. 2016).

Very homogenous seafloor conditions exist in offshore areas, dominated by fine sand and silt. Water depths range from 114.8 to 170.6 feet (35 to 52 meters) over a gently sloping seafloor that dips toward the south-southwest. There is a distribution of localized patches of ripples and sand waves throughout the area. These features represent the only vertical relief in an otherwise relatively flat, featureless seafloor that slopes gradually offshore. These features range from 32 to 656 feet (10 to 200 meters) wide by 328 to 1,640 feet (100 to 500 meters) long, but may exceed 3,280 feet (1,000 meters) in length. These features are typically less than 3.3 feet (1 meter) in height, but can reach up to 22.9 feet (7 meters).

Seafloor features that are stable and exhibit vertical relief provide a significant rare habitat amidst the broad sand flats. Such habitats include gravel or pebble-cobble beds, sand waves, biogenic structures (e.g., burrows, depressions, sessile soft-bodied invertebrates), shell aggregates, boulders, hard bottom patches, sulfur sponge (*Cliona celata*) beds, and cobble beds with and without sponge cover. These coarser substrates provide complex interstitial spaces for shelter and generally exhibit greater faunal diversity. Other special, sensitive, and unique habitats (living bottom, hard/complex bottom, eelgrass [*Zostera marina*] beds, and marine mammal habitats) occur in places within the proposed Project area (see COP Volume II-A, Section 5.2; Epsilon 2018).

The seafloor near Muskeget Channel is particularly complex, being composed mostly of sand, but with a variety of slopes, contours, and sand wave dimensions (COP Section 2.1, Volume II; Epsilon 2018). This area also includes a significant amount of hard/complex bottom habitat, as well as boulders that are buried shallowly and could be exposed by shifting sands. Water depths in the Muskeget Channel area range from 0 to 100 feet (0 to 30 meters), with the main part of the channel lying mostly between 23 and 65 feet (7 to 20 meters). The seafloor in the proposed OECC is primarily a flat bed of sand and silt, but it includes sparse small patches of minor vertical relief, as well as several eelgrass beds nearby. Water depths in the proposed OECC, which Vineyard Wind has routed to avoid shoals and eelgrass beds, are around 40 to 50 feet (12 to 15 meters) for most of the route, becoming gradually shallower over the final 2 miles (3.2 kilometers) approaching the land.

B.4. PHYSICAL OCEANOGRAPHY

Key factors nearshore include the daily modification of the seabed by tidal currents, and episodic extreme storm events that are capable of extensive erosion and redistribution of coastal materials. Offshore, an area immediately to the west of the proposed Project area has been extensively studied (the Rhode Island Ocean Special Area), and the results can be informative for the offshore portions of the proposed Project area (Rhode Island Coastal Resources Management Council 2010). Water temperature is seasonally variable and at the surface ranges from approximately 37 °F (3 °C) in winter to 65 °F (18 °C) in summer.

B.4.1. Regional Ocean Forces

Clockwise movement around Georges Bank and flow towards the equator dominates large-scale regional water circulation, which is strongest in late spring and summer (Gulf of Maine Census 2018). The edge of the continental shelf creates a shelf-break front that encourages upwelling. Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011). Variable temperature-salinity water masses occupying nearshore and offshore regions converge over Nantucket Shoals, creating a persistent frontal zone in the area. Offshore from the islands, shelf currents flow predominantly toward the southwest, beginning as water from the Gulf of Maine heading south veers around and over Nantucket Shoals. Tidal water masses from nearshore transitioning through Nantucket Sound mix with the shelf current generally following depth contours offshore.

Offshore water masses may extend northward onto the shelf toward the islands and through the Massachusetts Wind Energy Area (MA WEA) at different times of the year (Ullman and Cornillon 1999), while nearshore waters appear to be affected by freshwater runoff in the spring and show increased sea surface temperature gradients extending seaward from Nantucket Sound tidal exit points. A southeasterly flow along the inner shelf depth contours from Nantucket Sound (Limeburner and Beardsley 1982) may be a factor in maintaining the frontal system over Nantucket Shoals. While the dynamics of this system may not be completely understood at this time, the variability observed in shelf water characteristics plays a role in supporting the diverse marine ecology present offshore New England.

B.4.2. Tides and Tidal Currents

Tidal range in the Nantucket Sound area is typically 2 to 3.2 feet (0.6 to 1 meter), and tidal currents can exceed 3.5 knots (6.5 km/hr) in Muskeget Channel. Elsewhere, 1- to 1.5-knot (1.8- to 2.8-km/hr) flows run west to east in the Main Channel of Nantucket Sound (NOAA 2013) immediately south of Horseshoe Shoal.

In the WDA, previous studies found that currents are tidally dominated (Spaulding and Gordon 1982), with wind and density variations playing a smaller role. Data suggest that the depth-averaged current speed is approximately 0.58 knot (1.0 km/hr) and the surface current speed is approximately 0.66 knot (1.2 km/hr). While there are no WDA-specific observational data available, a three-dimensional tide and wind driven model described in COP Appendix A (Volume III; Epsilon 2018) has been validated to observed currents at the Rhode Island Ocean Special Area Management Plan (Rhode Island Coastal Resources Management Council 2010). In the WDA, the bottom flood current is predicted to move towards the northeast and the ebb current towards the southwest. Peak predicted current speeds are relatively weak (less than 0.39 knot [0.7 km/hr]). At a similar site nearby, Vineyard Wind collected and reported data in COP Volume II-A Table 2.2-5 (Epsilon 2018). Currents there were usually less than 0.7 knot (1.3 km/hr) at the surface and less than 0.6 knot (1.1 km/hr) at the bottom, and speeds at both surface and bottom were generally less than 0.31 knot (0.6 km/hr).

B.4.3. Waves

In the Rhode Island Ocean Special Area Management Plan, average wave height ranges from 3 to 10 feet (1 to 3 meters) and is likely to have little impact on the bottom at depth. Extreme wave height estimates range from 21 to 23 feet (6.5 to 7 meters) in a 10-year span to 29 to 30 feet (8.8 to 9 meters) in a 100-year span (Rhode Island Coastal Resources Management Council 2010).

Within the proposed Project area, the annual average of the monthly average significant wave height is approximately 5.9 feet (1.8 meters) and the maximum significant wave height occurs in September. The annual average of the monthly average wave period is approximately 5.9 seconds and the maximum wave period occurs in February.

In many portions of Nantucket Sound, wave heights are limited by the short distance over which the wind can generate waves. This effect can be dramatic in places where the Project area is close to shore, such as a west wind off Chappaquiddick Island or a north wind offshore from the Cape. In addition, the presence of shoals (e.g., Muskeget area, Horseshoe Shoal) scattered around the area force the waves to increase in height locally and break, thereby diminishing further wave building.

Tidal currents can similarly play a role in modifying wave action nearshore. Wind-generated waves working against the tidal current quickly build and can develop standing waves under certain conditions. Conversely, a strong tidal current flowing in the same direction as the waves can actually diminish wave height as a result of the reduced opposing force. These effects come into play where large volumes of water are moving in and out of the Sound, such as through Muskeget Channel and surrounding passages, as well as the channels north and south of Horseshoe Shoal.

B.5. BIOLOGICAL RESOURCES

B.5.1. Sea Life

Moderate productivity and a mostly fine sand bottom, which has a large effect in shaping the biological resources of the area, characterize the marine areas within the proposed Project area.

B.5.1.1. Marine Mammals

Marine mammals use the coastal waters of the northwest Atlantic outer continental shelf and the proposed Project area for feeding, breeding, nursery grounds, socializing, and migration (Stone et al. 2017; Leiter et al. 2017). Around 15 species of marine mammals, many of which are migratory, are likely to occur within the proposed Project area (Table B.5-1). In particular, the federally endangered North Atlantic right whale (*Eubalaena glacialis*) frequents the area. Accordingly, several marine zones near the proposed Project area are managed using seasonal or year-round restrictions to protect right whales and their habitats. The COP (Epsilon 2018) and BOEM 2014 present a list of all marine mammals that may occur in the area and corresponding detailed descriptions.

Table B.5-1: Marine Mammals Regularly or Commonly Occurring in the Proposed Region

Common Name	Scientific Name	ESA (MMPA) Status [a]	Relative Occurrence in Region [b]	Seasonal Occurrence in Region
Order Cetacea, Suborder Mysticeti (baleen whales), Family Balaenopteridae				
North Atlantic right whale [c]	*Eubalaena glacialis*	E(D)	Common	Year-round, peak winter-spring
Fin whale [c]	*Balaenoptera physalus*	E(D)	Common	Year-round, peak spring-summer
Sei whale [c]	*Balaenoptera borealis*	E(D)	Regular	Spring-summer
Minke whale [c]	*Balaenoptera acutorostrata acutorostrata*	(N)	Common	Year-round, peak spring-fall
Humpback whale [c]	*Megaptera novaeangliae*	(N)	Common	Year-round, peak spring-summer
Suborder Odontoceti (toothed whales and dolphins)				
Family Physeteridae				
Sperm whale [c]	*Physeter macrocephalus*	E(D)	Common	Year-round, peak summer-fall
Family Delphinidae				
Risso's dolphin	*Grampus griseus*	(N)	Common Offshore	Year-round, peak spring-fall
Long-finned pilot whale	*Globicephala melas*	(S)	Common	Year-round, peak spring-summer
White-beaked dolphin	*Lagenorhynchus albirostris*	(N)	Regular	Spring
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	(N)	Common	Year-round, peak spring-fall
Atlantic spotted dolphin	*Stenella frontalis*	(N)	Rare/Regular [c]	Spring-fall [d]
Striped dolphin	*Stenella coeruleoalba*	(N)	Rare/Regular [c]	NA
Short-beaked common dolphin	*Delphinus delphis*	(N)	Common	Year-round, peak summer-fall
Bottlenose dolphin (Western North Atlantic offshore stock)	*Tursiops truncatus*	(D)	Common	Year-round

Common Name	Scientific Name	ESA (MMPA) Status [a]	Relative Occurrence in Region [b]	Seasonal Occurrence in Region
Family Phocoenidae				
Harbor porpoise	*Phocoena phocoena*	(N)	Common	Year-round, peak fall-spring
Order Carnivora, Suborder Caniformia, Family Phocidae (earless seals)				
Harbor seal	*Phoca vitulina concolor*	(N)	Common	Year-round [e]
Gray seal	*Halichoerus grypus*	(N)	Common	Year-round [e]
Harp seal	*Pagophilus groenlandicus*	(N)	Common	Year-round [e]
Hooded seal	*Cystophora cristata*	(N)	Regular	Year-round [e]

[a] ESA (Endangered Species Act) status: E = endangered; MMPA (Marine Mammal Protection Act) status: D = Depleted, S = Strategic; N = Not Strategic. See Section 3.3.7 for details regarding MMPA status.

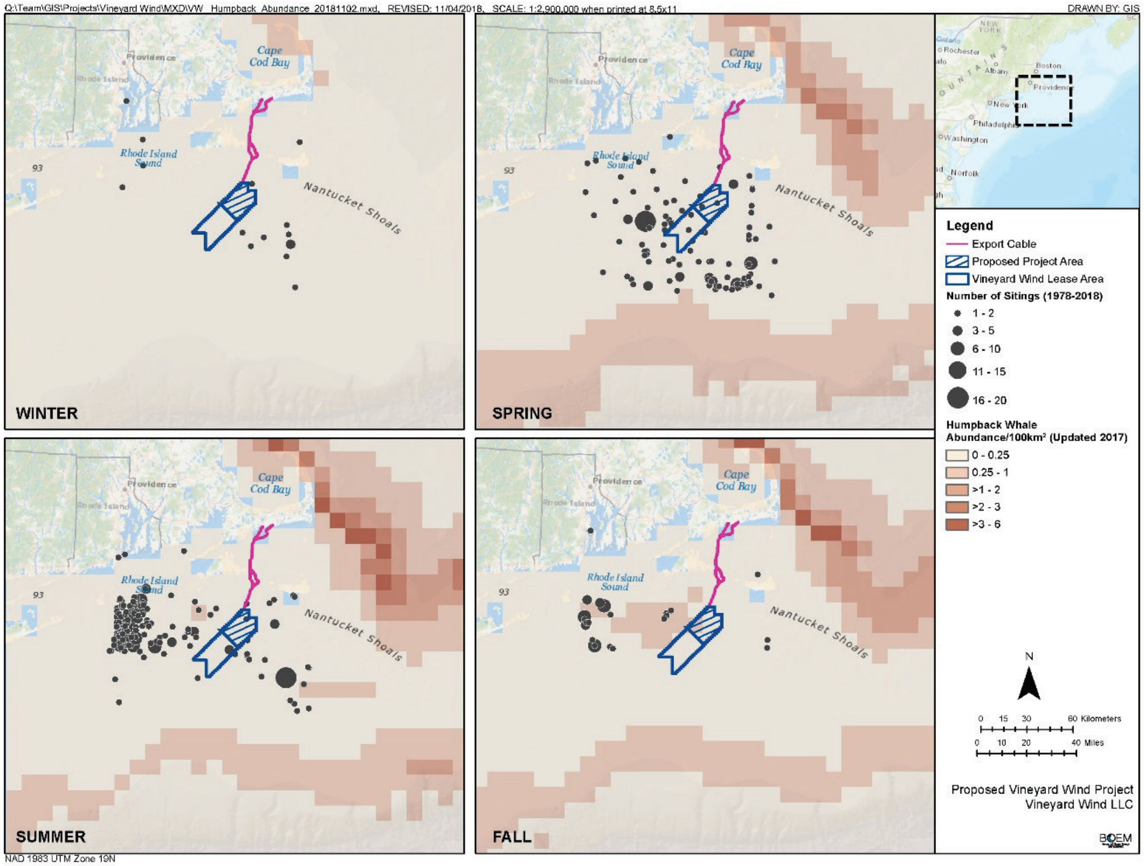
[b] Based on occurrence within Rhode Island Ocean Special Area Management Plan Study Area (which includes the WDA and surrounding Project Area): Common = greater than 100 records; Regular = 10–100 records; Rare = less than 10 records; Hypothetical = the remote possibility to occur in the region at some time (Kenney and Vigness-Raposa 2010).

[c] NEFSC and SEFSC 2011a.

[d] Based on Kraus et al. 2016b; BOEM 2014a. Region defined as the waters south of Martha's Vineyard and Nantucket and Nantucket Shoals.

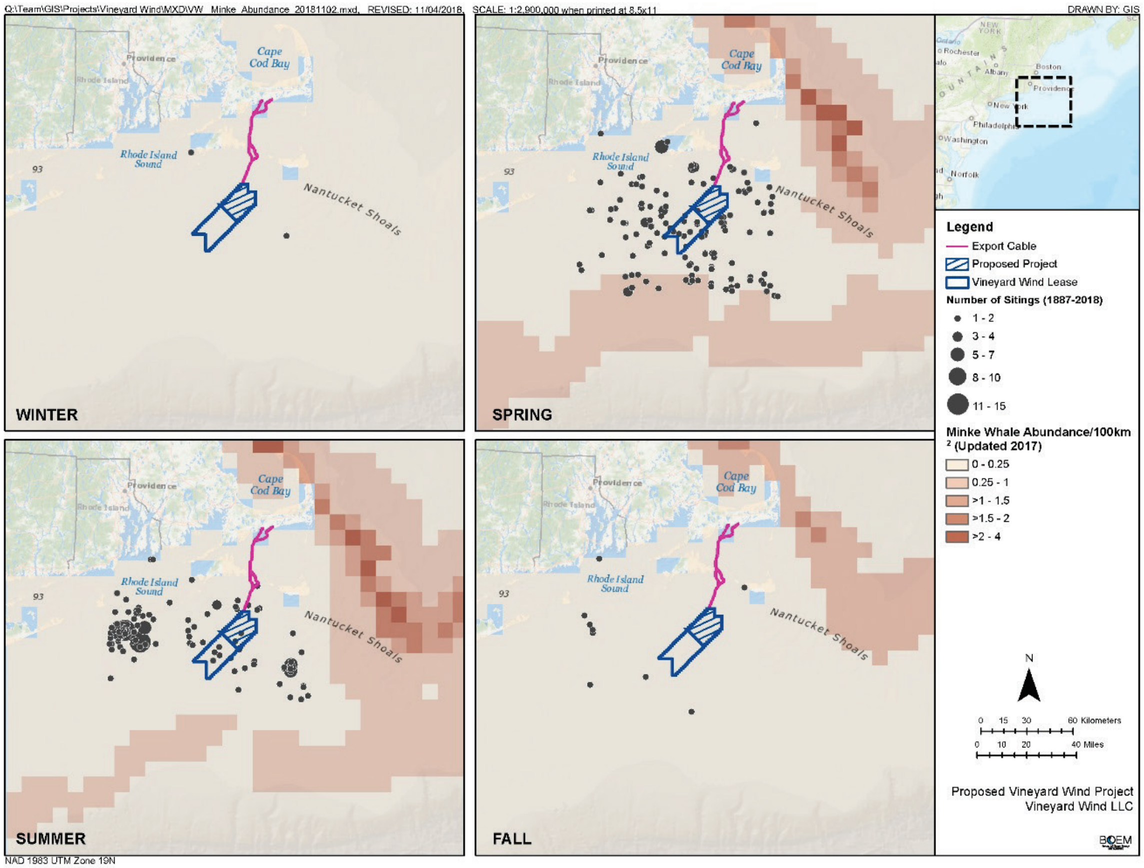
[e] Based on Kenney and Vigness-Raposa 2010.

Marine mammals are highly migratory, and seasonal occurrences in the proposed Project area vary for each species. The BA includes distribution maps of the listed species in the Project area and details regarding their seasonal occurrence (BOEM 2018b). Seasonal distributions for humpback whales, minke whales, harbor porpoise, and three dolphin species in the proposed Project area are shown in Figures B.5-1 through B.5-4).



Source: Roberts et al. 2016b; Right Whale Consortium 2018

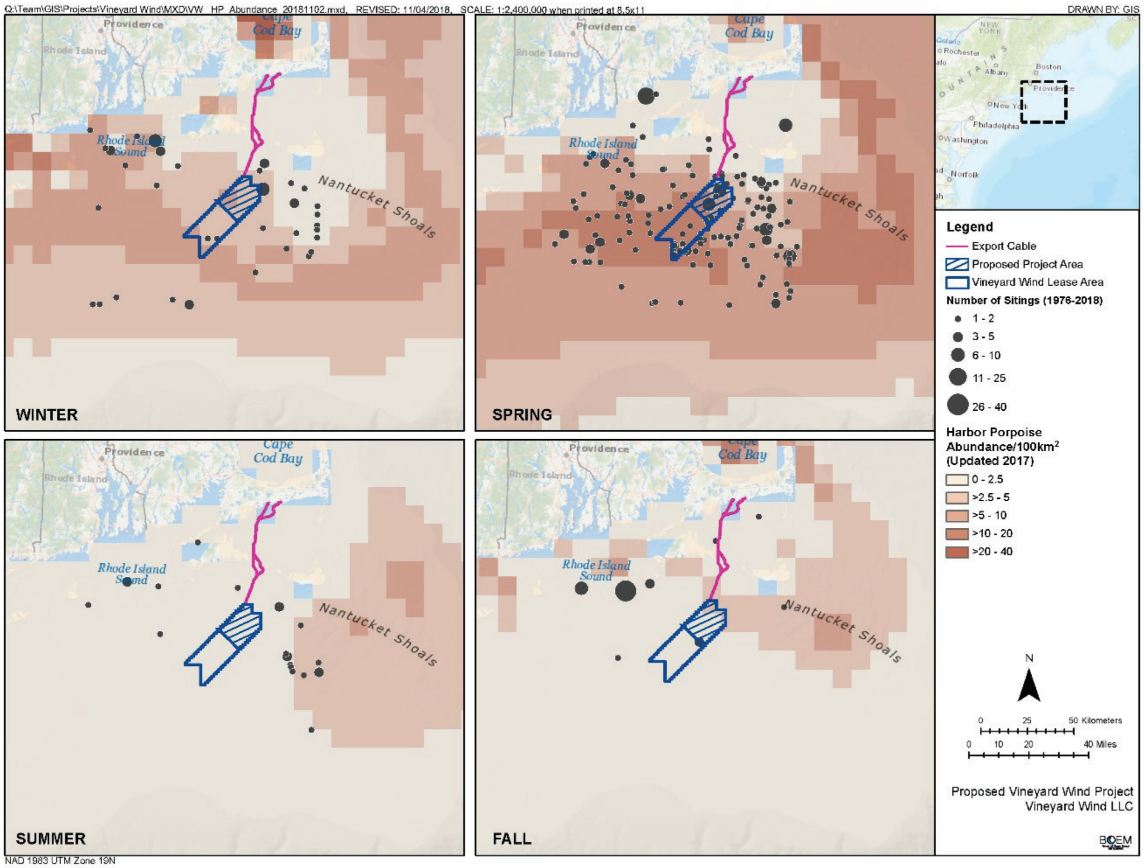
FigureB.5-1: Humpback Whale Abundance Estimates (Number of Whales per 100 km^2) with Sightings Data from 1978 to 2018 Overlaid in the Vineyard Wind Project Area



Source: Roberts et al. 2016b; Right Whale Consortium 2018

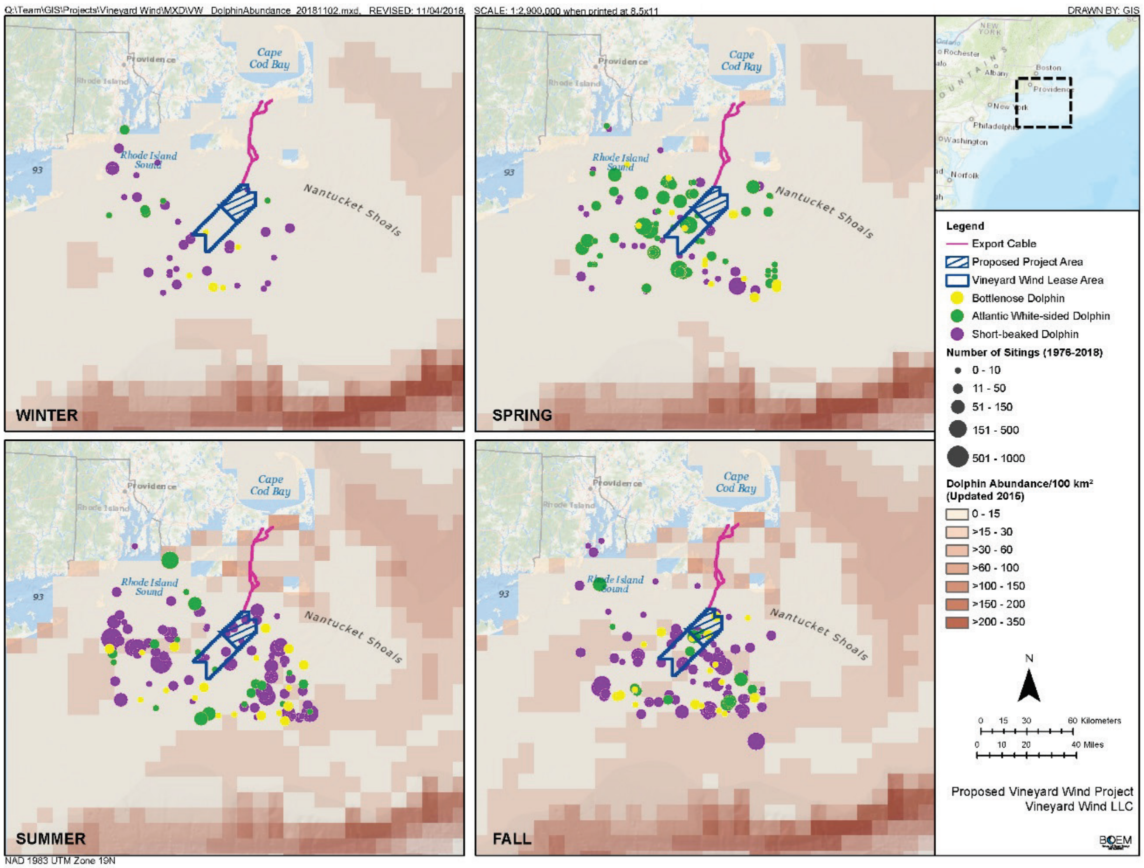
Note: Three sightings of single whales prior to 1962; all others from 1997–2018 in the Vineyard Wind Project area

Figure B.5-2: Minke Whale Abundance Estimates (Number of Whales per 100 km^2) with Sightings Data from 1978 to 2018 Overlaid in the Vineyard Wind Project Area



Source: Roberts et al. 2016b; Right Whale Consortium 2018

Figure B.5-3: Harbor Porpoise Abundance Estimates (Number of Porpoise per 100 km^2) with Sightings Data from 1976 to 2018 Overlaid in the Vineyard Wind Project Area



Source: Roberts et al. 2016a; Right Whale Consortium 2018

Figure B.5-4: Bottlenose Dolphin, Atlantic White-Sided Dolphin, and Short-Beaked Common Dolphin Abundance Estimates (Number of Dolphins per 100 km^2) with Sightings Data from 1976 to 2018 Overlaid in the Vineyard Wind Project Area

B.5.1.2. Finfish and other Species of Commercial Importance

Resident and migratory finfish species as well as demersal (bottom feeders) and pelagic (inhabiting the water column) types occur in portions of the MA WEA and within the WDA. Many of these species have designated Essential Fish Habitat, a delineation of important marine and diadromous (migratory between salt and fresh waters) fish habitat for all federally managed species (finfish and invertebrates) mandated through the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR part 600) (BOEM 2018a). A complete list of species with Essential Fish Habitat near the proposed Project Area can be found in BOEM 2018b. Table B.5-2 shows some of the most significant species occurring in this area, and indicates those species of commercial/recreational importance. For more information on commercial and for-hire recreational fishing activities and species, see Section 3.4.5 as well as COP Section 7.6.5, Volume II (Epsilon 2018).

Table B.5-2: Major Finfish and Invertebrate Species in Southern New England

Common Name	Scientific Name	Regional Species	Project Area Species	Listing Status	Federally managed, EFH in WDA	Federally managed, EFH in OECC	Resident [a]	Migratory [a]	Benthic [b]	Demersal [b]	Pelagic [b]	Commercial/ Recreational Importance
alewife	*Alosa pseudoharengus*	X	X					X			J A	X
albacore tuna	*Thunnus albacares*	X	X		X	X		X			J A	X
American eel	*Anguilla rostrata*	X	X					X			A	X
American lobster	*Homarus americanus*	X	X					X	E J A		L	X
American oyster	*Crassostrea virginica*	X	X				X		A		L	X
American sand lance	*Ammodytes americanus*	X	X				X			E J A		X
American shad	*Alosa sapidissima*	X	X					X			J A	X
Atlantic butterfish	*Peprilus triacanthus*	X	X		X	X		X			E L J A	X
Atlantic cod	*Gadus morhua*	X	X		X	X		X		J A	E L	X
Atlantic croaker	*Micropogonias undulatus*	X					X			J A	E L	X
Atlantic herring	*Clupea harengus*	X	X		X	X		X			L J A	X
Atlantic mackerel	*Scomber scombrus*	X	X		X	X		X			E L J	X
Atlantic menhaden	*Brevoortia tyrannus*	X	X					X			E L J A	X
Atlantic salmon	*Salmo salar*	X		X				X			J A	
Atlantic sea scallop	*Placopecten magellanicus*	X	X		X	X	X		E L J A		L	X
Atlantic skipjack tuna	*Katuwonus pelamis*	X	X		X	X		X			J A	X
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	X	X	X				X			A	
Atlantic surfclam	*Spisula solidissima*	X	X		X	X	X		J A			X
Atlantic wolffish	*Anarhichas lupus*	X	X		X	X	X			E J A	L	
Atlantic yellowfin tuna	*Thunnus albacares*	X	X		X	X		X			J A	X
barndoor skate	*Dipturus laevis*	X	X		X		X			J A		
basking shark	*Cetorhinus maximus*	X	X		X			X			J A	
bay scallops	*Argopecten irradians*	X	X				X		A	L		X
black drum	*Pogonias cromis*	X					X			J A		X
black sea bass	*Centropristis striata*	X	X		X	X		X		J A		X
blue mussels	*Mytilus edulis*	X	X				X		A	L		X
blue shark	*Prionace glauca*	X	X		X	X		X			J A	
blueback herring	*Alosa aestivalis*	X	X					X			J A	X
bluefin tuna	*Thunnus thynnus*	X	X		X	X		X			J A	X
bluefish	*Pomatomus salatrix*	X	X		X	X		X			J A	X
channeled whelk	*Busycotypus canaliculatus*	X	X				X		E J A	L		X
cobia	*Rachycentron canadum*	X	X		X	X		X			E L J A	X
common thresher shark	*Alopias vulpinus*	X	X		X	X		X			J A	
dusky shark	*Carcharhinus obscurus*	X	X		X	X		X			J A	
giant manta ray	*Manta birostris*	X		X				X			J A	
haddock	*Melanogrammus aeglefinus*	X	X		X	X		X			E L	X
horseshoe crab	*Limulus polyphemus*	X	X				X		E J A		L	X
jonah crab	*Cancer borealis*	X	X					X	E J A		L	X
king mackerel	*Scomberomorus maculatus*	X	X		X	X		X			E L J A	X
knobbed whelk	*Busycon carica*	X	X				X		E J A			X
little skate	*Leucoraja erinacea*	X	X		X	X	X			J A		X
longfin squid	*Doryteuthis pealeii*	X	X		X	X		X	E		J A	X
monkfish	*Lophius americanus*	X	X		X	X	X			J A	E L	X
northern sea robin	*Prionotus carolinus*	X	X					X		J A	E L	
ocean pout	*Zoarces americanus*	X	X		X	X		X		E J A		X
ocean quahog	*Arctica islandica*	X	X		X		X		J A			X
pollock	*Pollachius virens*	X	X		X			X		J	E L	X
porbeagle shark	*lamna nasus*	X	X		X			X			J A	
red hake	*Urophycis chuss*	X	X		X	X		X		J A	E L	X

Common Name	Scientific Name	Regional Species	Project Area Species	Listing Status	Federally managed, EFH in WDA	Federally managed, EFH in OECC	Resident [a]	Migratory [a]	Benthic [b]	Demersal [b]	Pelagic [b]	Commercial/ Recreational Importance
sandbar shark	*Carcharhinus plumbeus*	X	X		X	X		X			J A	
sand tiger shark	*Carcharias taurus*	X	X		X	X		X			J A	
scup	*Stenotomus chrysops*	X	X		X	X		X		J A		X
shortfin mako shark	*Isurus oxyrinchus*	X	X		X			X			J A	
shortfin squid	*Illex illecebrosus*	X	X			X		X			A	X
shortnose sturgeon	*Acipenser brevirostrum*	X		X				X		A		
silver hake	*Merluccius bilinearis*	X	X		X	X		X			E L J	X
smooth dogfish	*mustelus canis*	X	X		X	X		X			J A	
Spanish mackerel	*Scomberomorus maculatus*	X	X		X	X		X			E L J A	X
spiny dogfish	*Squalus acanthias*	X	X		X	X		X		A	A	X
spot	*Leiostomus xanthurus*	X						X		J A	E L J A	
spotted sea trout	*Cynoscion nebulosus*	X					X			E L J A		X
striped bass	*Morone saxatilis*	X	X					X		J A	J A	X
summer flounder	*Paralichthys dentatus*	X	X		X	X		X		J A	E L	X
tautog	*Tautoga onitis*	X	X					X		E L J A	E	X
tiger shark	*Galeocerdo cuvier*	X	X		X			X			J A	X
weakfish	*Cynoscion regalis*	X						X			E L J A	X
white hake	*Urophycis tenuis*	X	X		X	X		X		J	E L J	X
white shark	*Carcharadon carcharias*	X	X		X	X		X			J A	X
windowpane flounder	*Scophthalmus aquosus*	X	X		X	X		X		J A	E L	X
winter flounder	*Pseudopleuronectes americanus*	X	X		X	X		X		L	E J A	X
winter skate	*Leucoraja ocellata*	X	X		X	X		X		J A		X
witch flounder	*Glyptocephalus cynoglossus*	X	X		X	X		X			E L	X
yellowtail flounder	*Scophthalmus aquosus*	X	X		X	X		X		J A	E L	X

A = adult; E = egg; EFH = Essential Fish Habitat; L = larvae; J = juvenile; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area

[a] Migration encompasses movements potentially affecting the presence of a species in the Project area. It includes short inshore/offshore seasonal movements (e.g., flatfish, skates) as well as long-distance migrations (e.g., tuna).

[b] Habitat use was separated by life stage based on information from several sources (BOEM 2018d, ASMFC 2018, Miller and Klimovich 2017, Nelson et al. 2018, ASMFC 1998, Roberts 1978, Collette and Klein-MacPhee 2002). Some species with EFH in the Project area did not have EFH designation for all life stages, while for other species, some life stages may not exist in the Project area.

B.5.1.3. Benthic Invertebrates

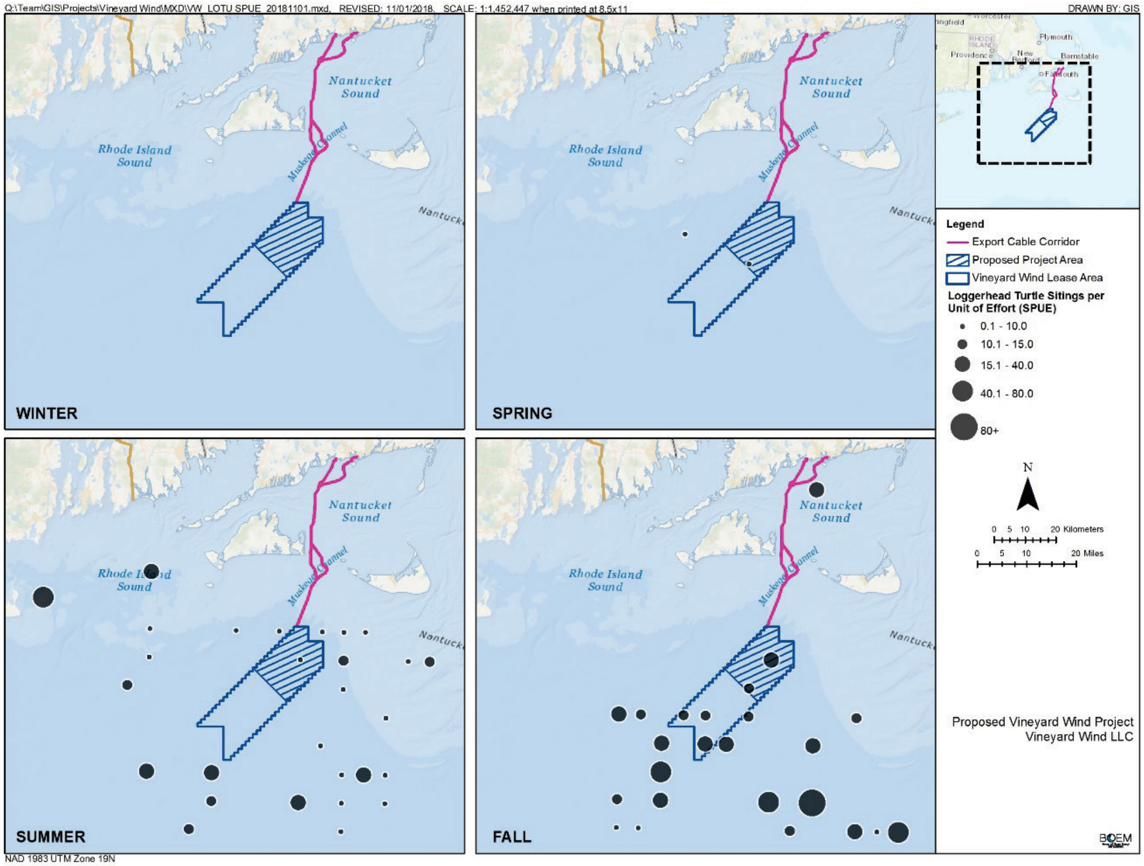
Typical invertebrates in the region include polychaetes (bristle worms), crustaceans (particularly amphipods), mollusks (gastropods and bivalves), echinoderms (e.g., sand dollars, brittle stars, and sea cucumbers), and various others (e.g., sea squirts and burrowing anemones) (BOEM 2014). Overall, the region experiences strong seasonality in water temperature and phytoplankton concentrations, with corresponding seasonal changes in the densities of benthic organisms (COP Section 6.5, Volume III; Epsilon 2018).

The WDA is part of the Southern New England Shelf as described by Theroux and Wigley (1998), which has a higher biomass and density of benthic fauna than neighboring geographic areas such as the Gulf of Maine and Georges Bank. Common sand dollars (*Echinarachnius parma*) are abundant in the WDA, as are hydrozoans, bryozoans, hermit crabs, euphausiids, sea stars, anemones, sand shrimp (*Crangon septemspinosa*), nematode worms, pandalid shrimp, and monkey dung sponge (*Suberites ficus*) (COP Section 6.5, Volume III; Epsilon 2018). Polychaete worms and amphipod crustaceans dominate infaunal assemblages. These are all common in the Nantucket Shelf region. Similar communities exist near Cape Cod along the proposed OECCs landfall sites, with abundant nut clams, polychaetes, and amphipods, as well as oligochaetes and nemertean ribbon worms (COP Section 6.5, Volume III; Epsilon 2018).

B.5.1.4. Sea Turtles

Four species of sea turtles may occur near the proposed Project area: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and green (*Chelonia mydas*). Each of these is protected under the Endangered Species Act (see Section 3.3.8). All of these sea turtles are migratory and enter New England waters primarily in the summer and fall. However, hawksbill sea turtles are rarely sighted in Massachusetts and are unlikely to occur near the proposed Project area. The other species may use the proposed Project area for travel, foraging, diving at depth for extended periods, and possibly for extended rest periods on the seafloor (COP Section 6.8, Volume III; Epsilon 2018). Targeted surveys have been conducted for sea turtles near the proposed Project area, and the results can be found in Kraus et al. 2016. A more detailed discussion regarding aspects of sea turtles potentially affected is available in the Vineyard Wind BA (BOEM 2018a).

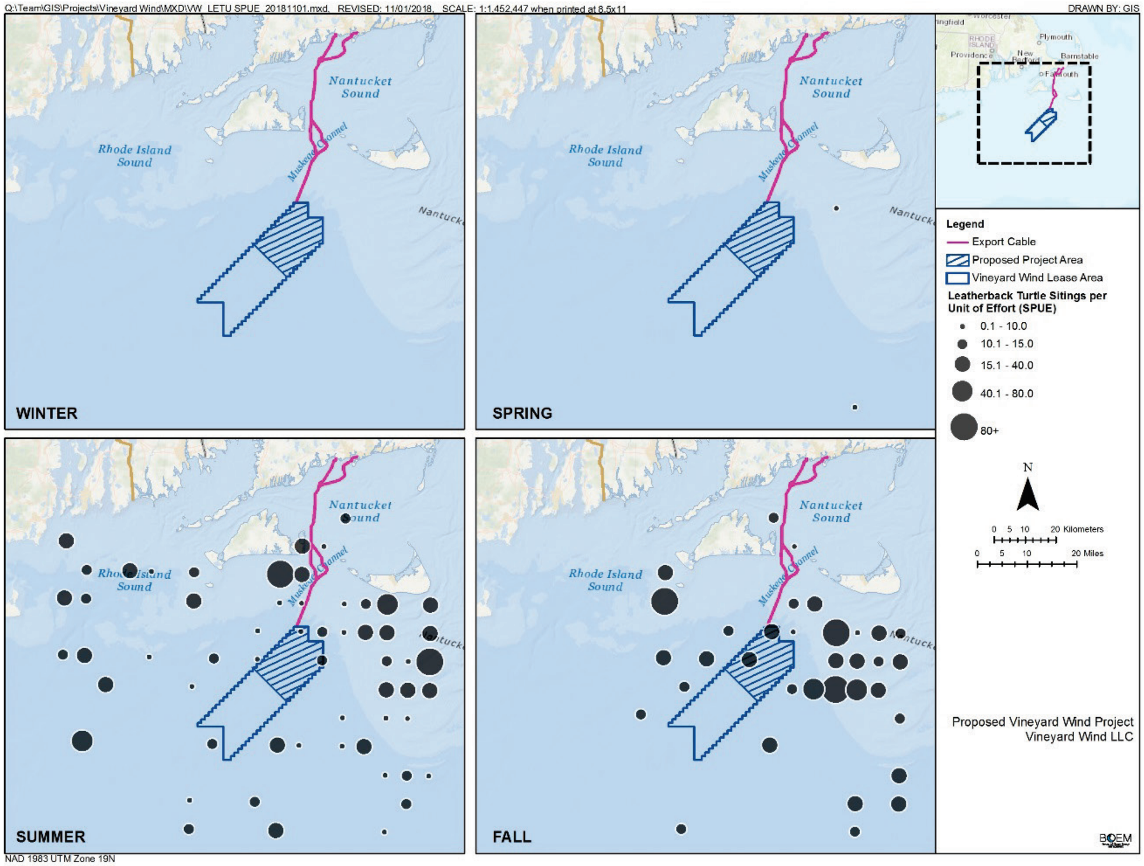
Strandings data for sea turtles from 1998 to 2017, sightings per unit effort (SPUE), indicate similar trends in the seasonal occurrence for loggerhead, leatherback, Kemp's ridley, and unidentified sea turtles in the Project area (see Figures B.5-5 through B.5-8). These SPUE maps do not depict the full level of distribution of a species in an area, but rather show the number of animals per unit of effort where surveys occurred. Additional information on sea turtle occurrence in the proposed Project Area is available in the Vineyard Wind BA (BOEM 2018c).



Source: Right Whale Consortium 2018

Note: Number of turtles per 621.4 miles (1,000 kilometers) in the proposed Project area during winter (December–February), spring (March–May), summer (June–August), and fall (September–November)

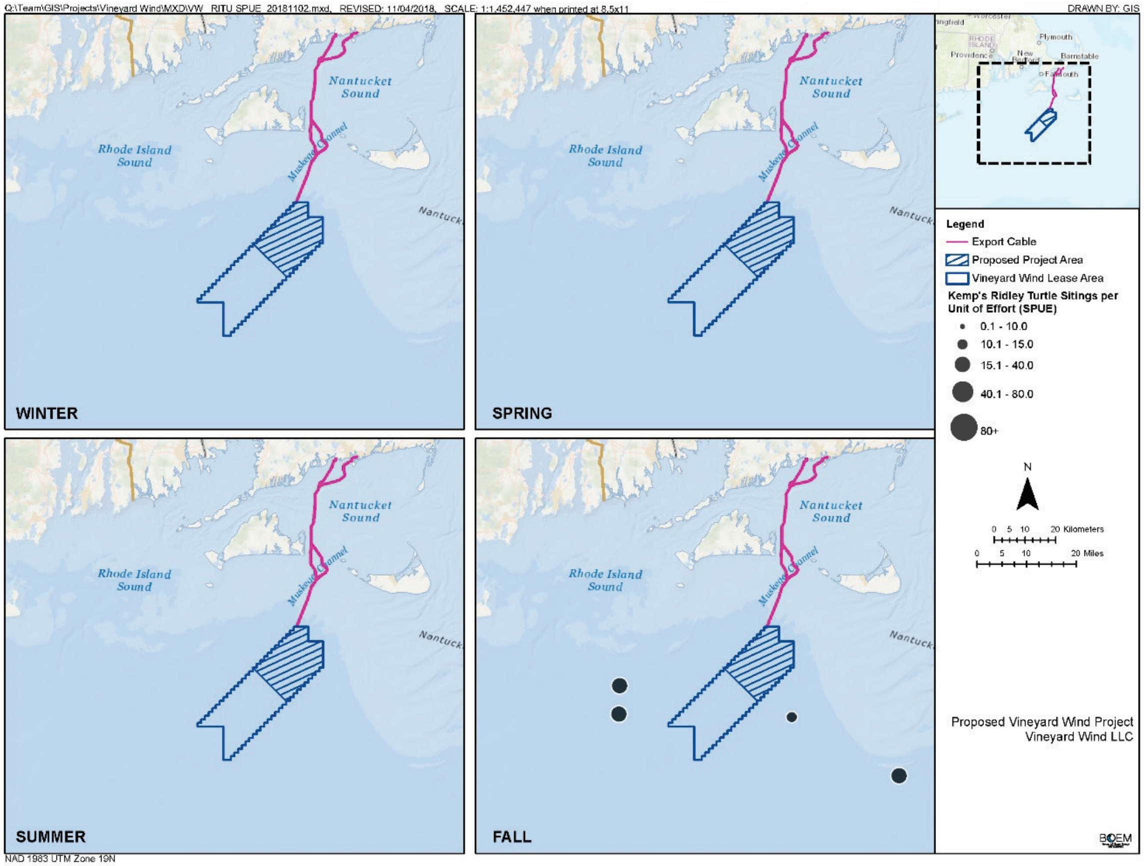
Figure B.5-5: Loggerhead Sea Turtle SPUE



Source: Right Whale Consortium 2018

Note: Number of turtles per 621.4 miles (1,000 kilometers) in the proposed Project area during winter (December–February), spring (March–May), summer (June–August), and fall (September–November)

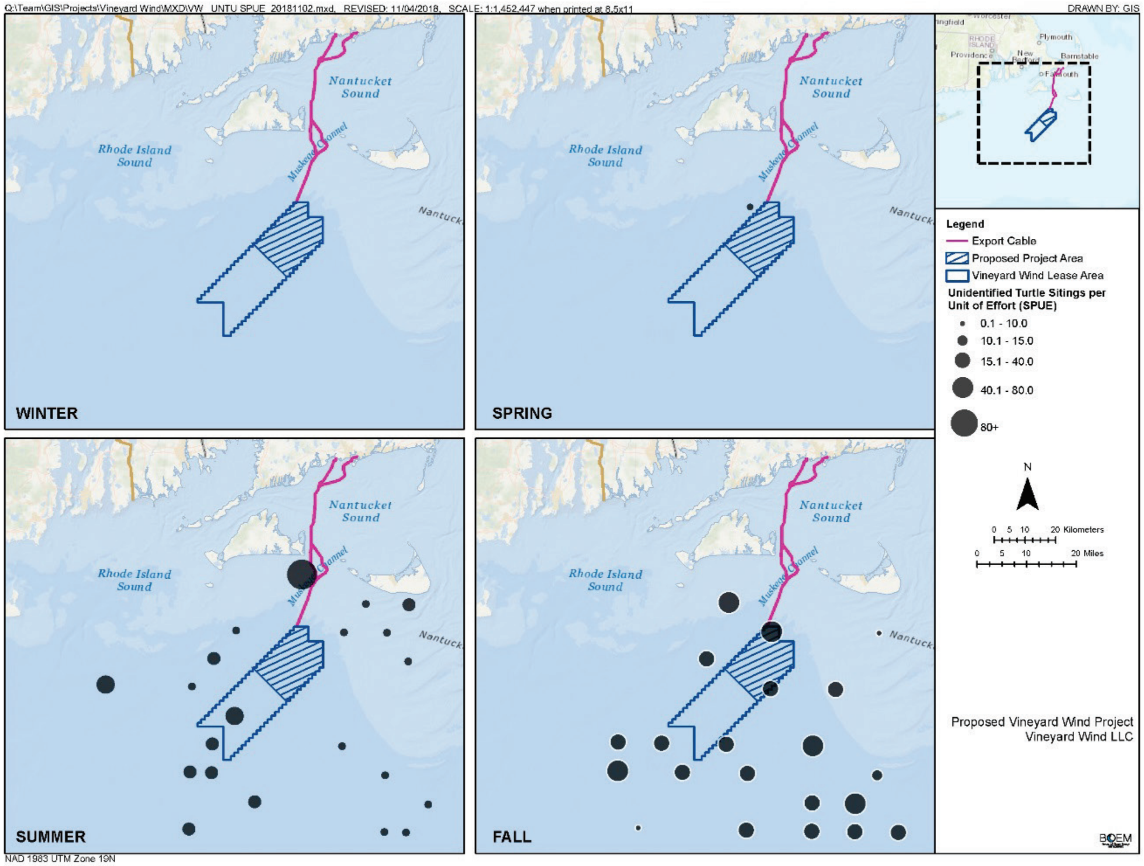
Figure B.5-6: Leatherback Sea Turtle SPUE



Source: Right Whale Consortium 2018

Note: Number of turtles per 621.4 miles (1,000 kilometers) in the proposed Project area during winter (December–February), spring (March–May), summer (June–August), and fall (September–November)

Figure B.5-7: Kemp's Ridley Sea Turtle SPUE



Source: Right Whale Consortium 2018

Note: Number of turtles per 621.4 miles (1,000 kilometers) in the proposed Project area during winter (December–February), spring (March–May), summer (June–August), and fall (September–November)

Figure B.5-8: Unidentified Sea Turtle SPUE

B.5.2. Terrestrial Resources

B.5.2.1. Habitats

The terrestrial portion of the proposed Project is located within the Long Island-Cape Cod Coastal Lowland Major Land Resource Area. Much of this area exhibits sandy soils, mixed hardwood-softwood forests, and scrublands subject to periodic fires (USDA 2006). Pine-oak forest is one of the most common habitat types on Cape Cod. This area also includes important habitats such as coastal wetlands, isolated freshwater wetlands, and a few small streams. Table B.5-3 shows some of the threatened and endangered plant species potentially occurring in this area.

Table B.5-3: Threatened and Endangered Plant Species Reported near the Proposed Project Area

Common name	Scientific name
American chaffseed	*Schwalbea americana*
Mitchell's sedge	*Carex mitchelliana*
Purple needlegrass	*Aristidia purpurascens*
Rigid flax	*Linum medium var. texanum*
Dwarf bulrush	*Lipocarpha micrantha*
Heartleaf twayblade	*Listera cordata*
Bayard's green adder's-mouth	*Malaxis bayardii*
Maryland meadow beauty	*Rhexia mariana*
Short-beaked bald-sedge	*Rhynchospora nitens*
Torrey's beak-sedge	*Rhynchospora torreyana*
Slender marsh pink	*Sabatia campanulata*
Papillose nut sedge	*Scleria pauciflora*
Swamp oats	*Sphenopholis pensylvanica*
Grass-leaved ladies'-tresses	*Spiranthes vernalis*
Northern gama-grass	*Tripsacum dactyloides*
Cranefly orchid	*Tipularia discolor*

Source: Commonwealth of Massachusetts 2018

B.5.2.2. Birds

Many of the bird species in this area, especially migratory ducks, utilize terrestrial, freshwater, and marine habitats. The Atlantic Flyway, which follows the Atlantic coast of North America, is an important migratory route for many bird species migrating from breeding grounds in New England to winter habitats in North, Central, and South America. Bays, beaches, coastal forest, marshes, and wetlands provide important stopover and foraging habitat for migrating birds during the fall and spring migration (MMS 2007). Both the onshore and offshore facilities associated with the proposed Project area would be located within the Atlantic Flyway.

Generally, bird species count and diversity decrease as distance from shore increases (Petersen et al. 2006; Paton et al. 2010; Watts 2010). The proposed Project area would be located in an area that was part of a detailed resource assessment, including a review of bird resources (BOEM 2012a, 2012b, 2015); based on that information, areas of important offshore sea duck habitat were excluded from the MA WEA (BOEM 2012a). As such, avian use of offshore habitats in the region is well documented and has been further refined with site-specific surveys (see NOAA 2016; Veit et al. 2015; Veit et al. 2016; Winship et al. 2018).

Common bird species known to inhabit the Project area that can be found along the proposed Onshore Export Cable Route or at the proposed substation site include: Bald Eagle (*Haliaeetus leucocephalus*), Turkey Vulture (*Cathartes aura*), Sharp-shinned Hawk (*Accipiter structus*), Cooper's Hawk (*Accipiter cooperii*), Red-tailed Hawk (*Buteo jamaicensis*), Wild Turkey (*Meleagris gallopavo*), Mourning Dove (*Zeneida macroura*), Northern Saw-whet Owl (*Aegolius acadicus*), Whip-poor-will (*Caprimulgus vociferous*), Downy Woodpecker (*Picoides pubescens*), Blue Jay (*Cyanocitta cristata*), American Crow (*Corvus brachyrhynchos*), Fish Crow (*Corvus ossifragus*), Tufted Titmouse (*Beeoloptus bicolor*), White-breasted Nuthatch (*Sitta caroliniensis*), Hermit Thrush (*Catharus guttatus*), Ovenbird (*Seiurus aurcopillus*), Eastern Towhee (*Pipilo erythro-phtalmus*), Yellow-rumped Warbler (*Setophaga coronate*), Common Loon (*Gavia immer*), Great Blue Heron (*Ardea Herodias*), Blackcrowned Night Heron (*Nycticorax nycticorax*), Eastern Phoebe (*Sayornis phoebe*), and Chipping Sparrow (*Spizella passerine*) (COP Volume III; Epsilon 2018).

B.5.2.3. Bats

Nine species of bats occur in Massachusetts, and some of them can travel and forage over the sea as well as over land (see Table B.5-4 and Section 3.3.3) (COP Section 6.3, Volume III; Epsilon 2018). Bats occur on both Cape Cod and on the islands, and have been known to travel from one to the other (Dowling et al. 2017). Bat species can be classified as either cave-hibernating bats or migratory tree bats. Both groups sleep primarily in trees during the summertime. Each night, bats emerge from roosts to drink and feed on flying insects. Foraging occurs mostly in and above forests and grasslands, although bats also utilize agricultural fields, fresh waters, coastal waters, and areas developed for human use. Cave-hibernating bats spend each winter in caves, mines, or rocky outcrops that exhibit suitable temperature, humidity, and airflow. Populations of cave-hibernating bats in southern New England have suffered as a result of the disease known as white-nose syndrome. Suitable hibernation cave habitats are not known to occur near the proposed Project area. Tree bats migrate south each autumn, and, unlike cave bats, have been observed more than 3.5 miles (5.6 kilometers) offshore (BOEM 2014). The federally threatened Northern long-eared bat (*Myotis septentrionalis*) may occur in the proposed Project area, but the federally endangered Indiana bat (*Myotis sodalis*) has never been reported in the greater Cape Cod and islands region.

Table B.5-4: Bat Species Potentially Present in Massachusetts

Common Name	Scientific Name	State Status	Federal Status
Cave Bats			
Big brown bat	*Eptesicus fuscus*		
Eastern small-footed bat	*Myotis leibii*	E	
Little brown bat	*Myotis lucifugus*	E	
Northern long-eared bat	*Myotis septentrionalis*	E	T
Indiana bat[a]	*Myotis sodalis*	E	E
Tri-colored bat	*Perimyotis subflavus*	E	
Tree Bats			
Silver-haired bat	*Lasionycteris noctivagans*		
Red bat	*Lasiurus borealis*		
Hoary bat	*Lasiurus cinereus*		

Source: BOEM 2012c; USFWS 2015

E = Endangered; T = Threatened

[a] Does not occur in eastern Massachusetts

B.5.2.4. Land Animals

Table B.5-5 lists terrestrial and coastal faunal resources that are known to occur near the proposed Project area. Prominent animal communities include residents of woodlands (e.g., whitetail deer [*Odocoileus virginianus*], fox [*Vulpes vulpes*], raccoon [*Procyon lotor*], among others), scrub grasslands (e.g., New England cottontail [*Sylvilagus transitionalis*], coyote [*Canis latrans*]), and wetlands (e.g., beaver [*Castor canadensis*], muskrat [*Ondatra zibethicus*], diamondback terrapin [*Malaclemys terrapin*]). Amphibians and reptiles, including turtles, snakes, and a variety of frogs, may belong to several of these communities and may move between and among them.

Table B.5-5: Terrestrial Animal Species Reported near the Proposed Project Area

Taxonomic group	Common name	Scientific name
Amphibian	Red-backed salamander	*Plethodon cinereus*
Amphibian	Red-spotted newt	*Notophthalmus viridescens*
Amphibian	American bullfrog	*Lithobates catesbeianus*
Amphibian	Green frog	*Lithobates clamitans*
Amphibian	Northern leopard frog	*Lithobates pipiens*
Amphibian	Wood frog	*Lithobates sylvaticus*
Amphibian	American toad	*Anaxyrus americanus*
Amphibian	Fowler's toad	*Anaxyrus fowleri*
Amphibian	Northern spring peeper	*Pseudacris crucifer*
Amphibian	Gray tree frog	*Hyla versicolor*
Reptile	Eastern hognose snake	*Heterodon platirhinos*
Reptile	Eastern ribbon snake	*Thamnophis sauritus*
Reptile	Milk snake	*Lampropeltis triangulum*
Reptile	Painted turtle	*Chrysemys picta*
Reptile	Snapping turtle	*Chelydra serpentine*
Reptile	Common musk turtle	*Sternotherus odoratus*
Mammal	Coyote	*Canis latrans*
Mammal	Gray fox	*Urocyon cinereoargenteus*
Mammal	Red fox	*Vulpes*
Mammal	Raccoon	*Procyon lotor*
Mammal	Striped skunk	*Mephitis*
Mammal	Fisher	*Martes pennant*
Mammal	White-tailed deer	*Odoeoileus virginianus*
Mammal	Red squirrel	*Tamiasciurus hudsonicus*
Mammal	Virginia opossum	*Didelphis virginiana*
Mammal	Woodchuck	*Marmota monax*
Mammal	Common raccoon	*Procyon lotor*
Mammal	White-footed mouse	*Peromyscus maniculatus*
Insect	Blue dasher	*Pachydiplax longipennis*
Insect	Calico pennant	*Celithermis elisa*
Insect	Common whitetail	*Libellula lydia*
Insect	Eastern pondhawk	*Erythemis simplicicollis*
Insect	Golden-winged skimmer	*Libellula auripennis*
Insect	Slaty skimmer	*Libellula incesta*
Insect	White corporal	*Libellula exusta*
Insect	Eastern comma	*Polygonia comma*
Insect	Great spangled fritillary	*Speyeria cybele*
Insect	Mourning cloak	*Nymphalis antiopa*
Insect	Red admiral	*Vanessa atalanta*
Insect	Red-spotted purple	*Limenitis artemis astyanax*
Insect	Striped hairstreak	*Satyrium liparops*
Insect	True skipper sp.	*Hesperia sp.*
Insect	Polyphemus moth	*Antheraea polyphemus*
Insect	Six-spotted green tiger beetle	*Cicindela sexguttata*

Source: Epsilon 2018 (COP Section 6.1, Volume III)

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APPENDIX C

Cumulative Activities Scenario

APPENDIX C. CUMULATIVE ACTIVITIES SCENARIO

Cumulative impacts are the incremental effects of the Proposed Action on the environment when added to other past, present, or reasonably foreseeable future actions taking place within the region of the proposed Project, regardless of which agency or person undertakes the actions (40 Code of Federal Regulations [CFR] 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a given period. This Draft Environmental Impact Statement (EIS) identifies potential cumulative impacts over the life of the Proposed Action, which the Bureau of Ocean Energy Management (BOEM) anticipates could reasonably occur in the timeframe between the start of construction in 2019 and completion of decommissioning no later than 2052.

This section discusses resource-specific cumulative impacts that could occur if direct and indirect impacts associated with the Proposed Action occur in the same location and timeframe as impacts from other past, present, or reasonably foreseeable future actions. The geographic analysis area for cumulative impacts varies for each resource as shown in Table C-1. For example, BOEM used a localized geographic scope to evaluate cumulative impacts for resources that are fixed in nature (e.g., benthic and archeological resources), or for resources where impacts from the Proposed Action would only occur in waters in and around the proposed Project area (e.g., water quality). However, given the migratory nature of marine mammals, sea turtles, fisheries resources, and birds, the cumulative impact analysis area for these resources includes a much broader area.

Table C-1: Resource-Specific Geographic Analysis Areas for Cumulative Impacts

Resource	Cumulative Impact Geographic Analysis Area
Air Quality	The air shed within 15.5 miles (25 km) of each area potentially impacted by the proposed Project, including the lease area, the on-land construction areas, and the mustering port(s). Given the generally low emissions of the sea vessels and equipment used during proposed construction activities, any potential air quality impacts would likely be very close (within a few miles) to the source. BOEM selected the criteria of 15.5 miles (25 km) to provide a sufficient buffer and capture any possible impacts. Ozone, as a regional pollutant, is an exception; BOEM is including a full review of the potential Project impacts and cumulative impacts on regional ozone development. Please see Figure C.1-1.
Water Quality	The proposed Project used a ten-mile (16.1-kilometer) radius around the WDA, the OECC, and vessel approach routes to port facilities. This area would account for some transport of water masses. Please see Figure C.1-2.
Terrestrial and Coastal Faunas	A 0.5-mile (0.8-kilometer) buffer around all land areas that would be disturbed (COP Vol III, Figures 6.1-1 and 6.1-2; Epsilon 2018). As described in Draft EIS Section 3.3.1, BOEM expects the resources in this area to have small home ranges. These resources are unlikely to be affected by impacts outside their home ranges. Please see Figure C.1-3.
Birds	U.S. East Coast, to capture migratory species that winter as far south as South America/Caribbean, and those that breed in the Arctic or along the Atlantic Coast. The geographic analysis area includes a 100-mile (161-kilometer) buffer around the shoreline from Maine to Florida. Please see Figure C.1-4.
Bats	U.S. East Coast, to capture migratory species. Northern long-eared bats and other cave bats do not typically occur on the OCS. Tree bats are long-distance migrants whose ranges include the majority of the Atlantic coast from Florida to northern Quebec. While these species have been documented traversing open ocean and have the potential to encounter WTGs, use of offshore habitats is thought to be limited and restricted to spring and fall migration. The geographic analysis area includes a 100-mile (161-kilometer) buffer around the shoreline from Maine to Florida. Please see Figure C.1-4.

Resource	Cumulative Impact Geographic Analysis Area
Coastal Habitats	The Massachusetts Office of Coastal Zone Management defines coastal habitats as the lands and waters within the seaward limit of the state's territorial sea (COP Vol II-A, Figure 5.1-1; Epsilon 2018) to 100 feet (30.5 meters) landward of the first major land transportation route encountered (a road, highway, rail line, etc.). The cumulative impact analysis area includes all such areas that overlap the proposed Project area, plus a 1-mile (1.6-kilometer) buffer on all sides. Please see Figure C.1-5. Although the plants and animals that build biogenic types of coastal habitats do not move appreciably except through reproduction, this buffer allows for the gradual progression of these organisms across the seascape.
Benthic Resources	Ten-mile (16.1-kilometer) radius around the WDA and the OECC. This area would account for some transport of water masses and for benthic invertebrate larval transport due to ocean currents. While sediment transport beyond 10 miles (16.1 km) is possible, sediment transport related to proposed-Project activities is likely to be on a smaller spatial scale than 10 miles (16.1-kilometer). Vineyard Wind estimated the maximum extent of the 10 mg/L sediment contour just under 10 miles for dredging. Please see Figure C.1-6.
Finfish, Invertebrates, and Essential Fish Habitat	The Northeast Shelf LME, which is likely to capture the majority of the movement range for most species in this group.[a] Please see Figure C.1-7.
Marine Mammals	The Scotian Shelf, Northeast Shelf, and Southeast Shelf LMEs; likely to capture the majority of the movement range for most species in this group.[a] Please see Figure C.1-8.
Sea Turtles	The Northeast Shelf, Southeast Shelf LMEs, the Caribbean Sea, and the Gulf of Mexico. [a] When considering all sea turtles together for cumulative effects, the geographic range for the neritic (<656.2 feet [200 meters]) and oceanic (>656.2 feet [200 meters]) stages (post-hatchlings, juveniles, and adults) of eastern seaboard and Gulf of Mexico is from Nova Scotia/Maine to Texas, U.S. Virgin Islands, and Puerto Rico. Nesting range for all turtles combined ranges from North Carolina to Texas and US Virgin Islands, and Puerto Rico. Please see Figure C.1-9.
Economics	Barnstable, Bristol, Dukes, and Nantucket counties in Massachusetts; Providence and Washington counties in Rhode Island; and Fairfield and New London counties in Connecticut. These counties include those with proposed onshore infrastructure (Barnstable County, Dukes County), potential port cities (Fairfield, New London, Washington, Providence, and Bristol counties), and counties in closest proximity to the WDA (Dukes and Nantucket counties). These counties are the most likely to experience beneficial or negative economic impacts from the proposed Project. Please see Figure C.1-10.
Environmental Justice	Barnstable, Bristol, Dukes, and Nantucket counties in Massachusetts; Providence and Washington counties in Rhode Island; and Fairfield and New London counties in Connecticut. BOEM evaluated the Proposed Action's environmental justice impacts within this area. These counties include those with proposed onshore infrastructure (Barnstable County), potential port cities (Fairfield, New London, Washington, Providence, and Bristol counties), and counties in closest proximity to the WDA (Dukes and Nantucket counties). These counties, and economic justice communities located within, are the most likely to experience impacts from the proposed Project. Please see Figure C.1-10.
Cultural, Historical, and Archeological Resources	The geographic extent of the cumulative analysis area is the current direct and indirect areas of potential effect, as well as the locations of any known/planned future offshore wind blocks off the Coast of Cape Cod, Nantucket, and Martha's Vineyard. Please see Figure C.1-11.
Recreation and Tourism	Footprint of the proposed Project, plus 35.3-mile (56.8-kilometer) visual analysis area. BOEM evaluated the Proposed Action's recreation and visual impacts within this area. Please see Figure C.1-12.

Resource	Cumulative Impact Geographic Analysis Area
Commercial Fisheries and For Hire Recreational Fishing	The boundaries that define the management area of the New England Fishery Management Council and of the Mid-Atlantic Fisheries Management Council for all federal fisheries within the U.S. Exclusive Economic Zone (from 3 to 200 nautical miles from the coastline) plus the state waters of the Commonwealth of Massachusetts (from 0 to 3 nautical miles from the coastline). Please see Figure C.1-13.
Land Use and Coastal Infrastructure	Towns of Barnstable and Yarmouth, and ports potentially used for the proposed Project construction, operations, and maintenance. These areas encompass locations where BOEM anticipates direct and indirect impacts associated with proposed onshore facilities and ports. Please see Figure C.1-14.
Navigation and Vessel Traffic	The proposed Project used a 10-mile (16-kilometer) radius around the WDA, the OECC, and vessel approach routes to port facilities. Please see Figure C.1-2.
Other Uses	Specific analysis areas per resource are as follows: • Marine Mineral Extraction: Includes areas that could become incompatible with marine mineral extraction activities because of past, present, or reasonably foreseeable projects. Defined as areas within 0.25 mile (0.4 km) of the OECC, the WDA, and footprints of other cables and wind lease areas in the MA WEA and Deepwater Wind Lease Area (WLA). • National Security/Military Use: Includes military entities' use of airspace, surface, and subsea areas. Generally, an area roughly bounded by Montauk, New York; Providence, Rhode Island; Provincetown, Massachusetts; and within a 10-mile (16.1-kilometer) buffer from wind lease areas in the MA WEA and Deepwater WLA. • Aviation and Air Traffic: Airspace and airports used by regional air traffic. Generally, an area roughly bounded by Montauk, New York; Providence, Rhode Island; Provincetown, Massachusetts; and within a 10-mile (16.1-kilometer) buffer from wind lease areas in the MA WEA and Deepwater WLA. • Offshore Energy: Includes areas that could become incompatible with other offshore energy activities because of past, present, or reasonably foreseeable projects. • Cables and Pipelines: The area within 1 mile (1.6 km) of the OECC and WDA, and other undersea facilities and wind lease areas in the MA WEA and Deepwater WLA that could affect future siting or operation of cables and pipelines. • Radar Systems: Includes airspace used by regional air traffic. Generally, an area roughly bounded by Montauk, New York; Providence, Rhode Island; Provincetown, MA; and within a 10-mile (16.1-kilometer) buffer from wind lease areas in the MA WEA and Deepwater WLA. Please see Figure C.1-15. • Scientific Research and Surveys: Same study area as the aviation and land-based radar. This area was identified to encompass the locations where research similar to what may be conducted within the WDA and OECC may be sourced or conducted. These areas include the footprint of the Proposed Action, the Deepwater WEA, the Block Island Wind Farm, the OECC route, and all of Cape Cod. It is assumed that research in this area would consist of oceanographic, biological, geophysical, and archaeological surveys focused on the OCS and nearshore environments or resources that may be impacted by offshore wind development in the region.

COP = Construction and Operations Plan; EIS = Environmental Impact Statement; km = kilometer; LME = Large Marine Ecosystem; MA WEA = Massachusetts Wind Energy Area; mg/L = milligrams per liter; OCS = Outer Continental Shelf; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area; WTG = wind turbine generator; WLA = Wind Lease Area

[a] LMEs are delineated based on ecological criteria including bathymetry, hydrography, productivity, and trophic relationships among populations of marine species, and the National Oceanic and Atmospheric Administration uses them as the basis for ecosystem-based management. The Scotian Shelf LME is bordered to the north by the Laurentian Channel and to the south by the southern edge of the Scotian Shelf at the Fundian Channel (Northeast Channel); it contains the St. Lawrence Estuary. The Northeast Shelf LME extends from the southern edge of the Scotian Shelf (in the Gulf of Maine) to Cape Hatteras, North Carolina. The Southeast Shelf LME extends from the Straits of Florida to Cape Hatteras, North Carolina. These LMEs extend from the coastline offshore to the shelf break (at approximately 328.1 to 656.2 feet (100 to 200 meters) depth).

C.1. Past, Present and Future Reasonably Foreseeable Activities and Projects

This section includes a list and description of projects that BOEM has identified as potentially contributing to cumulative impacts when combined with impacts from the Proposed Action over the geography and time scale described above. Projects or actions that are identified as not reasonably foreseeable are considered speculative per the definition provided in 43 CFR § 46.30[1] and are therefore excluded from the cumulative impact analysis.

Cumulative projects and activities include 10 types of actions: (1) other offshore wind energy development activities, such as site characterization surveys, site assessment activities, construction, operation, and decommissioning of wind energy facilities; (2) undersea transmission lines, gas pipelines, and other submarine cables (e.g., telecommunications); (3) tidal energy projects; (4) marine minerals use and ocean-dredged material disposal; (5) military use; (6) marine transportation; (7) fisheries use and management; (8) global climate change; (9) oil and gas activities; and (10) onshore development activities in central Cape Cod, particularly those proximate to Onshore Export Cable Routes and interconnection facilities.

C.1.1. Offshore Wind Energy Development Activities

Under the renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the Outer Continental Shelf (OCS) is a staged decision making process and occurs over several years with varying impacts. The process follows the following general steps:

- Lease Issuance—BOEM issues a commercial wind energy lease that gives the lessee exclusive rights to seek BOEM approval for the development of the lease area.
- Site Assessment Plan (SAP) Approval—Although a SAP is not required, BOEM assumes that every lessee will plan to install one meteorological tower and/or one to two meteorological buoys for site assessment purposes. If the lessee is proposing to install site assessment facilities, the lessee has 1 year after lease execution to submit a SAP, which contains a detailed proposal for the construction and/or installation of meteorological towers or buoys. BOEM must approve the SAP before site assessment activities commence. After SAP approval, the lessee has 5 years to complete site characterization and site assessment activities to support a Construction and Operation Plan (COP).
- COP Review/Approval—Six months prior to the end of the 5-year assessment term, the lessee submits a COP that contains a detailed plan for the construction and operation of a wind energy project on the lease area. COP approval triggers a project-specific National Environmental Policy Act (NEPA) document (for Vineyard Wind, this Draft EIS). After completion of the NEPA document, BOEM may approve, approve with modification, or disapprove a lessee's COP. If approved, the lessee is allowed to construct and operate wind turbine generators and associated facilities for the operations term of the lease (typically 25 years) (BOEM 2016).

BOEM currently has 12 active leases offshore the U.S. East Coast, which are in varying stages of development. This section describes the wind energy development activities being conducted in other BOEM lease areas and in waters over state submerged lands that BOEM should consider in the cumulative effects analysis, based on the geographic analysis areas defined in the table above.

C.1.1.1. Site Characterization Studies

A lessee is required to provide the results of site characterization activities (shallow hazard, geological, geotechnical, biological, and archeological surveys) with its SAP or COP. A reasonably foreseeable consequence of issuing these leases is site characterization and site assessment (discussed in Section C.1.1.2). For the purposes of the cumulative effects analysis, BOEM assumes site characterization surveys will occur on all existing leases

[1] 43 CFR §46.30 - Reasonably foreseeable future actions include those federal and non-federal activities not yet undertaken, but sufficiently likely to occur, that a Responsible Official of ordinary prudence would take such activities into account in reaching a decision. These federal and non-federal activities that BOEM must take into account in the analysis of cumulative impact include, but are not limited to, activities for which there are existing decisions, funding, or proposals identified by the bureau. Reasonably foreseeable future actions do not include those actions that are highly speculative or indefinite.

during the life of the proposed project. BOEM makes the following assumptions for survey and sampling activities:

- Site characterization would likely take place in the first 3 years following execution of lease, based on the fact that a lessee would likely want to generate data for its COP at the earliest possible opportunity. Site assessment would likely take place starting within 1 to 2 years of lease execution, as preparation of a SAP (and subsequent BOEM review) takes time.
- Lessees would likely survey most or all of the proposed lease area during the 5-year site assessment term to collect required geophysical information for siting of a meteorological tower and/or two buoys and commercial facilities (wind turbines). The surveys may be completed in phases, with the meteorological tower and/or buoy areas likely to be surveyed first.
- Lessee would not use air guns, which are typically used for deep penetration two-dimensional or three-dimensional exploratory seismic surveys to determine the location, extent, and properties of oil and gas resources (BOEM 2016).

Table C.1-1 describes the typical site characterization surveys, the types of equipment and/or method used, and which resources the survey information would inform.

Table C.1-1: Site Characterization Survey Assumptions

Survey Type	Survey Equipment and/or Method	Resource Surveyed or Information Used to Inform
High-resolution geophysical surveys	Side-scan sonar, sub-bottom profiler, magnetometer, multi-beam echosounder	Shallow hazards,[a] archaeological,[b] Bathymetric charting, benthic habitat
Geotechnical/ sub-bottom sampling [c]	Vibracores, deep borings, cone penetration tests	Geological [d]
Biological [e]	Grab sampling, benthic sled, underwater imagery/ sediment profile imaging	Benthic habitat
	Aerial digital imaging; visual observation from boat or airplane	Avian
	Ultrasonic detectors installed on survey vessels used for other surveys	Bat
	Visual observation from boat or airplane	Marine fauna (marine mammals and sea turtles)
	Direct sampling of fish and invertebrates	Fish

Source: BOEM 2016

[a] 30 CFR § 585.610(b) and 30 CFR § 585.626(a)(1)
[b] 30 CFR § 585.610–585.611 and 30 CFR § 585.626(a)
[c] 30 CFR § 585.610(b)(1) and 30 CFR § 585.626(a)(4)
[d] 30 CFR § 585.610(b)(4) and 30 CFR § 585.626(a)(2)
[e] 30 CFR § 585.610(b)(5), 30 CFR § 585.611(b)(3-5), 30 CFR § 585.626(a)(3), and 30 CFR § 585.627(a)(3-5)

The following sections provide specific details by reference of these types of surveys as provided in the *Revised Environmental Assessment for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York* (BOEM 2016), as well as an overview of survey techniques such that potential impacts may be evaluated.

C.1.1.2. Site Assessment Activities

After SAP approval, a lessee can evaluate the meteorological conditions, such as wind resources, with the approved installation of meteorological towers and/or buoys. For those lessees with submitted SAPs (see Table C.1-2), site assessment activities are also considered in this cumulative analysis.

Table C.1-2: Cumulative Effects Projects - Site Assessment Activities

Lease Number	State	Company Name	Initial Date SAP Received	Date SAP Approved	Date Deployed or to be Deployed	Facility Description
OCS-A 0483	VA	Dominion Energy Services, Inc.	5/2014	10/12/2017	Q2 2019	One met buoy
OCS-A 0486	RI and MA	Deepwater Wind New England, LLC	4/1/2016	10/12/2017	TBD	One met buoy
OCS-A 0490	MD	US Wind, Inc.	11/2015	3/22/2018	TBD	One met tower
OCS-A 0497	VA	Virginia Department of Mines, Minerals and Energy/Dominion Energy Services, Inc.	12/2014[a]	NA	March-October 2020	One wave/current buoy
OCS-A 0498	NJ	OceanWind LLC	9/15/2017	5/16/2018	8/20/18	Two met buoys
OCS-A 0500	MA	Bay State Wind	12/20/16	6/29/17	7/10/17	Two met buoys
OCS-A 0501	MA	Vineyard Wind LLC	3/31/17	5/10/18	5/22/18	Two met buoys
OCS-A 0512	NY	Equinor (Statoil), LLC	6/18/2018	NA	TBD	Two met buoys and one wave buoy

met = meteorological; NA = not applicable; TBD = to be determined
[a] included in modifications to Research Activities Plan rather than SAP

C.1.2. Construction and Operation of Offshore Wind Facilities

The Block Island Wind Farm is the only presently operating offshore wind facility on the U.S. East Coast. It consists of five turbines located off the southeast coast of Block Island, Rhode Island. Commercial operations started in December 2016 and the operator/owner expects the project to be operational for 25 years.

For purposes of this cumulative analysis, BOEM is classifying potential future offshore wind construction activities based on their stage in the leasing and permitting process, the quantity of information BOEM has about the activity, and the likely economic viability of the activity. Table C.1-3 sets forth the tiers of activity and the analytical approach BOEM is using for each tier. While BOEM only considers Tier 1 and Tier 2 activities to be reasonably foreseeable future actions under 40 CFR § 1508.7, BOEM believes that given the nature and scope of the Proposed Action, it is prudent at the COP stage to analyze more speculative potential activities within its jurisdiction. Such analysis is commensurate with the level of detail of BOEM's knowledge, and is conducted in full acknowledgement of uncertainties regarding the nature and scope of the activities and the resulting potential for cumulative impacts. There are four projects in Tier 3, and although these projects are not considered reasonably foreseeable, development is possible and could contribute to cumulative effects in the future. Table C.1-3 summarizes offshore wind leasing activities along the U.S. East Coast, with details for activity in each lease area provided in Table C.1-4.

Table C.1-3: Tiers for Offshore Wind Construction Activities

Tier	Stage of Permitting/Assessment	Reasonably Foreseeable?	CEA Approach	Offshore Wind Project Stage		Lease Area/Project
				COP	Lease Award	
Tier 1	Approved—the project has an approved permit or plan (e.g., construction and operations plan).	Reasonably Foreseeable	Assessed in resource sections, primarily quantitatively (calculation of potential project impacts is possible in most cases).	Approved	Yes	• NJ State Waters/Nautilus-Atlantic City Wind Farm • CVOW (OCS-A 0497)
Tier 2	Advanced—the project has a submitted permit application or plan.	Reasonably Foreseeable	Assessed in resource sections, primarily quantitatively (calculation of potential project impacts is possible in most cases).	Submitted	Yes	• South Fork Wind Farm (OCS-A 0486)
Tier 3	Preliminary—no submitted permit or plan, but the project has been awarded a PPA/ OREC and/or is a designated FAST-41 project.	Not Reasonably Foreseeable	Incorporated into resource sections quantitatively or qualitatively based on information available.	Not submitted	Yes	• Revolution Wind (OCS-A 0486) • Bay State Wind (OCS-A 0500) • Skipjack Wind (OCS-A 0519) • U.S. Wind (MD) (OCS-A 0490)
Tier 4	Very Preliminary—the project has an active lease with BOEM and the adjacent state(s) have made commitments to the procurement of offshore wind energy. No PPA/OREC awarded; not designated a FAST-41 Project.	Not Reasonably Foreseeable	Not addressed in resource sections.	Not submitted	Yes	• GSOE I, LLC (OCS-A 0482) • Ocean Wind (NJ) (OCS-A 0498) • U.S. Wind (NJ) (OCS-A 0499) • Empire Wind (NY) (OCS-A 0512) • Maine Aqua Ventus Project (ME)
Tier 5	Active leases and identified lease areas that have moved towards auction through the announcement of a proposed sale notice or final sale notice. No PPA/OREC awarded; not designated a FAST-41 Project.	Not Reasonably Foreseeable	Not addressed in resource sections.	Not submitted	Yes, or lease areas identified through sale notice	• Virginia Electric and Power Company (OCS-A 0483) • Kitty Hawk Offshore Wind (OCS-A 0508) • OCS-A 0520 • OCS-A 0521 • OCS-A 0522

BOEM = Bureau of Ocean Energy Management; CEA = Cost-Effectiveness Analysis; COP = Construction and Operations Plan; CVOW = Coastal Virginia Offshore Wind; OCS = Outer Continental Shelf; OREC = Offshore Renewable Energy Credit; PPA = Power Purchase Agreement

[a] Call areas and Wind Energy Areas (WEAs) that have no proposed sale notice or final sale notice (FSN) and unsolicited requests are not considered in the cumulative impacts scenario. These areas are highly speculative and do not have sufficient project information available to conduct a meaningful qualitative analysis. Call areas and WEAs that have no proposed sale notice or FSN along the East Coast include the New York Bight Call Area offshore New York; the Wilmington West Wind Energy Area and the Wilmington East Wind Energy Area offshore North Carolina; and the Grand Strand Call Area, the Winyah Call Area, the Cape Romain Call Area, and the Charleston Call Area offshore South Carolina. In addition to the offshore wind projects identified in Table C.1-4, BOEM received an unsolicited lease request in 2016 for a proposed offshore wind facility outside of the New York call area. If BOEM moves forward with this application, BOEM will issue a public notice to determine whether or not there is competitive interest in bidding for a lease. To date, no public notice has been issued and BOEM does not consider the project to be reasonably foreseeable.

[b] Although the Vineyard Wind lease is not listed in Tier 4, BOEM is aware that future development could be proposed in the undeveloped portions of the Vineyard Wind lease area.

Table C.1-4: Offshore Wind Leasing Activities in the U.S. East Coast

Project Tier	Lease Number	States	Project/Company Name	Construction Date	Operations Date	Facility Description	BOEM Permitting Stage	PPA/OREC Status
Tier 1	NA (located in state waters)	New Jersey	Nautilus Wind Farm/Atlantic City Wind Farm (Fisherman's Energy of New Jersey, LLC and EDF Renewables North America)	2019	2020	24 MW, three to four wind turbines generators (WTGs)	NA (located in state waters)	NJ Board of Public Utilities currently considering the application for an OREC agreement.
	OCS-A 0497	Virginia	CVOW (Virginia Electric and Power Company/Orsted)	2020	2022	12 MW, two WTGs	Research Activities Plan approved, but a revised Research Activities Plan is pending approval	NA
Tier 2	OCS-A 0486	Rhode Island	South Fork Wind Farm (Deepwater ONE) / Deepwater Wind New England, LLC	2021	2022	90 MW, 15 WTGs	COP submitted June 2018	PPA signed with the Long Island Power Authority in 2017.
Tier 3	OCS-A 0486	Rhode Island	Revolution Wind / Deepwater Wind New England, LLC	2022	2023	600 MW	SAP approved, COP in development	PPA signed with the State of Rhode Island for 400 MW and the State of Connecticut for 200 MW
	OCS-A 0500	Massachusetts	Bay State Wind LLC	2022	Q3 2023	110 WTGs; two export cables landing in Somerset, MA, with power going to Brayton Point	SAP approved, COP in development	No PPAs signed to date
	OCS-A 0519 (formerly OCS-A 0482)	Delaware	Skipjack Wind Farm/Deepwater Wind	2021	2022	120 MW, 15 WTGs	Lease granted	OREC awarded by State of Maryland.
	OCS-A 0490	Maryland	U.S. Wind (MD)	2020	2021	250 MW, 32 WTGs	Lease granted, SAP approved	OREC awarded by State of Maryland.

Project Tier	Lease Number	States	Project/Company Name	Construction Date	Operations Date	Facility Description	BOEM Permitting Stage	PPA/OREC Status
Tier 4	OCS-A 0482	Delaware	GSOE I, LLC	TBD	TBD	TBD	Lease granted	No PPAs signed to date
	OCS-A 0498	New Jersey	Ocean Wind (NJ)	TBD	TBD	TBD	SAP approved, COP in progress	No PPAs signed to date
	OCS-A 0499	New Jersey	U.S. Wind (NJ)	TBD	TBD	TBD	Lease granted	No PPAs signed to date
	OCS-A 0512	New York	Empire Wind / Equinor (Statoil), LLC	TBD	TBD	1,000–1,500 MW	Lease granted, SAP submitted	No PPAs signed to date
	NA (located in state waters)	Maine	University of Maine Aqua Ventus Project (floating wind turbines)	2021	Late 2021	12 MW, 2 WTGs	NA (located in state waters).[3]	PPA being evaluated by the Maine Public Utilities Commission
Tier 5	OCS-A 0483	Virginia	Virginia Electric and Power Company	TBD	TBD	TBD	Lease granted	No PPAs signed to date
	OCS-A 0508	North Carolina	Kitty Hawk Offshore Wind/Avangrid	TBD	TBD	TBD	Lease granted	No PPAs signed to date
	OCS-A 0520	Massachusetts	NA	TBD	TBD	TBD	FSN published	NA
	OCS-A 0521	Massachusetts	NA	TBD	TBD	TBD	FSN published	NA
	OCS-A 0522	Massachusetts	NA	TBD	TBD	TBD	FSN published	NA

BOEM = Bureau of Ocean Energy Management; COP = Construction and Operations Plan; CVOW = Coastal Virginia Offshore Wind; FSN = final sale notice; MW = megawatt; NA = not applicable; PPA = Power Purchase Agreement; TBD = to be determined; WTG = wind turbine generator

[a] The U.S. Department of Energy (DOE) is proposing to provide the University of Maine funding to support development of the Aqua Ventus Project. A draft Environmental Assessment with the DOE is currently being developed but has not yet been completed. A permit from the U.S. Army Corps of Engineers and a permit from the State of Maine Department of Environmental Protection are also required but have not yet been submitted.

[b] Although the Vineyard Wind lease is not listed in Tier 4, BOEM is aware that future development could be proposed in the undeveloped portions of the Vineyard Wind lease area.

Tier 1 projects that have an approved permit or plan and are considered reasonably foreseeable include the Coastal Virginia Offshore Wind Project and the proposed Atlantic City Wind Farm (also called the Nautilus Offshore Wind Project). The South Fork Wind Farm has a submitted a COP, and BOEM considers it a Tier 2 project, which is also considered reasonably foreseeable. BOEM considers the proposed Revolution Wind Farm to be a Tier 3 project as it has secured a 400-megawatt (MW) Power Purchase Agreement (PPA) with the State of Rhode Island and a 200-MW PPA with the State of Connecticut, but the proponent has not yet submitted a COP to BOEM. In addition, BOEM considers the Skipjack Wind Farm and the U.S. Wind project offshore Maryland to be Tier 3 projects as the State of Maryland awarded them Offshore Renewable Energy Credits (ORECs). BOEM considers the Bay State Wind project to be a Tier 3 project as well because although it does not have a PPA/OREC or a submitted COP, it is a designated Fixing America's Surface Transportation (FAST-41) Act project.[2] Although BOEM does not consider Tier 3 projects to be reasonably foreseeable because no COP has been submitted, BOEM has incorporated current Tier 3 projects into its cumulative impacts analyses presented in Chapter 3 as appropriate based on currently available information. BOEM acknowledges the possibility that one or more Tier 3 projects could enter Tier 2 through the submittal of a COP before the Final EIS and Record Of Decision are published.

As described in Table C.1-3, development within Tier 4 and Tier 5 projects and lease areas are considered speculative and therefore not reasonably foreseeable. These proposed projects may be publicized and recognizable to the public and may have lease awards or sale notices, but do not have a submitted COP, a signed PPA/OREC agreement, or FAST-41 designations. Submittal of a COP, signing of a PPA or OREC agreement, or designation of a project as a FAST-41 would add certainty to a project's potential to move forward, and the project would be elevated to a Tier 3 status.

Future offshore wind projects would be subject to evolving economic, environmental, and regulatory conditions. Lease areas may be split into multiple projects, expanded, or removed, and development within a particular lease area may occur in phases over long periods of time. Research currently being conducted[3] in combination with data gathered regarding physical, biological, socioeconomic, and cultural resources during development of initial offshore wind projects in the United States could affect the design and implementation of future projects, as could advancements in technology. For these reasons, it is not possible to accurately predict the nature, location, and scale of potential impacts on resources for Tier 4 and Tier 5 named projects and lease areas. However, some broad assumptions about possible impacts from Tier 4 and Tier 5 projects include:

- Resources affected and generalized impacts would likely be similar in nature to those presented in this Draft EIS;
- Positive regional economic impacts could be realized from supply chain development for the offshore wind industry, the growing employment base, and to some degree tourism focused on offshore wind facility tours depending on the project location and distance from shore;
- Economies of scale could be realized in terms of port development and regional transmission support, as the onshore transmission systems could improve to support power incoming from multiple offshore wind projects;
- Impacts on the commercial and for-hire recreational fishing industry may be intensified if Tier 4 and Tier 5 projects are built, including impacts related to port access, increased risk of collision, restricted harvesting due to construction activities, gear loss due to cables, reduced access to and availability of fish

[2] PPAs and ORECs are binding commitments that are contingent on a project receiving its permitting, including from BOEM. PPAs are a commitment from a utility or state to purchase power produced at a specific offshore wind facility, while ORECs are credits or certificates awarded from the state to the offshore wind developer that facilitate financing for proposed offshore wind projects. FAST-41 is a federal program designed to streamline federal environmental review and authorization for covered infrastructure projects. For the purposes of this analysis, proposed projects that have signed PPAs, ORECs, or are designated FAST-41 projects are more likely to be constructed and have more project-specific information available.

[3] In addition to private and state-funded research, BOEM-funded research continues to contribute to the growing body of scientific knowledge on the marine environment and informs BOEM's decision-making regarding renewable energy planning, leasing, and development efforts. Ongoing and completed studies are listed on BOEM's website at https://www.boem.gov/Renewable-Energy-Environmental-Studies/.

within project areas, and increased conflict over fishing grounds due to displacement of fishing vessels from project areas;

- Noise-induced impacts on marine mammals and sea turtles as well as potential risk of vessel strikes could be intensified if Tier 4 and Tier 5 projects are built and result in overlapping construction schedules;
- Where possible, future projects could potentially seek to co-locate onshore facilities and offshore cabling systems to avoid creation of new impact areas;
- Public attitudes toward offshore wind facilities may change over time as Tier 1 and Tier 2 projects become operational, potentially affecting potential impacts on recreation, visual resources, and socioeconomic resources and affecting how future projects are designed;
- Adaptive management could be used for many resources, particularly regulated fisheries and wildlife resources (including birds, benthic resources, finfish, invertebrates, essential fish habitat, marine mammals, and sea turtles), which would likely be closely monitored for potential impacts with new regulations being implemented to lessen impacts in response to data collected; and
- Build-out of the U.S. offshore wind industry could displace non-renewable resources such as fossil fuel plants for power generation, resulting in a greater cumulative beneficial impact on air quality and potential reduction in regional and national greenhouse gas emissions to address climate change (see Section C.1.9).

BOEM assumes proposed offshore wind projects will include the same or similar components as the proposed Project: wind turbines, inter-array cable system, Offshore Export Cable Corridor (OECC), one or more ESPs, and onshore interconnection facilities. BOEM further assumes that other potential offshore wind projects will employ the same or similar construction, operation, and decommissioning activities as the proposed Project.

Ports in Connecticut, Rhode Island, and Massachusetts may require upgrades in order to support the offshore wind industry developing in the northeastern United States. Upgrades may include onshore developments or underwater improvements (such as dredging). The following summarizes reasonably foreseeable activities at regional ports that are planned to support the Proposed Action and other past, present, and reasonably foreseeable offshore wind project activities as identified in Table C.1-4:

- The Connecticut Port Authority is currently evaluating proposals from parties to develop, finance, and manage the Connecticut State Pier in New London under a long-term operating agreement (Connecticut Port Authority 2018a). According to the Connecticut Maritime Strategy 2018 (Connecticut Port Authority 2018b), New London is the only major port between New York and Maine that does not have vertical obstruction and offshore barriers, two factors that are critical for offshore wind turbine assembly. The document includes strategic objectives to manage and redevelop the Connecticut State Pier partially to support the offshore wind industry, which could create a dramatic increase in demand for the Connecticut State Pier and regional job growth. Redevelopment of the State Pier is considered a reasonably foreseeable activity, though specific redevelopment plans are not yet available.
- In Rhode Island, Deepwater Wind has committed to investing approximately $40 million in improvements at the Port of Providence, the Port of Davisville at Quonset Point, and possibly other Rhode Island ports for the Revolution Wind Project (Providence Journal 2018). This investment will position Rhode Island ports to participate in construction and operation of future offshore wind projects in the region (Rhode Island Governor's Office 2018). The Port of Davisville has added a 150-megaton mobile harbor crane, which will enable the port to handle wind turbines and heavy equipment, and enables the Port of Davisville to participate in regional offshore wind projects (Port of Davisville 2017). Further improvements at Rhode Island ports to support the offshore wind industry are considered reasonably foreseeable.
- The Massachusetts Clean Energy Center (MassCEC) has identified 18 waterfront sites in Massachusetts that may be available and suitable for use by the offshore wind industry. Potential activities at these sites include manufacturing of offshore wind transmission cables, manufacture and assembly of turbine components, substation manufacturing and assembly, operations and maintenance bases, and storage of turbine components. The 18 sites include two identified by Vineyard Wind as potential construction or operations and maintenance ports; the Brayton Point Power Plant site, and the Montaup Power Plant site.

- The Brayton Point Power Plant is currently being decommissioned, and has been identified as a potential port for use by the offshore wind industry. The MassCEC has identified several redevelopment scenarios for the Brayton Point Power Plant site, which include support for construction of turbine components, and for operations and maintenance activities (MassCEC 2017a). The site is being considered for a turbine manufacturing facility and for staging (South Coast Today 2018, Fall River Herald News 2018). Although final redevelopment plans are uncertain, it is reasonably foreseeable that this site will be developed to support the offshore wind industry.
- The Montaup Power Plant site is a former power plant site located in Somerset, Massachusetts, that was also identified by the MassCEC as having potential to support construction of turbine components, and for operations and maintenance activities (MassCEC 2017b). No plan for redevelopment of the Montaup Power Plant has been released (MassCEC 2017c) therefore improvements at this site are not considered reasonably foreseeable.

- The MassCEC manages the New Bedford Marine Commerce Terminal in New Bedford, Massachusetts. The 29-acre facility was completed in 2015, and is the first in North America designed specifically to support the construction, assembly, and deployment of offshore wind projects (MassCEC 2018). The Draft New Bedford Port Authority Strategic Plan 2018 – 2023 contains goals related to expanding the New Bedford Marine Commerce Terminal to improve and expand services to the offshore wind industry (Port of New Bedford 2018), but no new improvements were identified.
- Vineyard Wind would use Vineyard Haven Harbor in Tisbury as the location of the proposed Project's Operations and Maintenance Facility. Vineyard Haven Harbor is the island's year-round working port, and is home to most of the Martha's Vineyard boatyards. Small coastal tankers and ferries regularly use Vineyard Haven Harbor to transport freight, vehicles, and passengers. The areas of Tisbury near the Vineyard Haven Harbor are a mix of marine-related, commercial, and residential uses. Potential indirect impacts associated with the Vineyard Haven Operations and Maintenance Facility are discussed in the resource-specific sections in Chapter 3 of the Draft EIS.

This Draft EIS explores reasonably foreseeable impacts of construction and operation of offshore wind facilities as described in Table C.1-3. In summary, potential impacts could include, but are not limited to the following:

- Increased seafloor disturbance, turbidity, and benthic habitat alterations;
- A risk of direct physical impacts, displacement, or disturbance to wildlife, including threatened/ endangered species;
- Increased vessel traffic and associated effluent discharges, air emissions, and noise;
- Visual impacts to onshore and offshore observers within the daytime and nighttime visibility zones;
- Economic impacts, including beneficial impacts on tax revenues, employment, and economic activity associated with operating the wind energy facility, maintaining the wind energy facility, tourism, and other ocean economy sectors;
- Displacement or reduction in fishing opportunities (commercial and recreational), marine mineral extraction, and other ocean economy sectors;
- Displacement of recreational opportunities or change in value of recreational opportunities;
- Disturbance of cultural resources or impacts on cultural values; and
- Introduction of navigational obstructions to aviation and marine vessels (submarine and surface vessels).

C.1.3. Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables

As discussed in Draft EIS Section 3.4.8, existing undersea transmission lines, gas pipelines, and other submarine cables are located in the region around the proposed Project area, including the following:

- New Shoreham (Block Island), Rhode Island, is served by a submarine power cable from the Deepwater Wind Block Island Wind Farm to New Shoreham (Block Island).
- A submarine power cable connects Block Island to the mainland electrical grid at Narragansett, Rhode Island
- Service to Martha's Vineyard is provided by four electric cables from Falmouth, located in three corridors through Vineyard Sound. Two cables are located in the same corridor between Elm Road in Falmouth and

West Chop; one is located between Shore Street in Falmouth and Eastville (East Chop), and one connects between Mill Road in Falmouth and West Chop and was constructed in 2014.

- Two cables service Nantucket through Nantucket Sound, from Dennis Port and Hyannis Port to landfall at Jetties Beach.
- Additional submarine cables, including fiber-optic cables and trans-Atlantic cables that originate near Charlestown, Rhode Island, New York City, Long Island, and near Trenton, New Jersey, are located offshore New England and mid-Atlantic states, but outside the proposed Project area.
- Two natural gas pipelines are located offshore Boston, Massachusetts in Massachusetts Bay and lead to liquid natural gas (LNG) export facilities: the Neptune pipeline and the Northeast Gateway LNG pipeline (see also Section C.1.10).

Table C.1-4 lists two Tier 1, one Tier 2, and one Tier 3 offshore wind projects for which offshore cable routes have been identified (Atlantic City Wind Farm export cable, the Coastal Virginia Offshore Wind Export cable, the South Fork Export cable, and the Bay State Wind Export Cable). Cable routes have not yet been announced for the remainder of the projects.

Reasonably foreseeable impacts of new transmission and pipeline projects could include (BOEM 2016):

- Increased vessel traffic and associated effluent discharges, air emissions, and noise;
- Increases of accidental releases of trash and marine debris;
- Intermittent underwater noise associated with construction;
- Temporary disturbance of benthic habitat from installation;
- Increased potential for oil spills;
- Impacts on existing telecommunication cables; and
- Temporary sediment disturbance during installation or maintenance.

C.1.4. Tidal Energy Projects

The following tidal energy projects have been proposed or studied on the U.S East Coast and are in operation or considered reasonably foreseeable:

- The Bourne Tidal Test Site, located in the Cape Cod Canal near Bourne, Massachusetts, is a testing platform for tidal turbines that was installed in late 2017 by the Marine Renewable Energy Collaborative. The Bourne Tidal Test Site offers a test platform for tidal turbines (MRECo 2018).
- Cobscook Bay Tidal Project, located in Maine, is a Federal Energy Regulatory Commission- (FERC) licensed tidal project that began operations in 2012. The project owner, Ocean Power Energy Company, has informed FERC that it will not apply for relicensing, and removal and site restoration activities are anticipated to be conducted prior to its current license expiration date in January 2022.
- Western Passage Tidal Energy Project, a proposed tidal energy site in the Western Passage, received a preliminary permit from FERC in 2016. The preliminary permit allows developers to study a project but does not authorize construction.

Other tidal projects that are not considered reasonably foreseeable for the purpose of this analysis include the proposed Muskeget channel Tidal Test Site/Edgertown Nantucket Tidal Energy Power Plant Project, which does not have an active FERC license and completed environmental studies, and the Cape and Islands Tidal Project, which was proposed for Vineyard Sound but does not appear to be moving forward. The FERC-licensed New York Roosevelt Island Tidal Project, which is located in the East River, is not likely to contribute to cumulative impacts and is not included in the analysis.

Reasonably foreseeable impacts of tidal energy project include (FERC 2011, 2012a, and 2012b):

- Increased seafloor disturbance, turbidity, sedimentation, and benthic habitat alterations;
- A risk of direct physical impacts and disturbance to sea turtles, marine mammals, fish, and birds (particularly migratory and diving birds);
- Increased vessel traffic and associated effluent discharges, air emissions, and noise;
- Changes in recreational use and patterns;
- Potential impacts on cultural resources or values;

- Navigational hazard to marine vessel traffic;
- Visual impacts on observers in daytime and nighttime visibility zones;
- Accidental releases of trash and marine debris; and
- A risk of petroleum product spills.

C.1.5. Marine Minerals Use and Ocean Dredged Material Disposal

Table C.1-5 lists proposed requests under evaluation and active negotiated lease agreements from BOEM's Marine Minerals Program for sand borrow areas for beach replenishment. The closest lease area (proposed or active) to the proposed Project area is located offshore New Jersey (Lease Number OCS-A-0505).

In addition, reconnaissance and/or design-level OCS studies along the east coast from Rhode Island to Florida have identified potential future sand resources. Resources identified nearest the Wind Development Area (WDA) include locations offshore Rhode Island (between Block Island and Charlestown), Long Island (Rockaway Beach, Long Beach, and Fire Island, New York), and Sandy Hook, New Jersey. Additional recent projects used borrow areas about 5 miles (8 kilometers) offshore Dare County, North Carolina; the Surfside borrow area 3 to 5 miles (4.8 to 8 kilometers) offshore of Surfside, South Carolina; and borrow areas offshore Duval County, Martin County and Canaveral Shoals, Florida (listed in Table C.1-5). BOEM has also received requests for leases offshore of Sandbridge, Virginia, and Bogue Banks, North Carolina (Table C.1-5). Impacts from sand removal (i.e., seafloor disturbances) could contribute to cumulative impacts when combined with the Proposed Action.

The U.S. Environmental Protection Agency Region 1 is responsible for designating and managing ocean disposal sites for materials offshore in the region of the WDA. The U.S. Army Corps of Engineers issues permits for ocean disposal sites and all ocean sites are for the disposal of dredged material permitted or authorized under the Marine Protection, Research, and Sanctuaries Act (16 USC § 1431 et seq. and 33 USC § 1401 et seq.). There are 11 active projects and 12 inactive/closed projects identified in the South Atlantic coast (North Carolina to Florida), and 15 active projects and four inactive/closed projects identified in the North Atlantic coast (Virginia to Maine) (USACE 2018). The closest potential sand borrow location to the WDA is located east of Block Island, approximately 46 miles to the west-northwest of the WDA.

Reasonably foreseeable impacts of OCS sand mining and dredge material disposal include:

- Increased seafloor disturbance, turbidity, and benthic habitat alterations;
- A risk of direct physical impacts on sea turtles and marine mammals;
- Increased vessel traffic and associated effluent discharges, air emissions, and noise;
- Accidental releases of trash and marine debris;
- A risk of petroleum product spills; and
- Increased coastal and dune habitat (which creates nesting habitat for threatened birds and turtles).

Table C.1-5: BOEM Marine Minerals Program—Requests and Active Leases (September 2018) in the Cumulative Study Area

Current Request/ Active Negotiated Agreements	State	Applicant(s)	Request Date	Approved Through	Project Area	Volume Requested (cubic yards)	Borrow Status
Current Requests	NC	Carteret County, Bogue Banks	5/18/2018	NA	Bogue Banks, Carteret County	1,976,000	Ocean Dredged Material Disposal Site
	VA	Norfolk District and City of Virginia Beach	11/20/2017	NA	5 mi (8 km) shoreline Sandbridge Beach	2,200,000	Sandbridge Shoal
Active Negotiated agreements	FL	Martin County	NA	7/12/2020	4 mi (6.4 km) shoreline from St. Lucie County line southward to near the southern limit of Stuart Public Beach Park	1,000,000	Completed
	FL	Duval County (Amendment)	NA	4/12/2019	10 mi (16.1 km) shoreline between St. John's River Entrance and Duval/ St. Johns County Line	2,400,000	Not begun
	FL	Brevard County (N, S Reach)	NA	10/11/2020	Two shoreline segments totaling 13.4 mi (21.6 km) along central Brevard County	1,700,000	Construction completed on 4/10/2018
	FL	Patrick AFB (Amendment)	NA	1/12/2019	Shoreline adjacent to Patrick AFB	465,000	Not begun
	NJ	Long Beach Island, Barnegat Inlet to Little Egg Harbor Inlet (Amendment)	NA	6/29/2018	Harvey Cedars, Surf City, Long Beach Township, Ship Bottom, and Beach Haven	12,000,000	Begun
	SC	Myrtle Beach (Amendment) USACE-Charleston District and Horry County	NA	10/17/2020	Garden City/Surfside Beach	1,000,000 original lease; 100,000 (Amendment), and 500,000 (Amendment)	Not begun

Source: BOEM 2018a
AFB = Air Force Base; BOEM = Bureau of Ocean Energy Management; km = kilometer; mi = mile; N = north; NA = not applicable; S = south; USACE = U.S. Army Corps of Engineers

C.1.6. Military Use

Military activities can include various vessel training exercises, submarine and antisubmarine training, and U.S. Air Force exercises. The U.S. Navy, the U.S. Coast Guard (USCG), and other military entities have numerous facilities in the region. Major onshore regional facilities include Naval Station Newport, Naval Submarine Base New London, Northeast Range Complex/Narragansett Bay Operation Area, Joint Base Cape Cod, and numerous USCG stations (Epsilon 2018). Onshore and offshore military use areas may have designated surface and subsurface boundaries and special use airspace (see Figure C.1-16). Potential impact-producing factors include:

- Acoustic stressors (e.g., sonar, explosives, air guns, noise from weapons, vessels and aircraft);
- Energy stressors (e.g., electromagnetic devices, high energy lasers);
- Physical disturbances and strike stressors (e.g., increased vessel traffic, military expended materials);
- Entanglement stressors (e.g., fiber optic cables and guidance wires); and
- Ingestion stressors (e.g., military expended materials).

C.1.7. Marine Transportation

As described in COP Section 7.8.1 (Epsilon 2018) and Draft EIS Section 3.4.7, Navigation and Vessel Traffic, marine transportation in the region is diverse and sourced from many ports and private harbors from New York to Massachusetts, including the islands. Commercial vessel traffic in the region includes research, tug/barge, liquid tankers (such as those used for liquid petroleum), cargo, military and search-and-rescue vessels, and commercial fishing vessels. Recreational vessel traffic includes cruise ships, sailboats, and charter boats. A number of federal agencies, state agencies, educational institutions, and environmental non-governmental organizations participate in ongoing research offshore including oceanographic, biological, geophysical, and archaeological surveys. The Northeast Regional Planning Body anticipates that major vessel traffic routes will be relatively stable in the region for the foreseeable future, but that coastal developments and market demands that are unknown at this time could affect them (NRPB 2016). One new regional maritime highway project received funding from the Maritime Administration. A new barge service (Davisville/Brooklyn/ Newark Container-on-Barge Service) is proposed to run twice each week in state waters between Newark (New Jersey), Brooklyn (New York), and the Port of Davisville in Rhode Island, which is located on Quonset Point, one of the potential construction ports.

Reasonably foreseeable impacts associated with increased oceanic transportation include:

- Increase in vessel traffic, including associated effluent discharges, air emissions, and noise;
- Increase in use of underused capacity at ports and creation of jobs;
- More accidental releases of trash and marine debris;
- Increased risk of fuel spills from vessels; and
- Increased vessel strikes.

C.1.8. Fisheries Use and Management

The National Marine Fisheries Service (NMFS) implements regulations managing commercial and recreational fisheries in federal waters, including those within which the WDA is located; the Commonwealth of Massachusetts regulates commercial fisheries in state waters (within 3 nautical miles of the coastline). In Massachusetts state waters, cities and towns manage the shellfish fisheries in all waters within their boundaries, with the exception of the commercial harvest of Atlantic surfclams and ocean quahogs that remain under state control. Aquaculture operations in the region represent a growing industry, and include blue mussel and kelp (*Saccharina latissima*) aquaculture operations located within Horseshoe Shoals (a subtidal area of Nantucket Sound) and oyster aquaculture grants along the eastern shoreline of Lewis Bay (COP Section 7.6.1, Volume IIIl Epsilon 2018).

Several fisheries operate in the MA WEA. Based on the available data for the time period between 2007 and 2015, landings were identified for the bluefish Fisheries Management Plan (FMP), smooth dogfish, spiny dogfish, American john dory, monkfish FMP, Northeast multispecies FMP, northeast small mesh multispecies FMP, sea scallop FMP, skate FMP, and squid maceral butterfish FMP (Livermore 2017). Further, an estimated five to six lobster boats fished in the Vineyard WLA (COP Section 7.6.2.2, Volume III; Epsilon 2018). By gear type, bottom trawl fishery appeared in the WDA and along the OECC, limited dredge fishery appeared along the OECC, and limited gillnet fishery was present in the WDA and along the OECC. No pots and traps or fishing effort by longline occurred in the WDA or along the OECC (COP Section 7.6.2.2, Volume III; Epsilon 2018).

The governing statute for federal fisheries management is the Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1801 et seq.). This statute requires that fisheries be managed sustainably and created eight regional fishery management councils. Regional councils develop management plans for marine fisheries in waters seaward of state waters. Regional councils that operate in the region around the WDA include the New England Fishery Management Council, which manages fisheries from 3 to 200 miles (4.8 to 321.9 kilometers) off the coast from Maine to New York, and the Mid-Atlantic Fishery Management Council, which manages fisheries from 3 to 200 miles (4.8 to 321.9 kilometers) off the coast from New York to North Carolina. FMPs are updated periodically, which may result in changes to fish mortality, fishing effort, and vessel traffic. The most recent report from NMFS, which includes a summary of the stock status for various species, indicates that several species fished in the WDA and OECC areas are on the overfished lists for the New England and Mid-Atlantic regions (Table C.1-6; NOAA Fisheries 2018).

A number of commercially important species in the Greater North Atlantic rely on benthic habitats for shelter, reproduction, and food. Mobile bottom-tending gears such as bottom trawls and dredges are most likely to contribute to cumulative impacts on sediments and benthic habitats. Fisheries use both gear types throughout the New England and Mid-Atlantic waters. Fisheries targeted by bottom trawling include the Northeast multispecies, whiting, monkfish, skate, Atlantic herring, bluefish, Atlantic mackerel, squid, butterfish, spiny dogfish, summer flounder, scup, and black sea bass. Fisheries targeted by dredges include Atlantic sea scallop, ocean quahog, and surfclam (NEFMC 2016). Bottom trawling also occurs in South Atlantic waters for white shrimp, pink shrimp, brown shrimp, and rock shrimp.

In general, fishing gear impacts on benthic habitats depend on a variety of factors, including habitat vulnerability and gear type. Species that live in low-energy environments are generally more vulnerable to bottom trawling disturbance (ICES 2000; NRC 2002). Repeated trawling and dredging changes benthic communities and reduces habitat complexity (NRC 2002). Bottom trawling also reduces the overall productivity of benthic habitats (NRC 2002).

Reasonably foreseeable impacts from federally regulated commercial fishing include:

- Fish, sea turtle, and marine mammal mortality;
- Mobile bottom-tending fishing gear impacts on benthic habitats;
- Regulated fishing effort; and
- Vessel traffic.

C.1.9. Global Climate Change

Section 7.6.1.4 of the Programmatic EIS for Alternative Energy Development and Production and Alternate Use of Activities on the Outer Continental Shelf (MMS 2007) describes global climate change with respect to assessing renewable energy development. Climate change is predicted to affect Northeast fishery species differently (Hare et al. 2016), and the NMFS Biological Opinion discusses in detail the potential impacts of global climate change on protected species that occur within the proposed action area (NMFS 2013). The following is a summary of the above-referenced information, incorporating updated information.

A balance between the radiation received from the sun, the amount reflected by the earth's surface and clouds, the amount of radiation absorbed by the earth, and the amount re-emitted to space as long-wave radiation regulates the temperature of the earth's atmosphere. Greenhouse gases (GHGs) keep the earth's surface warmer than it would otherwise be because they absorb infrared radiation from the earth and, in turn, radiate this energy back down to the surface. While these gases occur naturally in the atmosphere, there has been a rapid increase in concentrations of GHGs in the earth's atmosphere from human sources since the start of industrialization, which has caused concerns over potential changes in the global climate. The primary GHGs produced by human activities are carbon dioxide, methane, nitrous oxide, and halocarbons (MMS 2007). The heavy use of fossil fuels from the nineteenth century onwards, in addition to other human activities, has artificially increased the amount of GHGs within the Earth's atmosphere.

Table C.1-6: NOAA Fisheries Stock Status as of September 30, 2018

Region	Stock	On Overfished List (biomass is below threshold)	On Overfishing List (fishing mortality is above threshold)	Stocks Rebuilt (year)
New England	Atlantic Cod—Georges Bank	X	X	
	Atlantic Cod—Gulf of Maine	X	X	
	Atlantic Herring – Northwestern Atlantic Coast	Not overfished	Not overfishing	NA
	Windowpane flounder—Gulf of Maine/Georges Bank	X		
	Witch Flounder	X		
	Yellowtail flounder—Cape Cod/Gulf of Maine	X	X	
	Yellowtail flounder—Georges Bank	X	X	
	Yellowtail Flounder—S. New England/Mid-Atlantic	X	X	
	Thorny skate—Gulf of Maine	X		
	Atlantic Halibut	X		
	Atlantic salmon	X		
	Atlantic wolffish	X		
	Ocean pout	X		
	Winter flounder—Southern New England	X		
	Red hake—Southern Georges Bank/Mid-Atlantic	X	X	
	Sea Scallop			X (2001)
	Silver hake—Gulf of Maine/N. Georges Bank, S. Georges Bank/Mid-Atlantic			X (2002, 2007)
	Winter flounder—Georges Bank			X (2003)
	Haddock—Georges Bank, Gulf of Maine			X (2010, 2011)
	Pollock—Gulf of Maine/Georges Bank			X (2010)
	Acadian redfish—Gulf of Maine/Georges Bank			X (2012)
	Windowpane flounder—S. New England/Mid-Atlantic			X (2012)
	Yellowtail flounder—So. New England/Mid-Atlantic			X (2012)
	Barndoor skate—Georges Bank/S. New England			X (2016)
	Smooth Skate – Gulf of Maine			X (2018)
New England and Mid-Atlantic	Goosefish (Monkfish)—Gulf of Maine/N. Georges Bank, S. Georges Bank/Mid-Atlantic			X (2008)
	Spiny Dogfish			X (2010)

Region	Stock	On Overfished List (biomass is below threshold)	On Overfishing List (fishing mortality is above threshold)	Stocks Rebuilt (year)
Mid-Atlantic	Summer Flounder		X	
	Bluefish—Atlantic Coast			X (2008)
	Atlantic mackerel—Gulf of Maine/Cape Hatteras	X	X	
	Scup—Atlantic Coast			X (2009)
	Black sea bass—Mid-Atlantic Coast			X (2009)
	Summer flounder—Mid-Atlantic Coast			X (2011)
	Tilefish—Mid-Atlantic Coast			X (2014)
	Butterfish—Gulf of ME to Cape Hatteras			X (2014)
	Northern Shortfin Squid – Northwestern Atlantic Coast	No	Unknown	NA
	Longfin Inshore Squid – Georges Bank/Cape Hatteras	Unknown	No	NA
	Atlantic Surfclam and Ocean Quahog – Mid-Atlantic Coast and Atlantic Coast	No	No	NA
Highly Migratory Species	Blacknose Shark—Atlantic	X	X	
	Blue Marlin—Atlantic	X	X	
	Dusky Shark—Atlantic	X	X	
	White marlin—Atlantic	X	X	
	Scalloped hammerhead—Atlantic	X	X	
	Porbeagle shark—Atlantic	X		
	Sandbar shark—Atlantic	X		
	Bigeye tuna—Atlantic		X	
	Shortfin mako—North Atlantic	X	X	
	Blacktip shark—Atlantic/Gulf of Mexico			X (2003)
	Swordfish—N. Atlantic			X (2009)
	Albacore Tuna—N. Atlantic			X (2016)

Source: NOAA Fisheries 2018

NA = not applicable

The associated increase in global temperature has led to reduced sea-ice cover, rising sea levels, and changing weather patterns, with wide-ranging effects. As of July 2018, globally averaged sea surface temperatures have warmed 1.1 degrees Fahrenheit above the 20th century average of 61 degrees Fahrenheit, which is the fourth highest for January through July in the 1880 to 2018 record (NOAA NCEI 2018). Water below the surface is also experiencing strong warming trends in some parts of the world, including the western Atlantic (Nieves et al. 2015; NASA 2016). NOAA researchers predict that the ocean temperature in the U.S. Northeast Shelf will warm almost three times faster than the global average, which will likely cause more extreme effects on the ecosystem (Saba et al. 2016). The list below represents some of the wide-ranging environmental influence that these changes in the climate system have:

- Increased energy within the climate system may be generating stronger storm systems (Wang et al. 2006; Trapp et al. 2007; Screen and Simmonds 2013; Kunkel et al. 2013);
- Stronger storms due to climate change could result in increased sediment erosion, deposition, and bottom disturbance that may be harmful to benthic organisms including sea scallops (New Hampshire Fish and Game 2015);
- Enhanced sea level rise from the thermal expansion of water and the melting of continental ice sheets may negatively impact nesting and spawning sites of some animals, such as sea turtle species (Daniels et al. 1993; Fish et al. 2005; Baker et al. 2006);
- The seasonal timing and patterns of temperature are being altered by climate change, affecting ecological relationships and species distributions (Walsh et al. 2015; Drinkwater et al. 2003; Richardson et al. 2008);
- Ocean acidification from increased carbon dioxide absorbed by the ocean, affecting habitat availability, prey availability, species distribution and migration, community structures, reproductive success, and susceptibility to disease for a variety of marine organisms (Macleod 2009);
- Risk to fisheries due to changes in habitat/distribution shifts, disease incidence, risk of invasive species, and climate-driven extreme events and disasters; the catch potential for the Northeast Atlantic is projected to decrease between now and the 2050s (Barange et al. 2018);
- Health risks associated with extreme heat events, expansion of vector-bourne diseases, water quality, and coastal zone flooding (USGCRP 2014); and
- Socioeconomic stressors, including effects associated with infrastructure vulnerabilities, decrease in agricultural production, natural disaster recovery costs, property losses, and negative effects on employment (USGCRP 2014).

The Intergovernmental Panel on Climate Change (IPCC) released a special report in October 2018 that compared risks associated with an increase of global warming of 1.5 degrees Celsius (°C) and an increase of 2°C. The report found that climate-related risks depend on the rate, peak, and duration of global warming, and that an increase of 2°C was associated with greater risks associated with climatic changes such as extreme weather and drought; global sea level rise; impacts to terrestrial ecosystems; impacts to marine biodiversity, fisheries, and ecosystems and their functions and services to humans; and impacts to health, livelihoods, food security, water supply, and economic growth (IPCC 2018). According to the IPCC report, limiting global warming to 1.5°C will reduce these risks.

Detecting and measuring climate change and its impacts require data with adequate resolution stretching back multiple decades. In a marine environment, sources of data are often limited to what passing vessels recorded in regards to ambient conditions and their economic activities. Fishery data collected by the NMFS over the past 50 years reveal a gradual shift of fishery species towards higher latitudes and greater depths (Pinsky et al. 2013; OceanAdapt 2016). This may be part of an ecological shift affecting any species with a predator or prey relationship with these fishery species.

C.1.10. Oil and Gas Activities

Oil and gas leasing activities are not included in the cumulative impact assessment. At this time, there has been no decision by the Secretary of the Interior regarding future oil and gas leasing in the Atlantic Ocean. The proposed Project area is located in the North Atlantic Program Area of the OCS Oil and Gas Leasing Program (National OCS Program). The Draft Proposed Program (DPP), released on January 4, 2018, is the first stage of a three-stage process to develop the National OCS Program (BOEM 2018b). BOEM is currently developing a Proposed

Program, which will be followed by the Proposed Final Program. Development of a new National OCS Program typically takes two to three years to complete. The Department of the Interior's goal is to have the Final Program approved by the end of 2019. This process can help narrow the areas under consideration for oil and gas activities. Inclusion of an area at the DPP phase is not necessarily an indication it will be included in the National OCS Program or offered in a lease sale. BOEM can make future decisions to reduce or remove areas or sales.

BOEM issues Geological and Geophysical (G&G) permits to obtain data for hydrocarbon exploration and production; locate and monitor marine mineral resources; aid in locating sites for alternative energy structures and pipelines; identify possible manmade, seafloor, or geological hazards; and locate potential archeological and benthic resources. G&G surveys are typically classified into categories by equipment type and survey technique. Types of G&G surveys include Hydrocarbon Exploration and Development Deep-Penetration Seismic; High-Resolution Geophysical Seismic; Electromagnetic, Magnetic, Gravity, and Remote Sensing; and Geological Testing (Bottom Sampling and Drilling/Coring). A BOEM information sheet describing each technique (BOEM 2013) is incorporated by reference to provide details about G&G survey techniques and potential impacts. Table C.1-7 lists G&G permits currently under review by BOEM. There are currently no such permits under review for areas offshore Massachusetts and Rhode Island; the nearest areas under consideration for G&G surveys are located in federal waters offshore Delaware, approximately 250 miles (402.3 kilometers) southwest of the WDA.

Table C.1-7: Geological and Geophysical Permits Currently under Review by BOEM

Permit Number	Company	Submittal Date	States Adjacent to Area of Interest
E18-001	ABI Holdings Limited (Austin Exploration)	February 20, 2018	Delaware to Florida
E14-001	TGS	March 31, 2014	Delaware to Florida
E14-003	GX Technology Corporation	April 3, 2014	Delaware to Florida
E14-004	WesternGeco LLC	April 9, 2014	Virginia to South Carolina
E14-005	CGG Services (US) Inc.	April 29, 2014	Delaware to Florida
E14-006	Spectrum Geo Inc.	May 8, 2014	Delaware to Florida
E14-007	Petroleum Geo Services	May 9, 2014	Virginia, North Carolina
E14-010	TDI-Brooks International, Inc.	October 16, 2014	North Carolina to Florida

Potential impact-producing factors from G&G permit activities include:

- Acoustic stressors (e.g., sonar, explosives, air guns, noise from vessels, equipment and aircraft);
- Energy stressors (e.g., electromagnetic devices);
- Physical disturbances and strike stressors (e.g., increased vessel traffic, military expended materials, trash and debris, seafloor disturbance, stand-off distances);
- Entanglement stressors (e.g., lines, cables, and buoys); and
- Ingestion and environmental stressors (e.g., military expended materials, geological test well discharges, accidental fuel spills, vessel effluent discharges and emissions) (BOEM 2017).

Several liquefied natural gas ports are located on the east coast of the United States. Table C.1-8 lists existing, approved, and proposed LNG ports on the east coast of the United States that provide (or may in the future provide) services such as natural gas export, natural gas supply to the interstate pipeline system or local distribution companies, or storage of LNG for periods of peak demand, or production of LNG for fuel and industrial use (FERC 2018).

Table C.1-8: Existing, Approved, and Proposed LNG Terminals Located on the East Coast of the United States

Existing/ Approved/ Proposed	Terminal Name	Type	Company	Jurisdiction	Distance from WDA (approximate)
Existing	Everett, MA	Import Terminal	GDF SUEZ—DOMAC	FERC	91 mi (146.5 km) northwest
	Offshore Boston, MA	Import Terminal	Neptune LNG	MARAD/USCG	90 mi (144.8 km) north
	Offshore Boston, MA	Import Terminal, authorized to re-export delivered LNG	Excelerate Energy—Northeast Gateway	MARAD/USCG	90 mi (144.8 km) north
	Cove Point, MD (Chesapeake Bay)	Import Terminal	Dominion—Cove Point LNG	FERC	360 mi (579.4 km) southwest
	Elba Island, GA (Savannah River)	Import Terminal	El Paso—Southern LNG	FERC	840 mi (1,351.8 km) southwest
Approved	Elba Island, GA (Savannah River)	Export Terminal	Southern LNG Company	FERC	840 mi (1,351.8 km) southwest
Proposed	Jacksonville, FL	Export Terminal	Eagle LNG Partners	FERC	960 mi (1,545 km) southwest

Source: FERC 2018

FERC = Federal Energy Regulatory Commission; km = kilometer; MARAD = U.S. Department of Transportation Maritime Administration; mi = mile; USCG = U.S. Coast Guard

These facilities overlap with the cumulative impact geographic analysis area for birds, bats, sea turtles, marine mammals, and finfish, invertebrates, and essential fish habitat. Potential impact-producing factors from LNG import/export terminal activities related to those resources include:

- Acoustic stressors (noise from vessels and equipment);
- Physical disturbances and strike stressors (e.g., vessel traffic, trash and debris, seafloor disturbance);
- Entanglement stressors (e.g., lines, cables, and buoys); and
- Ingestion and environmental stressors (e.g., accidental fuel spills, pollution, vessel effluent discharges and emissions) (BOEM 2017).

C.1.11. Onshore Development Activities

Onshore development activities that may contribute to cumulative impacts are primarily onshore development projects located in proximity to the Onshore Export Cable Routes, landfalls, and substations. Onshore development projects with potential cumulative impacts could include visible infrastructure such as onshore wind turbines and cell towers, and other energy projects such as transmission and pipeline projects. Coastal development projects permitted through the Massachusetts regional planning commissions and towns may also contribute to cumulative impacts. These may include residential, commercial, and industrial developments spurred by population growth in the region.

Specific projects identified that may contribute to cumulative impacts include:

- Onshore Wind Projects—According to the USGS, there are approximately 17 onshore wind projects located on Cape Cod and near the potential port cities. These projects typically consist of one to two turbines for each project, ranging between 147.6 and 485.6 feet (45 and 148 meters) in height (USGS 2018). The turbines are visible in the daytime from multiple onshore viewpoints. Any structure exceeding 200 feet (61 meters) above ground level would require marking and/or lighting per Federal Aviation Administration (FAA) guidance

(FAA 2016). The Draft EIS would only assess turbines that are located within the cumulative analysis areas defined in Table C-1 and that would have a potential cumulative impact with resources evaluated (such as visual resources).

- Communications Towers—There are numerous communications towers located in Cape Cod, on offshore islands, and within the viewshed of the proposed Project components. If communications towers exceed 200 feet (61 meters) above ground level, they would be required to have marking/lighting per FAA guidance (FAA 2016). Thirty-nine communications towers were identified within the recreation/tourism cumulative impact study area, seven of which exceed the FAA height limit for marking/lighting requirements.
- Development Projects—The websites of the Massachusetts Regional Planning Agencies with jurisdiction over potentially affected areas were reviewed for onshore and coastal projects that may contribute to cumulative impacts:
  - The Cape Cod Commission's website identified current or active commercial developments, solar facilities, transmission projects, and gas pipeline projects in the planning region. The following were identified as projects with potential cumulative impacts (Cape Cod Commission 2018):
    - The Village at Barnstable (Hyannis, Massachusetts), a proposed senior-housing community located on Independence Drive and Communication Way that is under construction adjacent to the proposed substation location.
    - Additional development projects that have been approved and are located approximately 1 mile (1.6 kilometers) or less from the onshore facilities (either the cable routes or the substation), including Cape Cod Five Hyannis Banking Center, Cape Cod Mall Modification, Cape Cod Factory Expansion, Cape Cod Training Center, and restaurant, office and hotel developments. Many of these proposed developments are located along the Iyannough Road corridor, located approximately 1 mile (1.6 kilometers) south of the substation site and within 0.5 mile (0.8 kilometer) of one of the cable route alternatives.
  - The Martha's Vineyard Commission's website identifies three active projects that BOEM may consider in the cumulative impact assessment: the Chappy Wireless Antenna (104 feet [31.7 meters], approved), Verizon Tower Height Extension (130 feet [39.6 meters], under review), and Oak Bluffs Emergency Services Radio Tower (140 feet [42.7 meters], under review) (Martha's Vineyard Commission 2018). None of these proposed projects would exceed 200 feet (61 meters) above ground level and the FAA would not require marking/lighting.
  - The Nantucket Planning and Economic Development Commission's website lists several active projects, one of which BOEM may consider in the cumulative impact assessment: the town of Nantucket's Coastal Resilience Plan (Town and County of Nantucket 2018a). The Coastal Resilience Plan is being developed to address present and future challenges and vulnerabilities to the community on Nantucket, which include the effects of sea-level rise, shoreline changes, and increased magnitude and frequency of storms. The plan is currently under development, and while no actions have been identified to date, potential shoreline management activities could include sediment management, construction of seawalls and similar structures, and other types of coastal activities (Town and County of Nantucket 2018b).
  - In addition, the Massachusetts Department of Environmental Protection Bureau of Air and Waste approved National Grid's application for the construction and operation of a diesel generator and a battery electric storage system at an existing electric generating facility located at 32 Bunker Road in Nantucket, approximately 1 mile north of the coastline. The facility will be designed to comply with air quality regulations, and potential impacts include sound and visual impacts. The facilities are anticipated to be operational in 2019 (MassDEP 2017; Utility Dive 2018).

Reasonably foreseeable impacts from onshore developments include:

- Land use change;
- Erosion and sedimentation (mitigated by implementation of best management practices);
- Impacts to air quality;
- Visual impacts; and
- Traffic delays associated with construction.

C.1.12. Cumulative Analysis Area Maps

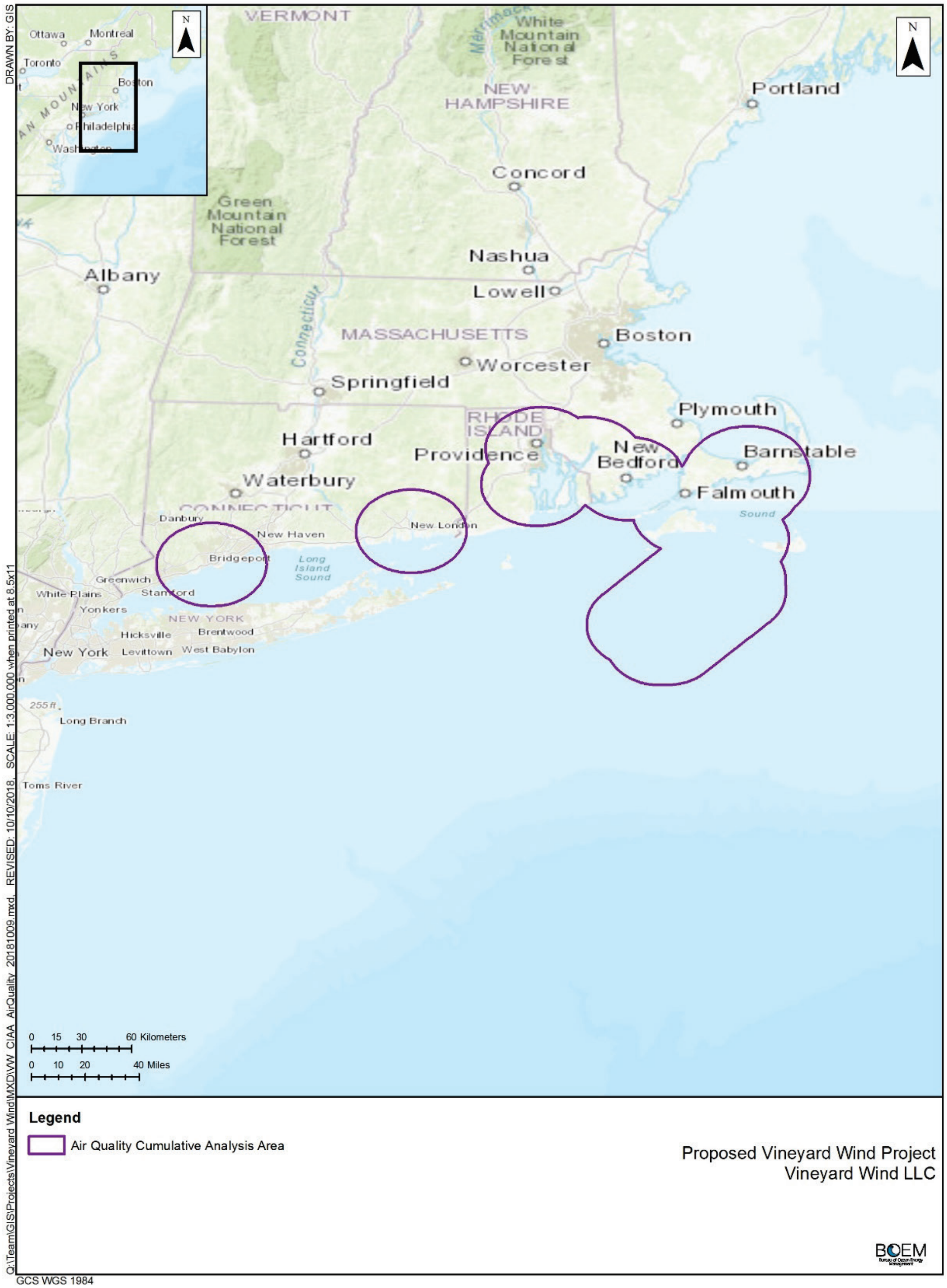

Figure C.1-1: Air Quality Cumulative Analysis Area

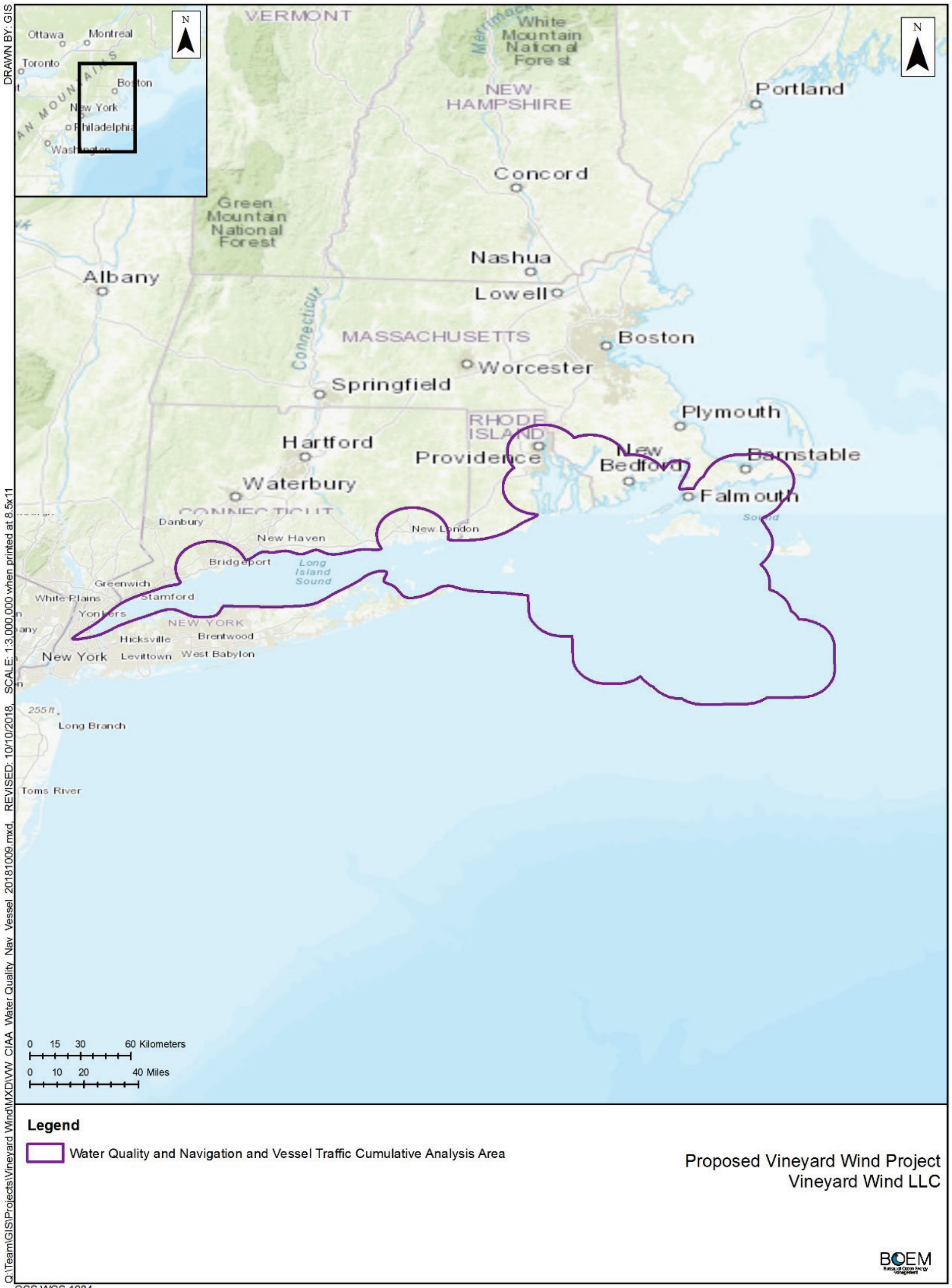

Figure C.1-2: Water Quality and Navigation and Vessel Traffic Cumulative Analysis Area

Figure C.1-3: Terrestrial and Coastal Faunas Cumulative Analysis Area

Figure C.1-4: Birds and Bats Cumulative Analysis Area

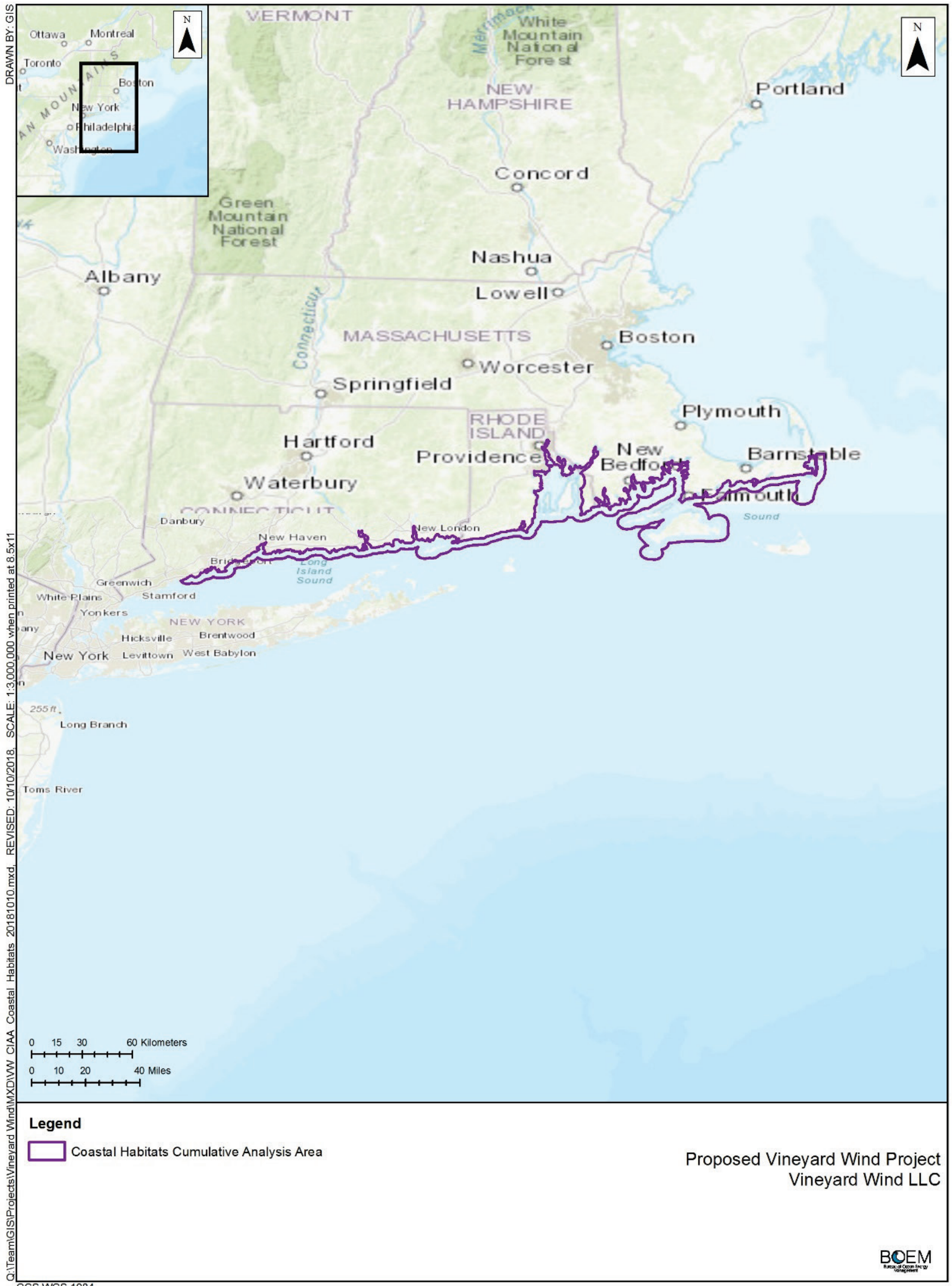

Figure C.1-5: Coastal Habitats Cumulative Analysis Area

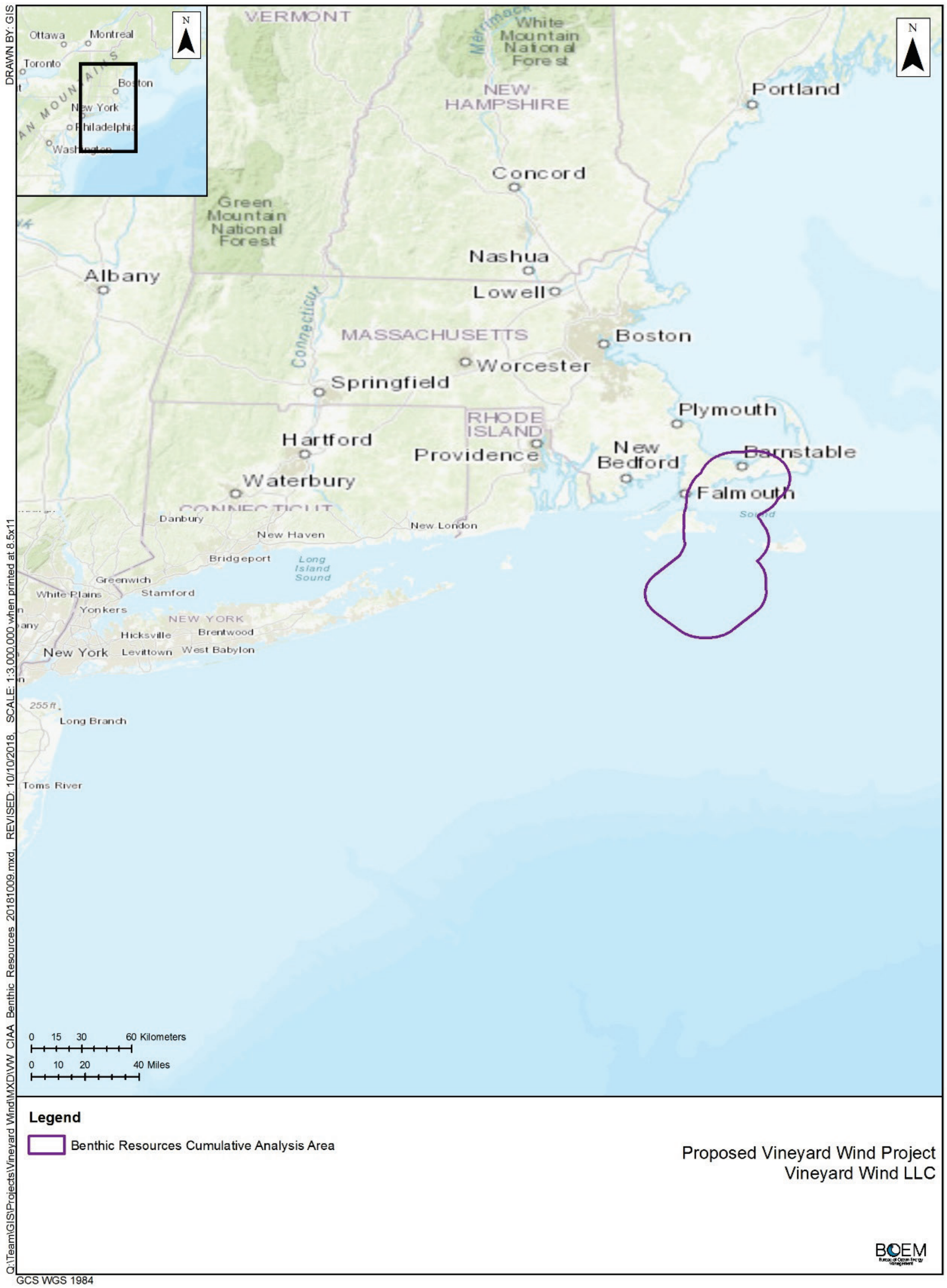

Figure C.1-6: Benthic Cumulative Analysis Area

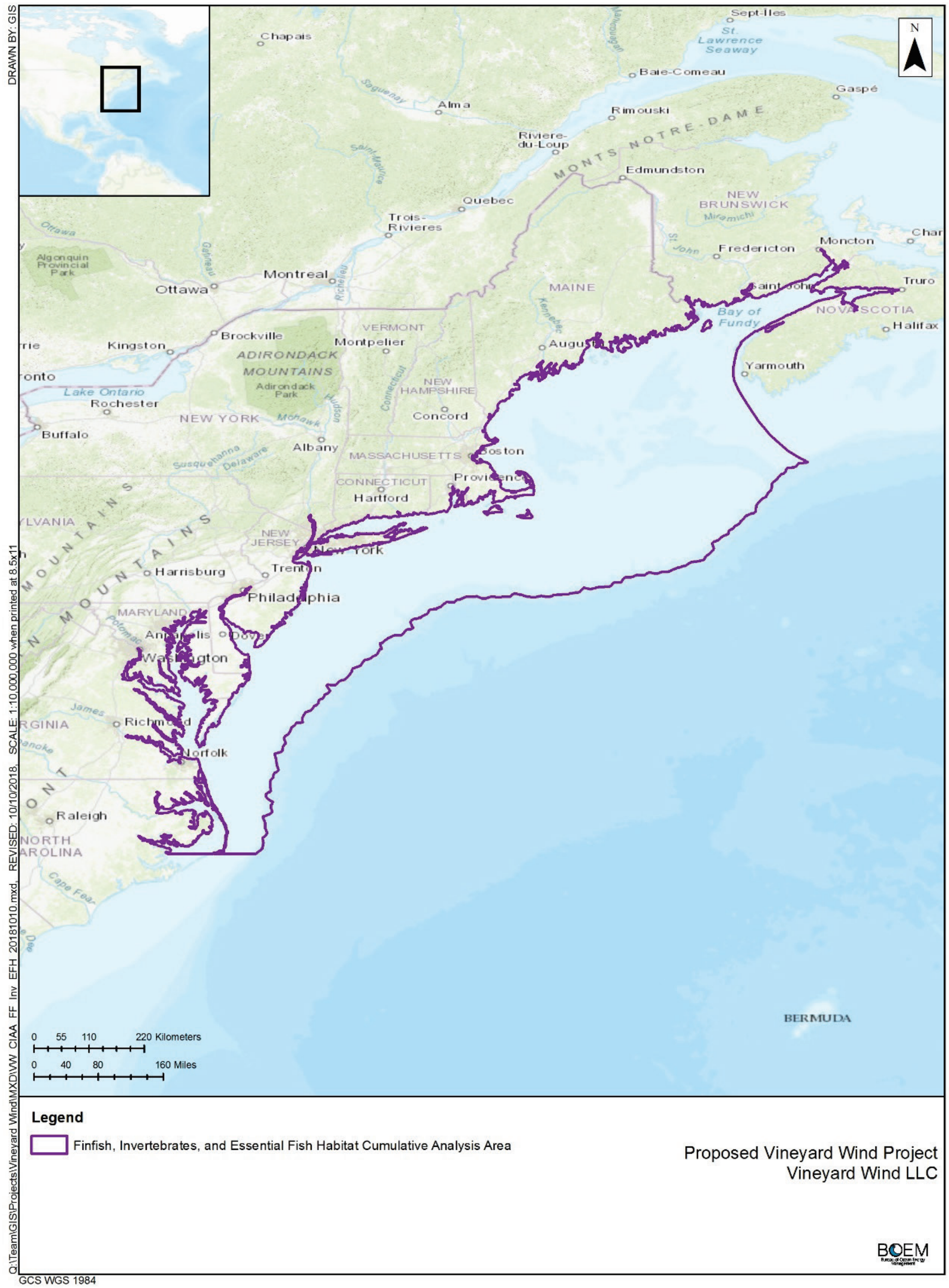

Figure C.1-7: Finfish, Invertebrates, and Essential Fish Habitat Cumulative Analysis Area

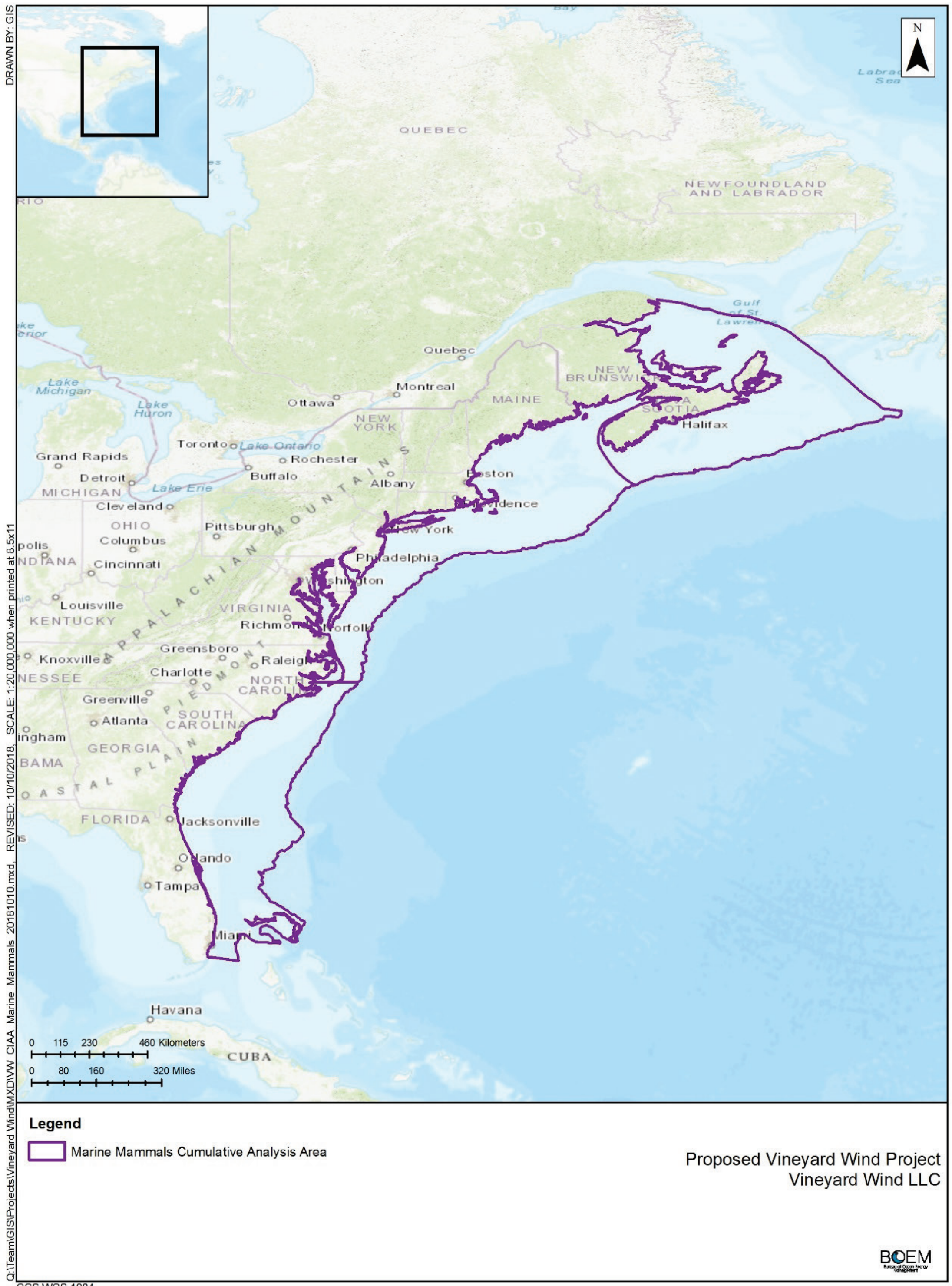

Figure C.1-8: Marine Mammals Cumulative Analysis Area

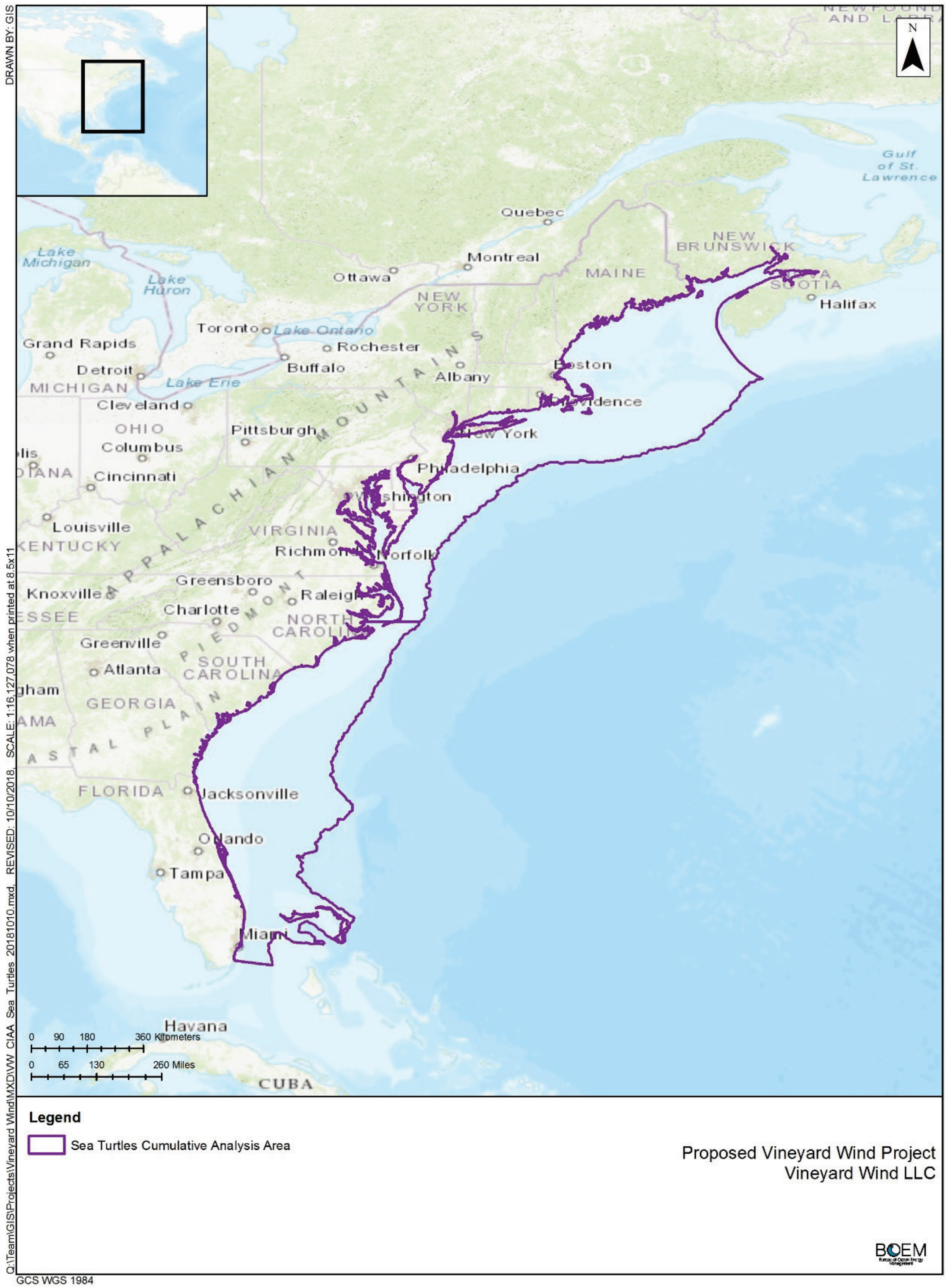

Figure C.1-9: Sea Turtles Cumulative Analysis Area

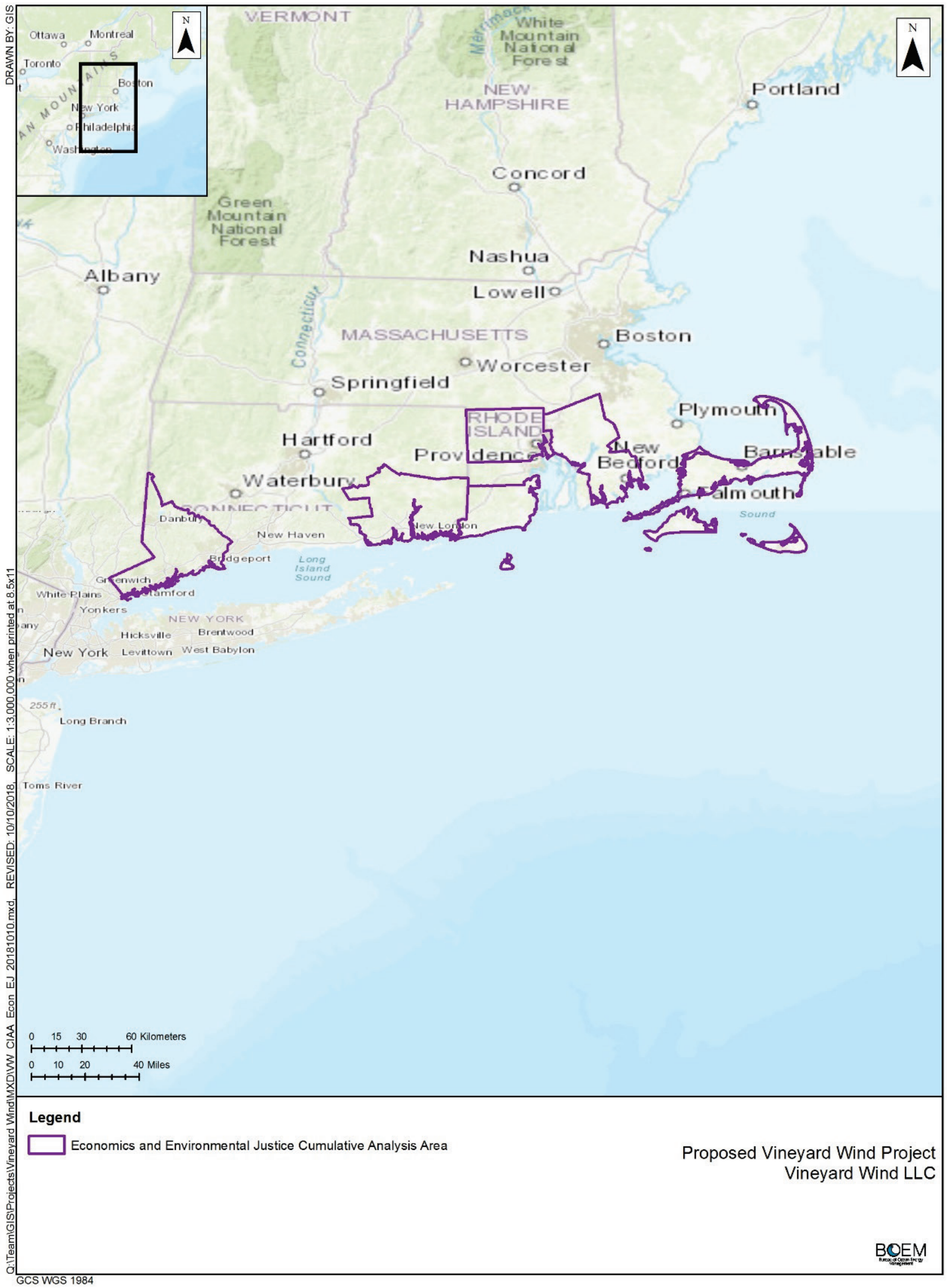

Figure C.1-10: Economics and Environmental Justice Cumulative Analysis Area

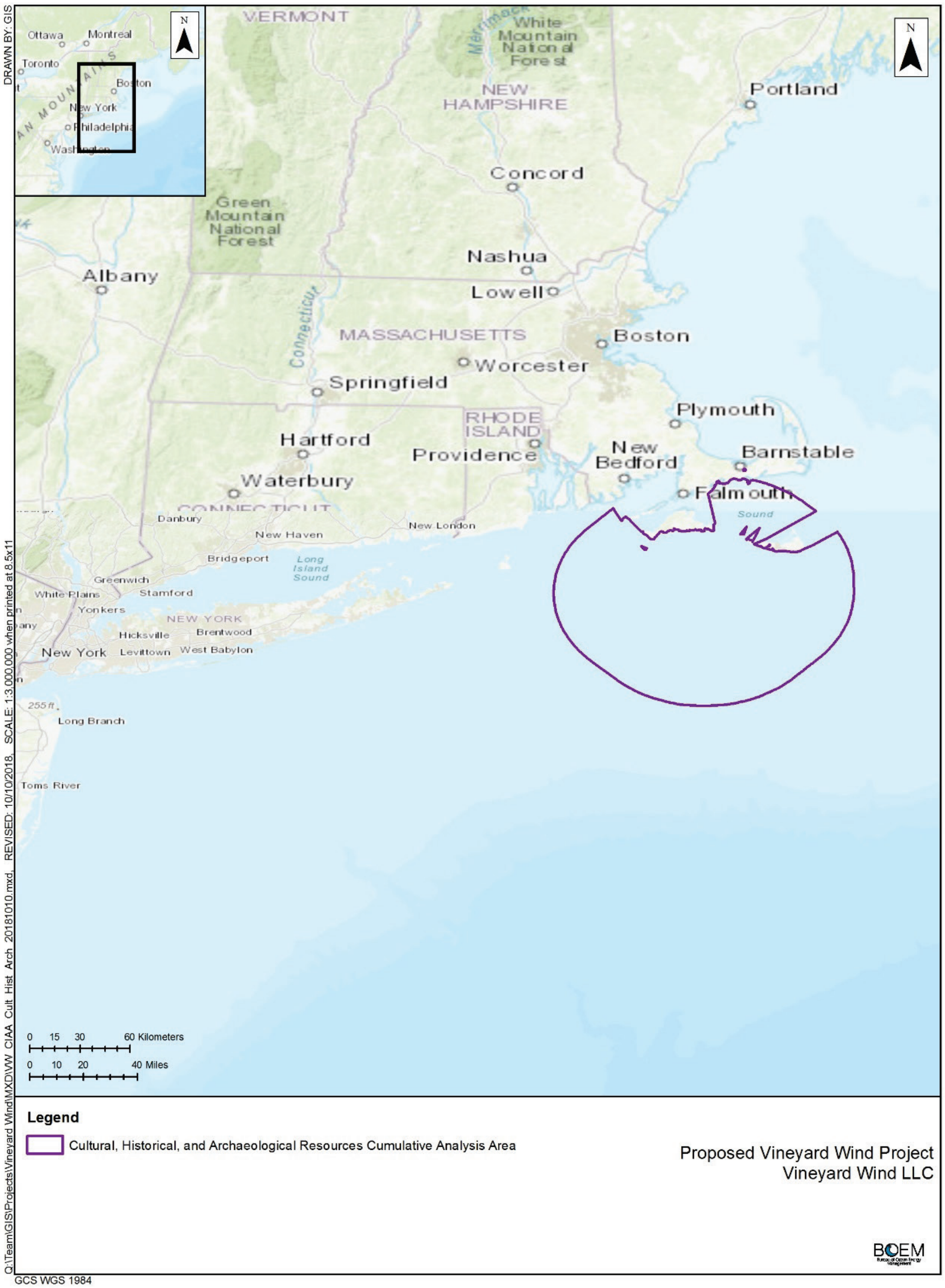

Figure C.1-11: Cultural, Historical, and Archaeological Resources Cumulative Analysis Area

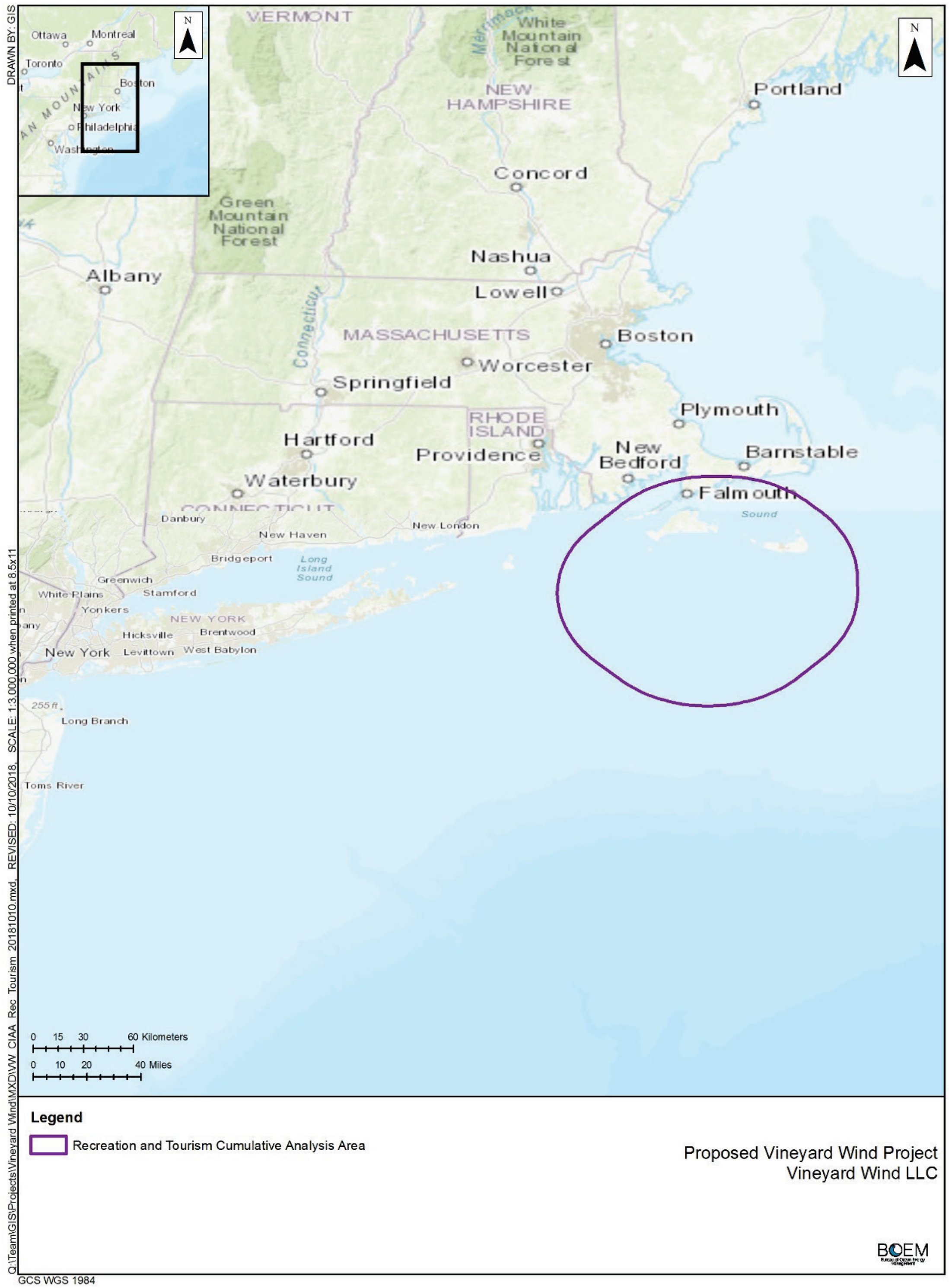

Figure C.1-12: Recreation and Tourism Cumulative Analysis Area

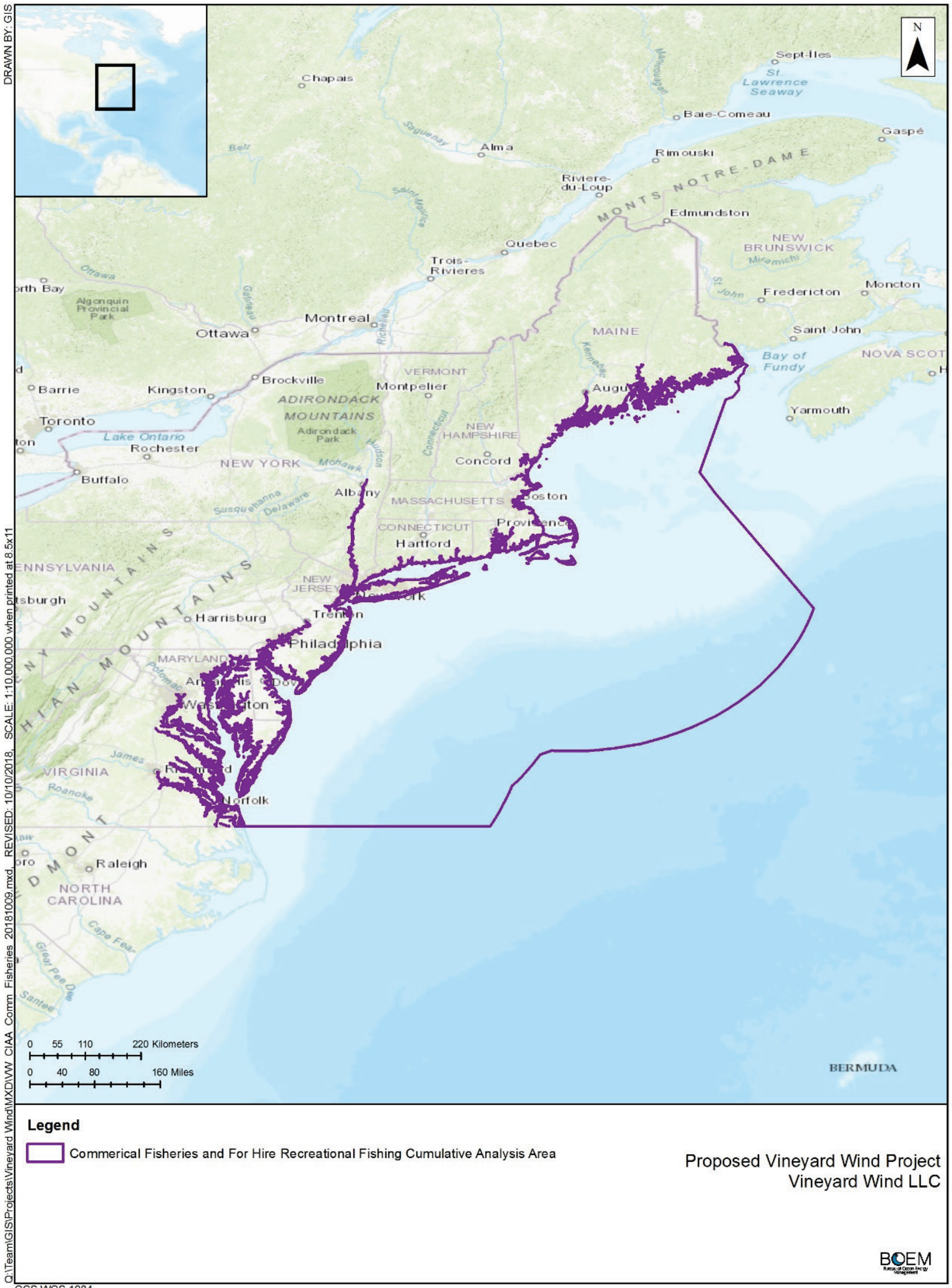

Figure C.1-13: Commercial Fisheries and For Hire Recreational Fishing Cumulative Analysis Area

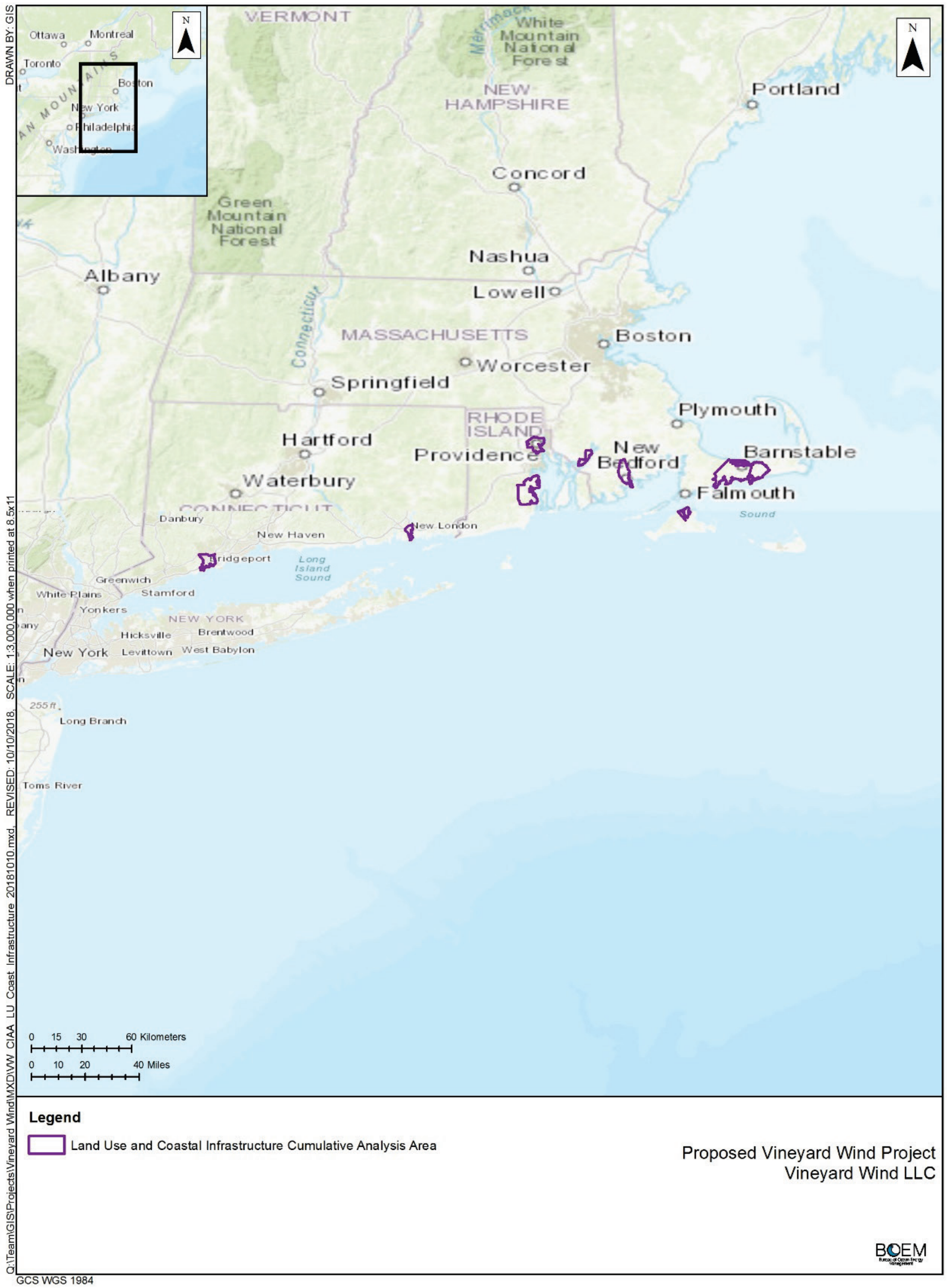

Figure C.1-14: Land Use and Coastal Infrastructure Cumulative Analysis Area

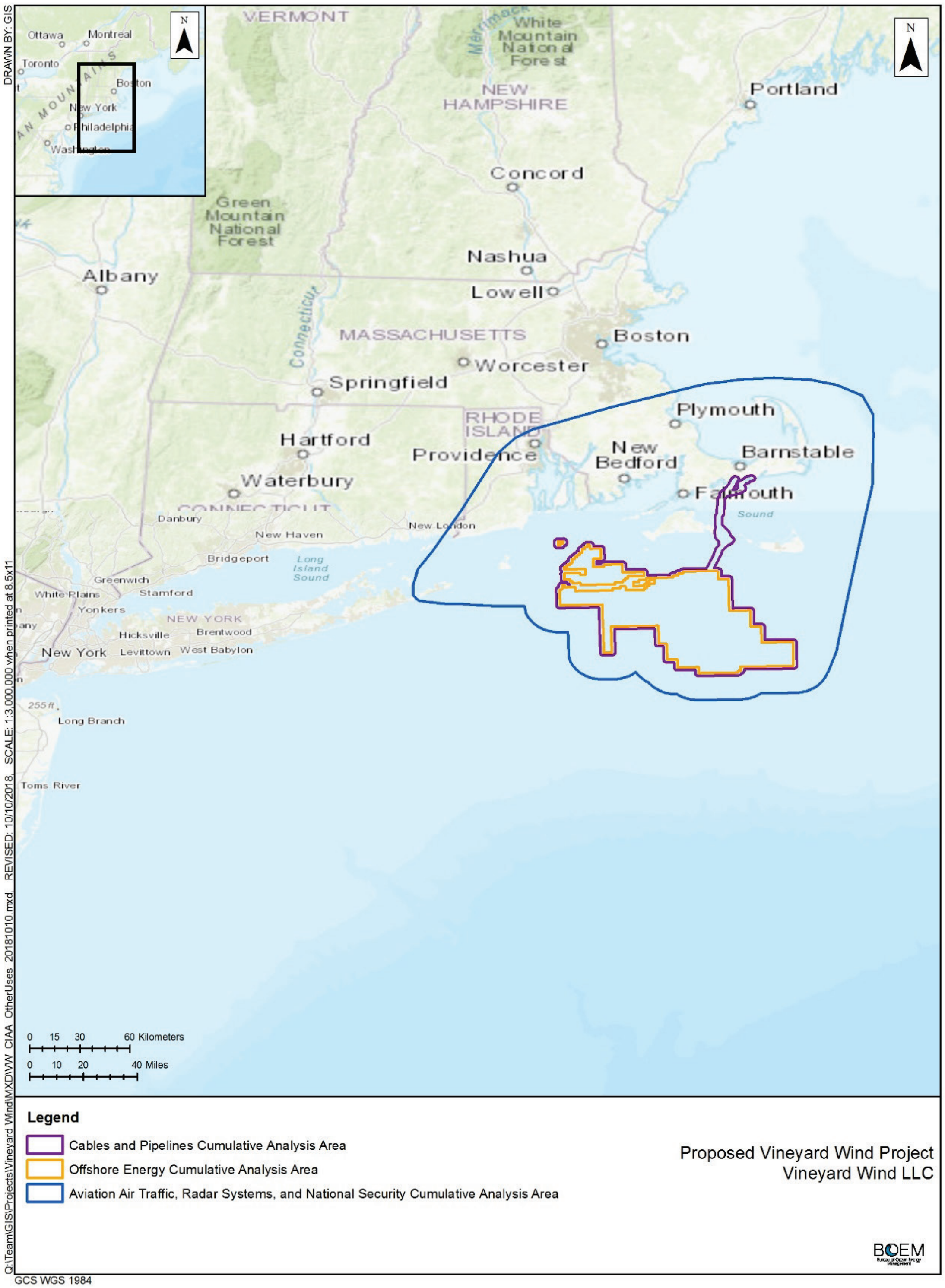

Figure C.1-15: Other Uses Cumulative Analysis Area

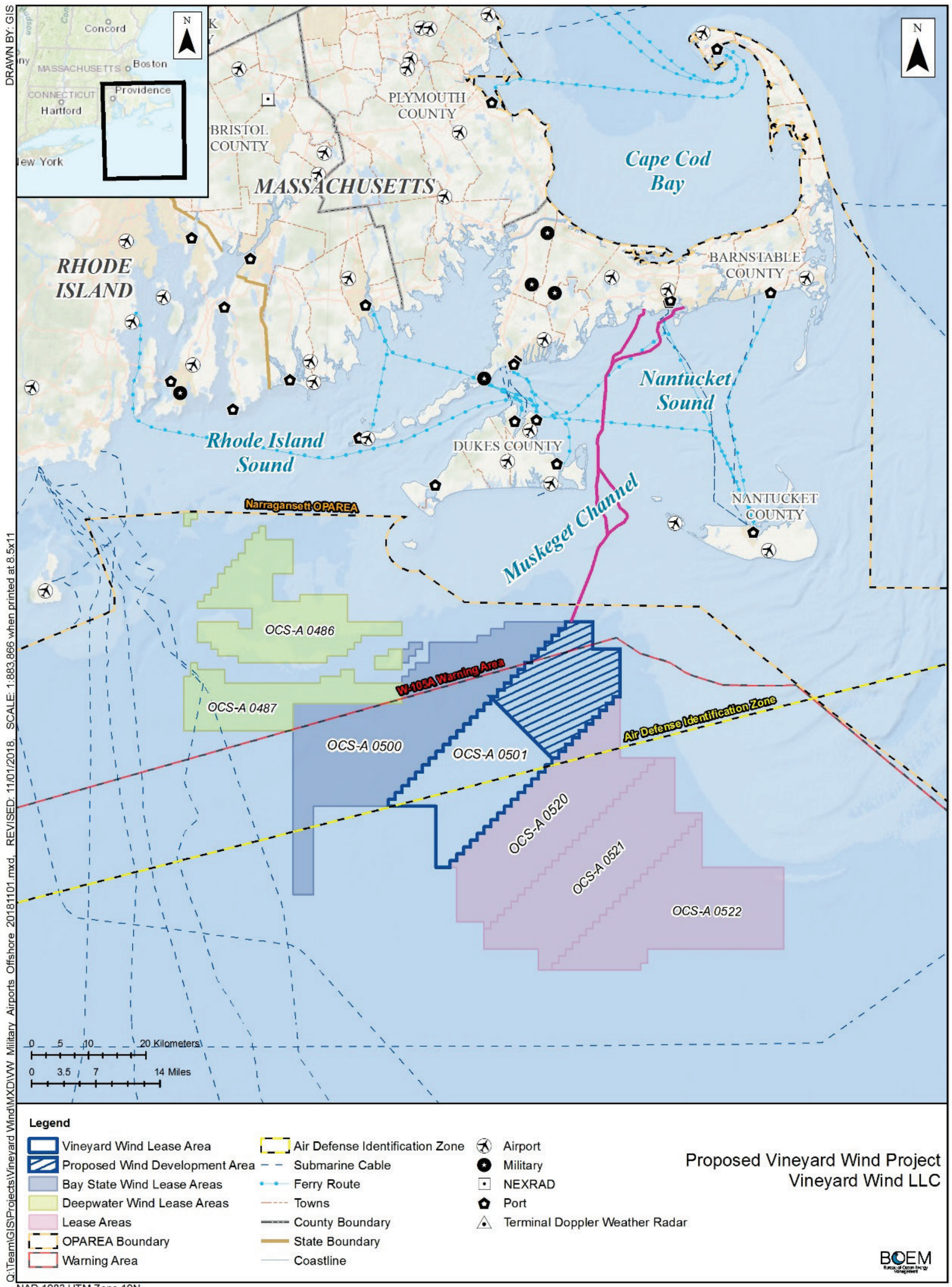

Figure C.1-16: Onshore and Offshore Military Use Areas

C.1.13. Cumulative Impact Analysis

Table C.1-9 lists projects and actions reviewed for the cumulative impact analysis, their category per the list in Table C-1, critical details, and if they are considered reasonably foreseeable and therefore included in the cumulative impact analysis.

Table C.1-9: Cumulative Projects

Tier	Past/ Present/ Reasonably Foreseeable	Category	Name	Geography	Location in Relation to Project Facilities	Description	Anticipated Project Timeline	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds	Bats	Coastal Habitats	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals	Sea Turtles	Economics	Environmental Justice	Cultural, Historical, and Archeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Recreational Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses	Reference
NA	Reasonably Foreseeable	Climate Change	Nantucket Coastal Resilience Plan (Nantucket Economic and Planning Commission)	Nantucket Coastline	Approximately 15 miles (24 km) northeast of the WDA	Coastal Resilience Plan is being developed to address present and future challenges and vulnerabilities to the community on Nantucket, including sea-level rise, shoreline changes, and increased magnitude and frequency of storms.	Currently under development; draft plan released April 2018	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	https://www.nantucket-ma.gov/1126/Coastal-Resiliency
NA	Present/ Reasonably Foreseeable	Climate Change	Global Climate Change	Throughout Project Area	Throughout Project Area	Environmental and Socioeconomic resources susceptible to impacts associated with climate change.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MA Coastal Zone Management MORIS website—data includes projected shoreline change, erosion, flooding, and sea level rise: http://maps.massgis.state.ma.us/map_ol/moris.php
NA	Present	Fisheries Use and Management	Mid-Atlantic Fisheries Management Council - Fisheries Management Plans	Areas covered by the Mid-Atlantic Fisheries Management Council plan areas	Generally, NY to NC; located approximately 60 miles (96.5 km) west of the WDA (boundaries under negotiation with New England Fisheries Management Council)	Fisheries management plans develop rules that affect fishing effort and vessel traffic in federal waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	http://www.mafmc.org/
NA	Present	Fisheries Use and Management	New England Fisheries Management Council Management Plans	Areas covered by the New England Fisheries Management Council	Planning area overlaps with the Project area (ME to NY)	Fisheries management plans develop rules that affect fishing effort and vessel traffic in federal waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.nefmc.org/
NA	Present	Fisheries Use and Management	MA Commercial Finfish Regulations	State Waters of MA	The OECC is located in state waters for approximately 3 nautical miles.	Commercial finfish regulations set daily limits for take in MA state waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.mass.gov/service-details/commercial-finfish-regulations

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NA	Present	Fisheries Use and Management	MA Division of Marine Fisheries - Commercial Lobster and Crab Regulations	State Waters of MA	The OECC is located in state waters for approximately 3 nautical miles.	Commercial lobster and crab regulations set limits for take in MA state waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.mass.gov/service-details/commercial-lobster-crab-regulations
NA	Present	Fisheries Use and Management	MA Division of Marine Fisheries – MA Commercial Shellfish and Sea Urchin Regulations	State Waters of MA	The OECC is located in state waters for approximately 3 nautical miles.	Commercial shellfish and crab regulations set limits for take in MA state waters.	Ongoing	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.mass.gov/service-details/commercial-shellfish-sea-urchin-regulations
NA	Present	Fisheries Use and Management	Town of Barnstable - Department of Natural Resources - Shellfish Harvest Regulations (Commercial and Recreational)	Town of Barnstable, MA	The OECC would cross into the Town of Barnstable if Vineyard Wind selects the landfall at Covell's Beach.	The Town of Barnstable sets commercial and recreational shellfishing regulations in Town waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://townofbarnstable.us/naturalresources/ShellfishManagement/ShellfishManagement.asp
NA	Present	Fisheries Use and Management	Town of Yarmouth - Department of Natural Resources, Shellfish Section - Shellfish Harvest Regulations (Commercial and Recreational)	Town of Yarmouth, MA	The OECC would cross into the Town of Yarmouth if Vineyard Wind selects the landfall at New Hampshire Avenue/Lewis Bay.	The Town of Yarmouth sets commercial and recreational shellfishing regulations in Town waters.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.yarmouth.ma.us/213/Shellfish-Management-Propagation
NA	Past	Management Planning	MA Ocean Management Plan	State waters offshore MA	Approximately 14 miles (22.5 km) north of the WDA	Management Plan for sustainable use of state ocean waters	Updated version released in 2015, first amendment to 2009 version	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.mass.gov/service-details/massachusetts-ocean-management-plan
NA	Past	Management Planning	RI Ocean Special Area Management Plan (Ocean SAMP)	Offshore RI, inclusive of Federal waters	Approximately 9 miles (14.5 km) west	Management Plan for state and federal waters off RI	Ocean SAMP completed in 2011 (management ongoing)	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	http://seagrant.gso.uri.edu/oceansamp/documents.html

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NA	Present	Marine Minerals Use and Ocean Dredged Material Disposal	Dredging Disposal Sites - USACE Disposal Area Monitoring System - Nearest is Rhode Island Sound Disposal Site (RISDS), but there are nine active disposal sites managed by the USACE, New England District and 14 inactive/ infrequently used sites.	RI to ME	RISDS is located approximately 43 miles (69 km) northwest of the WDA	The RISDS was designated in December 2004. This 1 nautical mi^2 site is centered at 41° 13.854' North, 71° 22.819' West (NAD 83) and lies approximately 13 miles (21 km) south of the entrance to Narragansett Bay, RI. It is situated within the Separation Zone for the Narragansett Bay Inbound and Outbound Traffic Lanes and lies within a topographic depression, with water depths from 118 to 128 feet (36 to 39 meters)	Ongoing		X		X	X			X	X	X	X	X			X	X	X	X	http://seagrant.gso.uri.edu/oceansamp/documents.html
NA	Past	Marine Minerals Use and Ocean Dredged Material Disposal	USACE Navigation Projects	State waters offshore MA and RI	Within approximately 70 miles (112.5 km)	18 past projects in RI, and 50 past projects in MA. Navigation maintenance and improvement projects - varying locations offshore RI and MA.	18 projects in RI and 50 projects in MA listed as "past" projects on the USACE New England District Website	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	http://www.nae.usace.army.mil/Missions/Navigation/Massachusetts-Projects/
NA	Present	Marine Minerals Use and Ocean Dredged Material Disposal	BOEM Marine Minerals Program Projects - Active Negotiated Leases	Six active leases on the U.S. East Coast, located in FL (4), NJ (1), and SC (1)	Closest project is approximately 180 miles (289.5 km) southwest of the WDA	Active leases for sand mining for beach nourishment	Current through 2020				X	X			X	X	X					X				https://www.boem.gov/Requests-and-Active-Leases/
NA	Reasonably Foreseeable	Marine Minerals Use and Ocean Dredged Material Disposal	Marine Minerals Use and Ocean Dredged Material Disposal - Active Requests	BOEM is currently evaluating requests for minerals leasing in NC and VA. BOEM identified future resource needs in NY and NJ. BOEM is	Closest active request is located in VA.	Lease and mining of sand and gravel to address beach nourishment and shore protection	1-5 years				X	X			X	X	X					X				https://www.boem.gov/marine-minerals-program/

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				currently conducting offshore surveys to identify new sources of sand in federal waters offshore NY and NJ.																						
NA	Reasonably Foreseeable	Marine Minerals Use and Ocean Dredged Material Disposal	BOEM-Identified Future Sand Resources	Federal waters offshore the East Coast, from RI to FL	Closest site is approximately 55 miles (88.5 km) northwest of the WDA (between Block Island and Charlestown, RI).	Potential future sand resources have been identified through reconnaissance or OCS studies from RI to FL.	BOEM has identified sand resources in this category, but they have not been used.		X		X	X			X	X	X					X		X	X	https://www.boem.gov/Multiple-Uses-of-the-OCS/
NA	Present	Marine Transportation	Offshore vessel traffic	Offshore MA and RI, and to port cities	Overlaps with vessel routes, port cities, OECC, and WDA.	Vessel traffic in the area includes commercial and recreational boating traffic. Vessel traffic is described in detail in the Revised Navigational Risk Assessment (Revised July 18, 2018) (COP Appendix III-I; Epsilon 2018).	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NA	Reasonably Foreseeable	Marine Transportation	Davisville/ Brooklyn/ Newark Container-on-Barge Service	State waters offshore RI, NY and NJ	Approximately 50 miles (80.5 km) northwest of the WDA.	Twice a week, barge service will run between Newark, NJ, Brooklyn, NY, and the Port of Davisville, RI. Project has received funding from the Marine Administration (MARAD)	Grant awarded to Quonset Development Corporation August 2018	X	X		X	X	X	X	X	X	X	X	X			X	X	X	X	https://www.marad.dot.gov/newsroom/news_release/2018/maritime-administration-awards-4-8-million-in-grants-for-marine-highway-projects-throughout-the-u-s/
NA	Present	Military Use	Onshore and offshore military uses	Offshore MA and RI and vessel routes to port cities, as well as airspace over Project facilities	Airspace and offshore use areas overlap with Project facilities.	Offshore vessel traffic, onshore military bases, use of airspace. COP Section 7.9, Volume III (Epsilon 2018) describes military use of the area.	Ongoing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	http://www.aftteis.com/Portals/3/docs/newdocs/Final%20EIS/EIS%20Sections/4.0_AFTT_FEIS_Cumulative_Impacts.pdf

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5	Not Reasonably Foreseeable	Offshore Wind	Commercial Leases in MA Wind Energy Areas proposed lease areas OCS-A 0520, OCS-A 0521, and OCS-A 0522	Adjacent to the proposed Project to the southeast	OCS-A 502 is located adjacent to the Proposed Project's southeast boundary. OCS-A 503 is located approximately 14 miles (22.5 km) southeast of the proposed Project. BOEM has not announced the location of OCS-A 0522.	Offshore wind developments may include turbines, offshore substations, undersea cables, and onshore electrical facilities.	Leasee's have not submitted SAPs yet for these areas.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/Massachusetts/
4	Not Reasonably Foreseeable	Offshore Wind	Ocean Wind (NJ) - Lease OCS-A 0498	Approximately 12 nautical miles southeast of Strathmere, NJ and 18 nautical miles south of Atlantic City, NJ	Approximately 230 miles (370 km) southwest of the WDA	Potential offshore wind project. Cable routes not yet identified.	SAP approved, COP in progress				X	X			X	X	X					X				https://www.boem.gov/Site-Assessment-Plan-New-Jersey/
4	Not Reasonably Foreseeable	Offshore Wind	GSOE I, LLC (OCS-A 0482)	Approximately 18 miles (30 km) offshore Rehoboth Beach, DE	Approximately 270 miles (434.5 km) southwest of the WDA	Potential offshore wind farm. Cable routes not yet identified. SAP not yet approved.	Lease awarded 2012, updated 2018. SAP not submitted. No PPAs signed to date.				X	X			X	X	X					X				https://www.boem.gov/Delaware/
4	Not Reasonably Foreseeable	Offshore Wind	U.S. Wind (NJ) - Lease OCS-A 0499	Approximately 17 miles (27.3 km) off the coast from Ocean City, NJ	Approximately 210 miles (339 km) southwest of the WDA	Potential offshore wind farm. Cable routes not yet identified. SAP not yet approved.	Lease awarded 2016. SAP must be submitted no later than March 1, 2019.				X	X			X	X	X					X				https://www.boem.gov/Commercial-Wind-Leasing-Offshore-New-Jersey/

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4	Not Reasonably Foreseeable	Offshore Wind	Empire Wind (NY) - Lease OCS-A 0512	Approximately 18 miles (29 km) southeast of New York City	Approximately 141 miles (227 km) west-southwest from the WDA	Potential offshore wind facility that may include turbines, offshore substations, undersea cables, and onshore electrical facilities. Cable routes not yet identified.	Lease awarded in 2017. SAP submitted, not yet approved.				X	X			X	X	X					X				https://www.boem.gov/Lease-OCS-A-0512/
5	Not Reasonably Foreseeable	Offshore Wind	Virginia Electric and Power Company - Lease OCS-A 0483	Approximately 28 miles (45 km) offshore Virginia beach	Approximately 380 miles (611.5 km) southwest of WDA	Potential offshore wind facility that may include turbines, offshore substations, undersea cables, and onshore electrical facilities. Cable routes not yet identified.	Lease granted, no PPAs assigned to date.				X	X			X	X	X					X				https://www.boem.gov/Renewable-Energy-Program/Commercial-Lease-Offshore-VA/
NA	Not Reasonably Foreseeable	Offshore Wind	NY4 - Excelsior Wind Park	Approximately 28 nautical miles southeast from Roland Road Substation in NY	Approximately 140 miles (225.5 km) east-southeast of WDA	Unsolicited lease request to BOEM for potential offshore wind facility out of NY call area	Unsolicited lease submitted to BOEM in 2016. Schedule unknown.				X	X			X	X	X					X				https://www.boem.gov/Unsolicited-Lease-Request-Offshore-New-York/
NA	Present	Offshore Wind	Offshore OCS Wind Site Characterization Studies	Assumed to be ongoing for all existing leases	All existing BOEM wind lease areas	Geophysical, geotechnical/sub-bottom sampling, and biological surveys	Ongoing	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	See discussion in NY Revised EA/FONSI - https://www.boem.gov/NY-EA-FONSI-2016/
3	Not Reasonably Foreseeable	Offshore Wind	U.S. Wind (MD) - Lease OCS-A 0490	Approximately 17 miles (27.5 km) off the coast of Ocean City, MD	Approximately 290 miles (466.5 km) southwest of the WDA	250 MW, 32 WTGs. Potential 250 MW offshore wind project. Cable routes not yet identified.	Lease awarded 2014, amended 2018. SAP approved in 2018.				X	X			X	X	X					X				https://www.boem.gov/Maryland/
3	Not Reasonably Foreseeable	Offshore Wind	Skipjack Wind Farm (Deepwater) - Lease OCS-A 0519 (formerly OCS-A 0482)	Approximately 18 miles (29 km) offshore Bethany Beach, DE	Approximately 270 miles (434.5 km) southwest of the WDA	120 MW, 15 WTGs. Cable routes not yet identified. SAP not yet approved.	Lease awarded 2012, updated 2018. SAP not submitted. OREC awarded by State of Maryland.				X	X			X	X	X					X				https://www.boem.gov/Delaware/

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NA	Not Reasonably Foreseeable	Offshore Wind	New York Bight Call Area	Offshore New York	Approximately 65 miles (104.4 km) east of the WDA	Potential offshore wind lease areas	NY Master Plan calls for 2.4 gigawatts of offshore wind by 2030, and BOEM is currently evaluating four areas for possible lease in the NY Bight Call Area - Barnegat Bay, Hudson North, Great South Bay, East End.	X	X		X	X	X		X	X	X	X	X			X	X	X	X	https://www.boem.gov/BOEM-Atlantic-Coast-Renewable-Energy-Leases/
4	Not Reasonably Foreseeable	Offshore Wind	University of Maine - Aqua Ventus Project	Approximately 2 miles (3 km) offshore Monhegan Island in ME	Approximately 190 miles (306 km) northeast from the WDA	Proposed floating wind turbine demonstration Project. 12 MW, 2 WTGs with export cable. Maine Public Utilities Commission evaluating PPA.	Construction 2021, operations late 2021				X	X			X	X	X					X				http://maineaquaventus.com/index.php/frequently-asked-questions/
5	Not Reasonably Foreseeable	Offshore Wind	Avangrid Renewables - Kitty Hawk Offshore Wind Lease - Currituck County, NC - Lease OCS-A-0508	Currituck Sound – Approximately 32 miles (51.5 km) east of Kitty Hawk, NC	Approximately 380 miles (611.5 km) southwest of WDA	Description not yet available. Lease granted, no PPAs to date.	Project timeline not yet released				X	X			X	X	X									https://www.boem.gov/North-Carolina/
5	Not Reasonably Foreseeable	Offshore Wind	Areas in awarded leases that are not part of proposed Projects (such as OCS-A 0501) where development is not currently proposed, but offshore wind turbines could be installed in the future.	Offshore MA	Immediately adjacent to WDA	Proposed offshore wind development	Unknown	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/Currently-submitted-Atlantic-OCS-Region-Permits/

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NA	Past/Present	Offshore Wind	Block Island Wind Farm	Off the southeast coast of Block Island, RI	Approximately 50 miles (80.5 km) west of the WDA	30 MW offshore wind farm (5 turbines)	Commercial operation started December 2016		X		X	X			X	X	X	X	X			X	X	X	X	https://www.boem.gov/BITS_FONSI/
NA	Present	Offshore Wind	Offshore OCS Wind Site Assessment Activities/ SAPs	BOEM has approved SAPs for federal waters offshore Virginia, Rhode Island, Massachusetts, Maryland, and New Jersey.	OCS-A 0483 (VA), OCS-A 0486 (RI/MA), OCS-A 0490 (MD), OCS-A 0497 (VA), OCS-A 0498 (NJ), OCS-A 0500 (MA), OCS-A 0501 (MA)	Site Assessment activities include deployment of meteorological towers and/or, and site characterization surveys and studies (e.g., avian, marine mammal, and archeological assessments).	BOEM approved the first SAPs in 2017.	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/Commercial-Leasing-Process-Fact-Sheet/
1	Reasonably Foreseeable	Offshore Wind	Nautilus Wind Farm/Atlantic City Wind Farm (Also called Nautilus Offshore Wind Farm) (proposed by Fisherman's Energy of New Jersey, LLC and EDF Renewables)	Located in State waters 2.8 nautical miles off the coast of Atlantic City.	Approximately 220 miles (354 km) southwest of the WDA.	Fishermen's Energy of New Jersey has proposed the Atlantic City Wind Farm in a two-phase approach. The first phase would be in State waters 2.8 miles (4.5 km) off the coast of Atlantic City, and would consist of 3-4 WTGS with generation capacity of 24MW.	The first phase received nearly all permits and licenses in 2011 and 2012. Construction of the project has not yet commenced. NJ Governor Murphy signed a bill in May 2018 that requires the New Jersey Board of Public Utilities to reconsider an application for Offshore Renewable Energy Credits (ORECs) from the Fishermen's Energy Atlantic City offshore wind farm project and make a determination in 90 days. Construction may start in 2019, operations in 2020.				X	X			X	X	X					X				https://www.energy.gov/sites/prod/files/2016/01/f28/EA-1970-FEA-2015.pdf

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1	Reasonably Foreseeable	Offshore Wind	CVOW (Dominion Energy and Orsted) - Lease OCS-A 0497	Located in federal waters approximately 27 miles (43.5 km) off the coast of Virginia Beach	Approximately 360 miles (579.5 km) southwest of the WDA	Two 6-MW turbines (12 MW total)	Project approved by Virginia State Corporation Commission on November 2, 2018. Pending approval of revised Research Activities Plan, the two turbines are expected to be constructed in 2020 and in operation by 2022 and will lay the groundwork for potential large-scale development in a 112,800-acre (456.5- km^2) commercial wind site Dominion Energy has leased from BOEM. BOEM approved Research Activities Plan.				X	X			X	X	X					X				https://www.dominionenergy.com/library/domcom/media/about-us/making-energy/renewable-generation/wind-generation/cvow-petition-public-version.pdf?la=en
2	Reasonably Foreseeable	Offshore Wind	South Fork Wind Farm (Deepwater ONE, Deepwater Wind New England, LLC) - Lease OCS-A 0486	Located approximately 35 miles (56.5 km) east of Montauk Point, NY and 19 miles (30.5 km) southeast of Block Island	Located approximately 30 miles (48 km) west of the WDA.	90 MW, 15 WTGs. COP was submitted in June 2018. PPA signed with the Long Island Power Authority in 2017.	Construction tentatively in 2021, operations in 2022	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	http://dwwind.com/wp-content/uploads/2018/05/2018-03-09_SFWF_EPA-FINAL.pdf

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3	Not Reasonably Foreseeable	Offshore Wind	Bay State Wind Farm (Orsted) - Lease OCS-A 0500	Located approximately 14 miles (22.5 km) south of Martha's Vineyard	Directly adjacent to the northwest side of the WDA	110 WTGs. Two export cables landing in Somerset, MA with power going to Brayton Point. SAP approved, COP in development. No PPAs signed to date.	Construction in 2022 and operations in Q3 2023	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/RIMA-TF-Bay-StateWind-LLC-Presentation/
NA	Reasonably Foreseeable	Offshore Wind	Offshore OCS Wind Site Assessment Activities/ SAPs	SAP Approval is pending for one project in federal waters offshore NY (Empire Wind) on OCS-A 512	OCS-A 0512	Site Assessment activities include deployment of meteorological towers and/or buoys, and site characterization surveys and studies (e.g., avian, marine mammal, and archaeological assessments).	The SAP for OCS-A 0512 was submitted to BOEM in 2018 and BOEM has not yet approved it.				X	X			X	X	X					X				https://www.boem.gov/Lease-OCS-A-0512/
3	Not Reasonably Foreseeable	Offshore Wind	Revolution Wind Farm (Deepwater Wind) - OCS-A 0486	Approximately 15 miles (24 km) south of Rhode Island, approximately midway between Block Island and Martha's Vineyard	Approximately 20 miles (32 km) northwest of the WDA	600 MW Project - 400 MW PPA with the State of Rhode Island, 200 MW PPA for State of Connecticut. SAP Approved, COP in progress.	Unknown; SAP approved and COP in development; PPA signed with Rhode Island and Connecticut	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/Commercial-Wind-Lease-Rhode-Island-and-Massachusetts/
NA	Reasonably Foreseeable	Offshore Wind	Offshore OCS Wind Site Assessment Activities/ SAPs	Wind leases recently announced for OCS-A 0520, OCS-A 0521, and OCS-A 0522	OCS-A 502 is located adjacent to the Proposed Project's southeast boundary. OCS-A 503 is located approximately 14 miles (22.5 km) southeast of the proposed Project.	Site Assessment activities include deployment of meteorological towers and/or buoys, and site characterization surveys and studies (e.g., avian, marine mammal, and archaeological assessments).	Unknown	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/Commercial-Leasing-Process-Fact-Sheet/
NA	Reasonably Foreseeable	Offshore Wind	Connecticut State Pier Redevelopment	New London, CT	New London is a port under consideration staging and fabrication activities in support	The Connecticut Port Authority is currently evaluating proposals to develop, finance, and manage the Connecticut State Pier in	Unknown	X	X		X	X	X		X	X	X	X	X			X	X	X	X	https://ctportauthority.com/about-us/in-the-news/ https://ctportauthority.com/wp-content/uploads/2018/08/Connect

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					of the Proposed Action and for other proposed offshore wind activities.	part to support the offshore wind industry.																				icut-Maritime-Strategy-2018.pdf
NA	Past/ Reasonably Foreseeable	Offshore Wind	Rhode Island Port Improvements	Port of Providence, Port of Davisville at Quonset Point, and possibly other Rhode Island ports.	The Port of Providence and Quonset Point are ports under consideration staging and fabrication activities in support of the Proposed Action and for other proposed offshore wind activities.	Deepwater Wind committed to investing $40 million in improvements at Rhode Island ports to support the offshore wind industry. The Port of Davisville has already added equipment to enable participation in offshore wind projects.	Unknown	X	X		X	X	X		X	X	X	X	X			X	X	X	X	https://commerceri.com/wp-content/uploads/2018/04/POD_Insert_2017_rev1.pdf http://www.providencejournal.com/news/20180530/deepwater-wind-to-invest-250-million-in-rhode-island-to-build-utility-scale-offshore-wind-farm https://www.ri.gov/press/view/33345
NA	Present/ Reasonably Foreseeable	Offshore Wind	Brayton Point Power Plant Decommissioning and Redevelopment	Brayton Point, Somerset, MA	Brayton Point is a port under consideration staging and fabrication activities in support of the Proposed Action and for other proposed offshore wind activities.	Decommissioning of the Brayton Point Power Plant and redevelopment to support the offshore wind industry.	Unknown	X	X		X	X	X		X	X	X	X	X			X	X	X	X	https://www.masscec.com/brayton-point-power-plant-site http://www.southcoasttoday.com/news/20180626/vineyard-wind-likely-to-add-brayton-point-to-staging-locations http://www.heraldnews.com/news/20180517/brayton-point-chosen-for-wind-turbine-foundation-factory
NA	Past	Offshore Wind	New Bedford Marine Commerce Terminal	New Bedford, MA	The New Bedford Marine Commerce Terminal is a port under consideration staging and fabrication activities, and proposed to be used for operations and maintenance in support of the	29-acre facility developed specifically to support construction, assembly, and deployment of offshore wind projects. Future improvements are possible.	Improvements completed in 2015.	X	X		X	X	X		X	X	X	X	X			X	X	X	X	https://www.masscec.com/facilities/new-bedford-marine-commerce-terminal http://www.portofnewbedford.org/NBPA%20Draft%20Strategic%20Plan.pdf

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					Proposed Action and for other proposed offshore wind activities.																					
NA	Past/Present	Oil and Gas Activities	Existing LNG Terminals (5)	GDF Suez-Domac Import Terminal (Everett, MA) Neptune LNG Import Terminal (Offshore Boston, MA) Excelerate Energy - Northeast Gateway Import and Re-Export Terminal (Offshore Boston, MA) Dominion Cove Point LNG Import Terminal (Cove Point, MD) El Paso-Southern LNG Import Terminal (Elba Island, GA)	90-800 miles (145 km-1,287.5 km) from WDA	Natural gas export, natural gas supply to the interstate pipeline system or local distribution companies, or storage of LNG for periods of peak demand, or production of LNG for fuel and industrial use.	Existing facilities				X	X			X	X	X					X				https://www.ferc.gov/industries/gas/indus-act/lng.asp
NA	Present	Oil and Gas Activities	Approved LNG Terminals - Southern Company LNG Export Terminal	Elba Island, GA	840 miles (1,352 km) southwest	Approved LNG export terminal, currently in construction	Currently in construction, in-service estimated to be Q3 2019				X	X				X	X									https://www.lngworldnews.com/us-elba-island-lng-export-project-pushed-back/

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NA	Reasonably Foreseeable	Oil and Gas Activities	Geological and Geophysical Survey Permits (Oil and Gas Exploration)	Generally, U.S. East Coast from DE to FL	200-1, 200 miles (322-1,931 km) southeast of WDA	G&G surveys are conducted for hydrocarbon exploration and potential production, to locate and monitor marine mineral resources, to aid in locating sites for alternative energy structures and pipelines, to identify possible manmade, seafloor, or geological hazards, and to locate potential archeological and benthic resources. The following factsheet explains typical G&G survey process techniques: https://www.boem.gov/G-and-G-Survey-Techniques-Information-Sheet/.	BOEM is currently reviewing eight G&G permit applications that have been submitted between 2014 and 2018.				X	X			X	X	X					X				https://www.boem.gov/Currently-submitted-Atlantic-OCS-Region-Permits/
NA	Reasonably Foreseeable	Oil and Gas Activities	Proposed LNG Terminal - Eagle LNG Partners	Jacksonville, FL	960 miles (1,545 km) southwest	Proposed LNG export terminal, currently undergoing NEPA review in FL	Currently in FERC permitting. Construction schedule for 2018 pending FERC approval. Start-up/commissioning date is Q3 2019.				X	X				X	X									See also FERC Docket PF-15-7 https://www.eaglelng.com/projects/jacksonville-fl
NA	Present	Onshore Development	Onshore Development (Various Projects)	Coastal areas of MA and RI	14-50 miles (22.5-80.5 km) north, northeast, northwest of WDA	Coastal development projects permitted through MA regional planning commissions and towns. Includes residential, commercial, and industrial developments spurred by population growth in the region. Includes onshore solar, transmission, gas pipeline, and cell tower projects.	Ongoing	X	X	X	X	X	X					X	X	X	X	X	X	X	X	http://www.capecodcommission.org/index.php?id=501&maincatid=21

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NA	Present	Onshore Development	Onshore Wind Turbines (USGS Wind Turbine Database)	Regional (MA and RI)	Approximately 30-65 miles (48-104.5 km) from WDA	Onshore wind turbines, identified through the USGS Wind Turbine Database	Current Projects	X	X		X	X						X	X	X	X		X		X	https://eerscmap.usgs.gov/uswtdb/
NA	Present	Onshore Development	Communications Towers	Multiple communications towers located within the viewshed of proposed Project that may be viewed in conjunction with the WTGs	Within approximately 36 miles (58 km) of the WDA	Communications towers are tall facilities that may be viewed in context with the proposed WDA if they are located within the visibility zone. If communications towers are over 200 feet (61 meters), FAA lighting/marking is required. 39 communications towers were identified within the Recreation/ Tourism cumulative impact study area, seven of which exceed the FAA height limit for marking/lighting requirements.	Current developments	X	X		X	X						X	X	X	X		X		X	See GIS data for communications towers
NA	Present	Onshore Development (non-wind)	Cape Cod Five Hyannis Banking Center	Hyannis, MA	Approximately 0.35 mile (0.5 km) northwest of the onshore cable route (NA Variant 1) and 37 miles (59.5 km) north of the WDA	Proposed demolition of all existing buildings and structures, and subsequent construction of a 78,220-ft^2 (7,267-km^2) banking center and drive-up retail branch, parking garage, and associated site improvements.	Approved 2017 - Construction status unknown	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21

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NA	Present	Onshore Development (non-wind)	Cape Cod Mall Modification	Hyannis, MA	Approximately 0.5 mile (0.8 km) south of the onshore facilities (NA Variant 1).	Mayflower Cape Cod LLC has filed a request with the Cape Cod Commission to modify the 1998 Development of Regional Impact decision for the Cape Cod Mall. The Applicant proposes certain changes to the site and to the Mall building on the eastern portion of the Property; the proposed changes to the Mall building are within its existing footprint.	Approved 2018 - Construction status unknown	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Present	Onshore Development (non-wind)	Cape Cod Potato Chips Factory Expansion	Hyannis, MA	Immediately adjacent to the onshore facilities (NA Variant 1) and 37 miles (59.5 km) north of the WDA	Proposed redevelopment of the existing 5.63-acre (22,662.5-m^2) manufacturing facility site with the demolition of the existing 3,300-ft^2 (306.5-m^2) visitor tour area and office space, reconstruction of the visitor tour area and office space with a 10,930-ft^2 (1,015.5-m^2) addition, the relocation and expansion of the existing loading and warehouse spaces including a 10,050-ft^2 (933.5-m^2) addition, and associated site improvements including improved pedestrian connections from the existing parking areas to the visitor entrance and additional/revised landscaping.	Approved, but uncertain - http://www.capecodtimes.com/business/20180611/cape-cod-potato-chips-expansion-under-review	X	X	X	X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Present	Onshore Development (non-wind)	Cape Cod Training Center	Hyannis, MA	Approximately 240 feet (73 meters) south of the onshore facilities (NA	Proposed construction of an approximately 91,885-ft^2 (8536.5-m^2), two-story athletic field house containing an	Approved, construction status unknown	X	X	X	X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21

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					Variant 1) and 37 miles (59.5 km) north of the WDA.	indoor ice rink, indoor turf field, indoor swimming pool, locker rooms, batting cages, fitness, training and rehab areas, food and concessions, community meeting space, sports-related museum, accessory retail pro shop, office, and child care areas, together with ancillary site improvements on an approximately 8.29-acre (33,548.5-m^2), industrially-zoned undeveloped site.																				
NA	Present	Onshore Development (non-wind)	Chick-Fil-A	Hyannis, MA	Approximately 0.5 mile (0.8 km) south of the onshore facilities (NA Variant 1) and 37 miles (59.5 km) north of the WDA	The Project involves the construction and operation of an approximately 5,219±-ft^2 (484.5±-m^2) Chick-Fil-A drive-through restaurant on the 1.74 +/- acre (7041.5+/-m^2) Project Site	Approved, construction status unknown	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Present	Onshore Development (non-wind)	Hyannis Courtyard Marriott Expansion	Hyannis, MA	Approximately 0.65 mile (1 km) southeast of the onshore facilities (NA Variant 1) and 37 miles (59.5 km) north of the WDA	Proposal of an approximately 31,470-ft^2 (2,923.5-m^2), two-story addition to the existing hotel in the northeast corner of the 6-acre (24,281-m^2) Project Site. The addition will accommodate 50 new hotel guest rooms, though overall the Project will result in a net increase of 49 guest rooms, as one existing room will be eliminated to connect the proposed addition to the existing building. The proposal also involves the reconfiguration of the access/egress on the project	Proposed, not approved	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21

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						site's Iyannough Road frontage, changes to the front parking area, construction of new rows of parking to the rear (south) of the Project Site, and new landscaping, stormwater improvements, new pedestrian amenities, and other site improvements.																				
NA	Present	Onshore Development (non-wind)	Greenside Office Park	Hyannis, MA	Approximately 0.55 mile (0.88 km) northwest of the onshore facilities (NA Variant 1) and 37 miles (59.5 km) north of the WDA	The Applicant proposes to redevelop the project site with a professional office park consisting of two buildings (a 20,018- ft^2 [1,860-m^2] building and a 4,900-ft^2 [455-m^2] building) and related site improvements. The site is currently used and developed primarily for trucking and freight related purposes.	Proposed, not approved.	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Present	Onshore Development (non-wind)	Lakeside Commons	Hyannis, MA	Approximately 0.45 mile (0.7 km) northwest of the onshore facilities (NA Variant 1) and 37 miles (59.5 km) north of the WDA	The Applicant now proposes to construct a second office building, approximately 8,500 ft^2 (789.5 m^2) Gross Floor Area, on the 1575 Iyannough Road lot. It will share the existing site driveway and curb cut with 1555 Iyannough Road, but will be served by its own septic system, stormwater management system, landscaping and parking area. The Applicant would provide 27 on-site parking spaces for the new building, which is no more than the Barnstable Zoning ordinance requires.	Approved, 2017	X	X		X	X						X	X				X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21

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NA	Present	Onshore Development (non-wind)	Villages At Barnstable	Hyannis, MA	Immediately adjacent to the onshore facilities (substation and cable routes) and 37 miles (59.5 km) north of the WDA	The Project consists of up to 340 active adult and/or assisted living units, underground garaged and surface parking, and other on-site amenities.	Proposed, not approved	X	X	X	X	X						X	X	X			X		X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Present	Onshore Development (non-wind)	Chappy Wireless Antenna	Chappaquid-dick, Martha's Vineyard	Approximately 18 miles (29 km) north of the WDA	115-foot (35-meter) wireless cellular antenna proposed for Chappaquiddick	Anticipated to be constructed 2018 - 2019	X	X		X	X	X	X				X	X	X	X		X		X	http://www.mvtimes.com/2018/03/21/edgartown-planning-board-puts-att-hold/
NA	Reasonably Foreseeable	Onshore Development (non-wind)	Verizon Tower Height Extension	Tisbury, Martha's Vineyard	Approximately 23 miles (37 km) north of the WDA	Proposal to increase the height of the current tower from 77 feet (23.5 meters) above ground level to 130 feet (39.5 meters) above ground level	Currently under review with Martha's Vineyard Commission. Staff report released 8/23/18.	X	X		X	X	X	X				X	X	X	X		X		X	http://www.mvcommission.org/dri/summary/677/53072
NA	Reasonably Foreseeable	Onshore Development (non-wind)	OB Emergency Services Radio Tower	Oak Bluffs Landfill	Approximately 21 miles (34 km) north of the WDA	Proposal for 140-foot (430-meter) self-supported communications tower and associated facilities.	Currently under review with Martha's Vineyard Commission. Referral from Town of Oak Bluffs Planning Board received 7/20/18.	X	X		X	X	X	X				X	X	X	X		X		X	http://www.mvcommission.org/dri/summary/685/54301
NA	Present	Onshore Development (non-wind)	National Grid Diesel and Battery Storage Project on Nantucket	32 Bunker Road, Nantucket	Approximately 20 miles (32 km) north of the WDA	Proposal to install a diesel turbine and battery storage on the Island of Nantucket.	Approved by the Town of Nantucket and MassDEP. Construction anticipated 2019.	X			X	X						X	X		X				X	https://www.utilitydive.com/news/there-once-was-an-energy-storage-system-on-nantucket/513650/ https://eeaonline.eea.state.ma.us/EEA/FileService/FileService.Download/file/AQPermit/dgjdgdbe
NA	Present	Tidal Energy	Bourne Tidal Test Site	Cape Cod Canal, Bourne, MA	Approximately 42 miles (67.5 km) north of the WDA	Tidal energy turbine testing platform in the Cape Cod Canal and remote sensor testing facility.	Installed in late 2017, currently operating				X	X						X	X						X	https://www.mreconewengland.org/marine_renewable_energy/wp-content/uploads/2017/08/MRECo_Testing_Facilities_v2017.pdf

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NA	Present	Tidal Energy	Cobscook Bay Tidal Project	Cobscook Bay, ME	Approximately 300 miles (483 km) northeast of the WDA	FERC-licensed tidal project that began operations in 2012	Planned to be decommissioned in 2022 (end of current license)				X	X			X	X	X					X				https://marineenergy.biz/2017/05/31/orpc-not-to-pursue-cobscook-bay-tidal-license-renewal/
NA	Reasonably Foreseeable	Tidal Energy	Muskeget Channel Tidal Test Site. Edgartown - Nantucket Tidal Energy Power Plant Project	Muskeget Channel (between Martha's Vineyard and Nantucket)	Approximately 16 miles (25.5 km) north-northwest of the WDA, adjacent to OECC.	Proposed tidal energy project. Town of Edgartown had submitted but not completed a FERC pilot license application. Site assessment studies have been completed, but additional studies are needed to move forward into permitting.	Uncertain	X	X		X	X		X	X	X	X	X	X	X	X	X		X	X	https://vineyardgazette.com/news/2016/06/29/tidal-energy-project-gains-fresh-momentum
NA	Reasonably Foreseeable	Tidal Energy	Western Passage Tidal Energy Project	Near Eastport, ME	Approximately 300 miles (484 km) northeast of the WDA	FERC awarded preliminary permit in 2016. Preliminary permit authorizes companies to study projects but does not authorize construction.	FERC preliminary permit awarded 2016				X		X		X	X	X					X				https://marineenergy.biz/2016/07/13/orpc-gets-preliminary-permit-for-maine-tidal-project/
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Block Island Transmission Cable	6.2-mile (10-kilometer) cable from Block Island Wind Farm to Block Island, and 21.8 nautical miles from Block Island (Crescent Beach) to mainland (Scarborough State Beach) in Narragansett, RI	Approximately 50 miles (80.5 km) west of the WDA	Submarine power cable	Commercial operation started December 2016		X		X	X	X		X	X	X	X	X			X		X	X	https://www.boem.gov/BITS_FONSI/

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NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Harwich (Dennis Port) to Nantucket Electric Cable	Nantucket Sound	Approximately 13 miles (21 km) east of the OECC, in Nantucket Sound	Submarine power cable	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Hyannis to Nantucket Electric Cable	Nantucket Sound	Approximately 10.8 miles (17.5 km) east of the OECC, in Nantucket Sound.	Submarine power cable	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Falmouth (Mill Road) - West Chop (Main Street Landing Site)	Vineyard Sound	Approximately 10.5 miles (17 km) west of the OECC, in Vineyard Sound.	Submarine power cable	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	See discussion in Section C.1.3 in CEA: http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Falmouth - Vineyard Haven Electric Cable	Vineyard Sound	Approximately 10.8 miles (17.5 km) west of the OECC, in Vineyard Sound.	Submarine power cable	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	See discussion in Section C.1.3 in CEA: http://www.capecodcommission.org/index.php?id=501&maincatid=21
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Falmouth - Tisbury Electric Cable	Vineyard Sound	Approximately 10 miles (16 km) west of the OECC, in Vineyard Sound	Submarine power cable	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	See discussion in Section C.1.3 in CEA: http://www.capecodcommission.org/index.php?id=501&maincatid=21

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NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Neptune Pipeline	Boston to offshore MA	Approximately 80 miles (128.5 km) north of the WDA	Submarine pipeline to LNG port	Existing facilities								X	X	X					X				http://maps.massgis.state.ma.us/map_ol/moris.php
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Northeast Gateway LNG Pipeline	Boston to offshore MA	Approximately 80 miles (128.5 km) north of the WDA	Submarine pipeline to LNG port	Existing facilities				X	X			X	X	X					X				http://maps.massgis.state.ma.us/map_ol/moris.php
NA	Past	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Additional submarine cables, including fiber-optic cables and trans-Atlantic cables	U.S. East Coast. Near the Project area, offshore cables are concentrated near Charlestown RI, New York City, Long Island, and Trenton NJ.	All located outside the Project area	Submarine cables, fiber-optic cables, and trans-Atlantic cables	Existing facilities	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	See maps at Northeast Ocean Plan - www.northeastoceandata.org

Tier	Past/ Present/ Reasonably Foreseeable	Category	Name	Geography	Location in Relation to Project Facilities	Description	Anticipated Project Timeline	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds	Bats	Coastal Habitats	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals	Sea Turtles	Economics	Environmental Justice	Cultural, Historical, and Archeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Recreational Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses	Reference
NA	Reasonably Foreseeable	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Atlantic City Wind Farm (proposed by Fisherman's Energy of New Jersey, LLC) - Export Cable	33-kV AC submarine transmission cable (approximately 2.8 nautical miles)	Approximately 220 miles (354 km) southwest of the WDA	33-kV AC submarine transmission cable (approximately 2.8 nautical miles)	The first phase received nearly all permits and licenses in 2011 and 2012. Construction of the project has not yet commenced. NJ Governor Murphy signed a bill in May 2018 that requires the New Jersey Board of Public Utilities to reconsider an application for ORECs from the Fishermen's Energy Atlantic City offshore wind farm project and make a determination in 90 days.				X	X			X	X	X					X				https://www.energy.gov/sites/prod/files/2015/02/f20/EA-1970-DEA-Appendix_C-2015_0.pdf
NA	Reasonably Foreseeable	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	CVOW Export cable	Between approximately Camp Pendleton and the CVOW Project	Approximately 360 miles (579.5 km) southwest of the WDA	A 34-kV distribution line buried in the ocean floor that will run from turbines to a connection point near Camp Pendleton	Clearance for the offshore cable for UXO started in August 2018				X	X			X	X	X					X				https://www.dominionenergy.com/library/domcom/media/about-us/making-energy/renewable-generation/wind-generation/cvow-petition-public-version.pdf?la=en

Tier	Past/ Present/ Reasonably Foreseeable	Category	Name	Geography	Location in Relation to Project Facilities	Description	Anticipated Project Timeline	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds	Bats	Coastal Habitats	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals	Sea Turtles	Economics	Environmental Justice	Cultural, Historical, and Archeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Recreational Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses	Reference
NA	Reasonably Foreseeable	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	South Fork Export Cable	Approximately 98 km (61 miles) of offshore cable from the offshore substation to the sea-to-shore transition located in East Hampton at Beach Lane in the hamlet of Wainscott. Onshore segment of the cable will be approximately 6.5 km (4 miles)	Easternmost cable endpoint located approximately 35 miles (56 km) west of the WDA	61 miles (56.5 km) of offshore cable and 4 miles (6.5 km) of undersea cable, sea-to-shore transition equipment, and onshore substation.	Construction tentatively in 2021, operations in 2022		X		X	X			X	X	X	X	X			X	X	X	X	http://dwwind.com/wp-content/uploads/2018/05/2018-03-09_SFWF_EPA-FINAL.pdf
3	Reasonably Foreseeable	Undersea Transmission Lines, Gas Pipelines, and other Submarine Cables	Bay State Wind Farm Offshore Export Cable	From OCS-A 0500 to cable landing in Somerset, MA or Falmouth, MA.	The cable routes are proposed to be located on the west side of Martha's Vineyard, compared to the proposed Project cables, which are proposed to be located on the east side.	Cable route corridors have been identified between OCS-A 0500 and Brayton Point (via the Sakonnet River) and to Bourne (via a landfall site in Falmouth).	Construction anticipated in 2022 and operations in Q3 2023	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	https://www.boem.gov/RIMA-TF-Bay-StateWind-LLC-Presentation/

AC = alternating current; BOEM = Bureau of Ocean Energy Management; COP = Construction and Operations Plan; CVOW = Coastal Virginia Offshore Wind; FAA = Federal Aviation Administration; FERC = Federal Energy Regulatory Commission; ft^2 = square foot; G&G = Geological and Geophysical; km = kilometer; km^2 = square kilometer; kV = kilovolt; LNG = liquid natural gas; m^2 = square meter; NA = not applicable; NAD = North American Datum; NEPA = National Environmental Policy Act; MW = megawatt; OCS = outer continental shelf; OECC = Offshore Export Cable Corridor; OREC = offshore wind renewable energy credit; Q = Quarter; RISDS = Rhode Island Sound Disposal Site; SAMP = Special Area Management Plan; SAP = Site Assessment Plan; USACE = U.S. Army Corps of Engineers; USGS = United States Geological Survey; UXO = unexploded ordnance; WDA = wind development area; WTG = wind turbine generator

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C.1.14. References

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APPENDIX D

Mitigation and Monitoring

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APPENDIX D. MITIGATION AND MONITORING

As part of the proposed Vineyard Wind Offshore Wind Energy Project (Project), Vineyard Wind LLC would self-implement measures to avoid or reduce impacts (summarized in COP Table 4.2-1; Epsilon 2018) on the resources discussed in Chapter 3 of the Draft Environmental Impact Statement (Draft EIS). The Bureau of Ocean Energy Management (BOEM) may select alternatives and/or require additional mitigation measures to further protect these resources, and other mitigation measures may be required through reviews under several environmental statutes as discussed in Section 2.1 of the Draft EIS. Those additional mitigation measures presented in the table below may not all be within BOEM's statutory and regulatory authority to be required; however, they could potentially be imposed by other governmental entities. Table D-1 provides descriptions of mitigation measures BOEM has identified for analysis in the Draft EIS.

This appendix will be updated to include additional details related to mitigation and monitoring if it becomes available prior to publication of the Final EIS.

Table D-1: Mitigation Measures Analyzed

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Construction	Dust-control plans for onshore construction and laydown areas	Develop dust-control plans for onshore construction areas to minimize impacts from fugitive dust resulting from construction activities.	Air Quality (3.2.1)
Construction	Tree clearing time-of-year restriction	Require that trees (greater than 5 inches [15.2 centimeters] diameter at breast height) not be cleared from April 15 through October 31. This would help protect bats, birds, and other terrestrial wildlife.	Terrestrial and Coastal Fauna (3.3.1); Birds (3.3.2); Bats (3.3.3)
Construction	Covell's Beach Landfall time-of-year restrictions	Installation of export cable conduits would not be allowed to occur from April 1 to August 31 to avoid potentially nesting shore birds.	Birds (3.3.2)
Construction	Lewis Bay nearshore low-tide cable laying time-of-year restriction	Avoid nearshore cable laying during low tide between mid-July and mid-September to minimize disturbing terns.	Birds (3.3.2)
Construction	Bird deterrent devices	Install devices to minimize bird attraction to operating turbines, where appropriate.	Birds (3.3.2)
Construction	Landfall site construction method	Require use of horizontal directional drilling (HDD) at landfall transition sites.	Water Quality (3.2.2); Coastal Habitats (3.3.4); Benthic Resources (3.3.5); Finfish, Invertebrates, and Essential Fish Habitat (3.3.6);
Construction	Dredging methods	Require that all dredging and cable installation activities use the least environmentally harmful method that would be effective in each area.	Coastal Habitats (3.3.4)
Construction	Adaptive management	Reduce impacts on marine trust resources through near-term refinement of exclusion zones based on field measurements of noise reduction systems, and long-term refinements of other pile-driving monitoring protocols based on monthly and/or annual monitoring results.	Benthic Resources (3.3.5); Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Construction	Pile Driving	Use noise reduction technologies during all pile-driving activities to achieve a required minimum attenuation (reduction) of 6 decibel (dB) re 1 micropascal (μPa) to reduce noise impacts during construction.	Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction	Long-term passive acoustic monitoring (PAM)	Use fixed PAM buoys or autonomous PAM devices to continuously record ambient noise in the lease area (before, during, and immediately after construction), record marine mammal vocalizations, and monitor Project noise including vessel noise, pile driving, and WTG operation. Data collection, archival, analysis, and reporting of the results would be conducted by third parties following established guidelines specified by BOEM.	Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction	Sunrise and sunset prohibition on pile driving	Prohibit commencing pile driving from 1 hour before sunset until 1 hour after sunrise to ensure effective visual monitoring can be accomplished in all directions. However, ongoing pile driving may continue after 1 hour before sunset until completed.	Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction	Daily pre-construction surveys	PAM and visual surveys must be conducted each day before pile driving begins to establish the abundance, presence, behavior, and travel directions of protected species in the area. These surveys would follow standard protocols and data collection specified by BOEM.	Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction	Avoidance or additional investigations of submerged archaeological resources	Require avoidance or additional investigations of potential submerged archaeological resources: • Any *potential archaeological resource* (i.e., one or more geophysical survey anomalies or targets with the potential to be an archaeological resource) would be avoided. If avoidance is not possible, the anomaly or target would be assessed to determine whether it constitutes an identified archaeological resource. • Any *identified archaeological resource* would then be avoided. If avoidance is not possible, additional investigations would be performed to determine eligibility for listing in the National Register of Historic Places. • Any *archaeological resources determined eligible for listing on the National Register* (i.e., historic properties) would be avoided or additional mitigations would be required for resolving adverse effects pursuant to 36 CFR § 800.6.	Cultural, Historical, and Archaeological Resources (3.4.3)

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Construction	Avoidance or additional investigations of terrestrial archaeological resources or Traditional Cultural Properties (TCPs)	Require avoidance or additional investigations of terrestrial archaeological resources: • Any *identified archaeological resource or TCP* would be avoided; or, if it cannot be avoided, additional investigations would be performed to determine eligibility for listing in the National Register of Historic Places. • Any archaeological resources or TCPs determined eligible for listing on the National Register (i.e., historic properties) would be avoided or additional mitigations would be required for resolving adverse effects pursuant to 36 CFR § 800.6.	Cultural, Historical, and Archaeological Resources (3.4.3)
Construction	OECC installation to avoid navigation channel	If the New Hampshire Avenue cable landfall site is selected, require that the OECC within the federally designated Lewis Bay navigation channel be buried at a depth (to be determined by the USCG) sufficient to allow ongoing maintenance dredging or future increased channel depth. OR OECC construction using a route that avoids the federally designated Lewis Bay navigation channel altogether.	Recreation and Tourism (3.4.4); Land Use and Coastal Infrastructure (3.4.6)
Construction	Cable burial to avoid hangs	Require that cables be buried 6.5 feet (2 meters) at a minimum between the WDA and Muskeget Channel to help avoid trawl hangs. Where cable burial is not technically feasible due to bottom geology or topography, or due to the need to cross other infrastructure, concrete mattresses, or rock placement would be permissible to secure and protect cables.	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction	Disruption payment for fishing industry during construction	Prior to in-water construction, compensate fishermen with a demonstrated history of fishing in any area that would be excluded from fishing during the in-water construction phase of the Project. Compensation programs would be directly negotiated between the lessee and impacted fishermen or follow a compensation program similar to that described for the gear compensation program. Compensation could include direct payments to fishermen and/or could fund fishery directed projects (e.g., research; infrastructure improvements, seafood promotion, etc.).	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction	Dynamic Squid Fishing Avoidance Plan	Require daily communication plans between squid fishery representative and cable-laying vessel operator to mitigate the potential for reduced access to squid resources by the commercial fishery in the spring and summer.	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Construction	Automatic Identification System (AIS) on all Project Vessels	Install operational AIS on all vessels associated with the construction and operation of the project. AIS would be required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements.	Marine Mammals (3.3.7); Sea Turtles (3.3.8); Navigation and Vessel Traffic (3.4.7)
Construction, Operations, and Maintenance	Use of fuel efficient engines for marine vessels and equipment	Require the most efficient engine ratings available for equipment and marine vessels during all phases of the proposed Project to minimize air quality impacts from combustion sources.	Air Quality (3.2.1)
Construction, Operations, and Maintenance	Anchor buoys to reduce impact of anchor line sweep	Require all vessels deploying anchors to use, whenever feasible and safe, mid-line anchor buoys to reduce the amount of anchor chain or line that touches the seafloor.	Coastal Habitats (3.3.4); Benthic Resources (3.3.5)
Construction, Operations, and Maintenance	Ecological monitoring	Conduct long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations and other benthic areas disturbed by the proposed Project, including protected species movement and habitat use.	Benthic Resources (3.3.5); Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction, Operations, and Maintenance	Regional monitoring initiative for protected species	Centrally fund long-term regional monitoring of population level impacts.	Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)
Construction, Operations, and Maintenance	Covell's Beach horseshoe crab time-of-year restriction	If Covell's Beach is selected for cable landfall, avoid the horseshoe crab spawning season when conducting nearshore area work on the shoreline to protect adults staging to spawn as well as eggs, larvae, and newly settled juveniles. This time-of-year restriction period would be from May 1 to July 31.	Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction, Operations, and Maintenance	Lewis Bay horseshoe crab, shellfish, and winter flounder time-of-year restrictions	This measure would protect the spawning period, larval settlement, and juvenile development of winter flounder as well as adult horseshoe crabs staging to spawn. It would implement time-of-year restriction on all in-water work within Lewis Bay from January 15 to June 30. Additional time-of-year restrictions could be required to protect shellfish spawning and settlement within Lewis Bay. Combined shellfish time-of-year restrictions covering all identified species would extend the time-of-year restriction for the Lewis Bay portion of the Project to September 30 to protect bay scallops from the spawning through larval settlement phases.	Benthic Resources (3.3.5); Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction, Operations, and Maintenance	Local hiring plan	Require preparation and implementation of a Local Hiring Plan to ensure that Vineyard Wind LLC achieves or exceeds the estimated direct hiring of Southeastern Massachusetts residents (see the Base Case in COP Appendix III-L; Epsilon 2018). Components of the plan could include coordination with unions, training facilities, and schools.	Demographics, Employment, and Economics (3.4.1); Environmental Justice (3.4.2)

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Construction, Operations, and Maintenance	Fishing gear loss or damage compensation	Implement a financial compensation program for damage to or loss of fishing gear due to collision with proposed Project infrastructure within the WDA and along the export cable corridor. Actual and consequential damages could include some or all of the following: A. ACTUAL DAMAGES. The lesser of the gear's repair or reasonable replacement cost. B. RESULTING ECONOMIC LOSS. Some or all gross income lost because of not being able to fish, or having to reduce fishing effort, during the period before the damaged or lost fishing gear is repaired or replaced. This period must be reasonable and documented. C. ATTORNEY, CPA, AND CONSULTANT FEES. Reasonable fees paid to an attorney, CPA, or other consultant for the preparation of the claim. There would not be compensation for these fees if the claim is denied. D. CONSEQUENTIAL (OTHER) DAMAGES. Damage or loss, except personal injury, that was incurred as a consequence of the fishing gear damage or loss.	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction, Operations, and Maintenance	Regional monitoring initiative for fishery impacts	Contribute funds to a long-term regional environmental monitoring program as directed by BOEM. The regional collaborative monitoring program would monitor the long-term health of the offshore continental shelf environment within the Massachusetts Wind Energy Area. Funds toward the regional collaborative monitoring program would not exceed $500,000 per year for the duration of the project.	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Construction, Operations, and Maintenance	Vessel safety practices	All project vessels involved in construction, operations, maintenance, and decommissioning activities will comply with U.S. and/or SOLAS standards with regards to vessel construction, vessel safety equipment, and crewing practices	Navigation and Vessel Traffic (3.4.7)
Operations and Maintenance	Aircraft Detection Lighting System (ADLS)	Require use of ADLS, which would only activate the FAA hazard lighting when an aircraft is in the vicinity of the wind facility. This is intended to reduce the visibility of nighttime lighting and thus reduce nighttime visual impacts.	Cultural, Historical, and Archaeological Resources (3.4.3); Recreation and Tourism (3.4.4)
Operations and Maintenance	Annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear clean up around WTG foundations	Monitor indirect impacts associated with charter and recreational gear lost from expected increases in fishing around WTG foundations. Surveys would inform frequency and locations of debris removal to decrease ingestion by and entanglement of protected species.	Finfish, Invertebrates, and Essential Fish Habitat (3.3.6); Marine Mammals (3.3.7); Sea Turtles (3.3.8)

Proposed Project Phase	Mitigation Measure	Description	Resource Area Mitigated and Draft EIS Section Number
Operations and Maintenance	Long-term monitoring of cable placements	Perform remote survey of cable placements to confirm cables remain buried and that rock placement and concrete mattresses remain secured and undamaged. Survey would be conducted annually along all cable placements for the first 3 years and biennially thereafter, and remedial action would be required as necessary to re-secure cables. The lessee would provide BOEM with the inter-array and export cable monitoring reports within 45 calendar days following the inspections schedule for the benthic monitoring plan and after major storm events.	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)
Operations and Maintenance	Compensation for lost income due to offshore wind energy facility operations and maintenance	Implement a financial compensation program for documented loss of income due to inability of fishing vessels to access previously fished locations within the WDA and temporary loss of use during cable maintenance. Compensation would be restricted to demonstrated loss of net revenue due to inability to access fishery resources within the WDA. The compensation would be directly negotiated between the claimant and the lessee, and could include direct payments to fishermen and/or funding of fishery directed projects (e.g., research; infrastructure improvements)	Commercial Fisheries and For-Hire Recreational Fishing (3.4.5)

WDA = Wind Development Area; WTG = wind turbine generator

REFERENCES

Epsilon Associates, Inc. 2018. Draft Construction and Operations Plan. Vineyard Wind Project. October 22, 2018. Accessed November 4, 2018. Retrieved from: https://www.boem.gov/Vineyard-Wind/

APPENDIX E

Distribution List

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APPENDIX E. DISTRIBUTION LIST

Cooperating Federal Agencies

U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement
Cheri Hunter, Sterling, Virginia

U.S. Coast Guard
Ed LeBlanc, East Providence, Rhode Island

U.S. Army Corps of Engineers
Christine Jacek, Concord, Massachusetts

U.S. Environmental Protection Agency
Tim Timmermann, Boston, Massachusetts

National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Sue Tuxbury, Gloucester, Massachusetts

Narragansett Indian Tribe
Jon Brown, Charlestown, Rhode Island

Participating Federal Agencies

Federal Aviation Administration
Cindy Whitten, Kansas City, Missouri

National Park Service
Mary Krueger, Boston, Massachusetts

U.S. Fish and Wildlife Service
Tom Chapman, Concord, New Hampshire

Cooperating State Agencies

Massachusetts Coastal Zone Management
Bruce Carlisle, Boston, Massachusetts

Rhode Island Coastal Resource Management Council
Grover Fugate, Wakefield, Rhode Island

Rhode Island Department of Environmental Management
Janet Coit, Providence, Rhode Island

Tribes and Native Organizations

Connecticut
Mashantucket (Western) Pequot Tribal Nation
Mohegan Tribe of Indians of Connecticut

Massachusetts
Mashpee Wampanoag Tribe
Wampanoag Tribe of Gay Head (Aquinnah)

New York
Shinnecock Indian Nation

Rhode Island
Narraganset Indian Tribe

Libraries

Massachusetts
Aquinnah Public Library, Aquinnah
Boston Public Library, Boston
Chilmark Free Public Library, Chilmark
Edgartown Public Library, Edgartown
Hyannis Public Library, Hyannis
New Bedford Free Public Library, New Bedford
Oak Bluffs Public Library, Oak Bluffs
Nantucket Atheneum, Nantucket
Vineyard Haven Public Library, Vineyard Haven
West Tisbury Free Public Library, Vineyard Haven
Woods Hole Public Library, Woods Hole

Rhode Island
Maury Loontjens Memorial Library, Narragansett

Other Interested Parties

Martha’s Vineyard Commission, Oak Bluffs
Massachusetts Historic Commission
Town and County of Nantucket
Town of Barnstable
Town of Tisbury
Town of Yarmouth

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APPENDIX F

Supplemental Material

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APPENDIX F. SUPPLEMENTAL MATERIAL

F.1. DEMOGRAPHICS, EMPLOYMENT, AND ECONOMICS

Table F.1-1: Demographic Trends 2000–2016

Jurisdiction	Population 2000	Population 2010	Population 2016	Percent Change 2000–2016	2016 Percent of Population Under 18	2016 Percent of Population 18–64 Years	2016 Percent of Population 65 or Older	2016 Median Age
Commonwealth of Massachusetts	6,349,105	6,547,629	6,811,709	6.2	21%	64%	15%	
Barnstable County	222,230	215,888	214,703	-3.4	16%	56%	28%	51.8
Bristol County	534,678	548,285	558,324	3.8	21%	63%	16%	40.7
Dukes County	14,987	16,535	17,246	14.4	18%	61%	20%	46.5
Nantucket County	9,520	10,172	11,008	12.3	20%	66%	14%	39.1
State of Rhode Island	1,048,319	1,052,567	1,054,491	0.6	20%	64%	16%	
Providence County	621,602	626,667	631,344	1.6	21%	65%	14%	37.3
Washington County	123,546	126,979	126,319	2.2	18%	64%	18%	43.9
State of Connecticut	3,405,602	3,574,097	3,576,452	5.4	22%	63%	15%	
Fairfield County	882,567	916,829	944,177	6.7	24%	62%	14%	39.9
New London County	259,106	275,055	274,055	5.0	20%	64%	16%	40.9

Sources: U.S. Census Bureau 2012a, b and c; U.S. Census Bureau 2018a; Epsilon 2018

Table F.1-2: Demographic Data

Jurisdiction	Population (2017) [a]	Population Density (persons per mi^2) [a]	Per Capita Income (2016) [a]	Total Employment (2017) [a]	Unemployment Rate (2017) [a]
Commonwealth of Massachusetts	6,859,819	879.5	$38,069	3,521,482	3.7%
Barnstable County	213,444	542.1	$39,104	107,254	4.7%
Bristol County	561,483	1,015.2	$30,525	278,472	4.7%
Dukes County	17,325	167.8	$40,051	9,007	4.9%
Nantucket County	11,229	249.7	$46,009	6,810	4.4%
State of Rhode Island	1,059,639	1,025.0	$31,904	554,658	4.5%
Providence County	637,357	1,556.4	$27,809	308,436	4.8%
Washington County	126,150	383.2	$37,692	66,369	4.0%
State of Connecticut	3,588,184	741.0	$39,906	1,828,858	4.7%
Fairfield County	949,921	1,520.1	$51,719	463,484	4.5%
New London County	269,033	404.6	$35,531	133,191	4.5%

Source: Epsilon 2018

mi^2 = square miles

[a] According to COP Table 7.1-1, population estimates are from U.S. Census Bureau, Population Estimates Program, PEPV2017; per capita income is from U.S. Census Bureau, American Community Survey 5-Year Estimates (2016); total employment and unemployment rates are from the Quarterly Census of Employment and Wage Program of the Bureau of Labor Statistics, accessed July 2018 (Epsilon 2018).

Table F.1-3: Housing Data (2016)

Jurisdiction	Housing Units	Seasonal Vacant Units [a]	Vacant Units (Non-Seasonal)	Non-Seasonal Vacancy Rate	Median value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
Commonwealth of Massachusetts	2,836,658	124,003	153,766	5.7%	$341,000	$1,129
Barnstable County	161,632	61,142	6,139	6.1%	$367,300	$1,137
Bristol County	231,247	3,040	15,274	6.7%	$273,700	$829
Dukes County	17,536	10,585	817	11.8%	$656,000	$1,448
Nantucket County	11,844	7,205	803	17.3%	$966,600	$1,615
State of Rhode Island	462,657	17,643	34,774	7.8%	$238,200	$938
Providence County	263,549	1,363	24,727	9.4%	$209,800	$900
Washington County	62,854	10,537	2,764	5.3%	$315,100	$1,062
State of Connecticut	1,493,798	29,047	110,038	7.5%	$269,300	$1,094
Fairfield County	364,737	5,223	24,305	6.8%	$413,400	$1,385
New London County	121,426	4,985	10,271	8.8%	$241,500	$1,039

Source: U.S. Census Bureau 2018a

[a] "Seasonal units are those intended for occupancy only during certain seasons of the year and are found primarily in resort areas" (U.S. Census Bureau Undated).

Table F.1-4: Employment of Residents, By Industry (2016)

	Massachusetts					Rhode Island			Connecticut		
	Total	Barnstable County	Bristol County	Dukes County	Nantucket County	Total	Providence County	Washington County	Total	Fairfield County	New London County
Agriculture, forestry, fishing	0%	1%	1%	2%	2%	0%	0%	1%	0%	0%	1%
Construction	5%	9%	7%	14%	17%	5%	5%	6%	6%	6%	5%
Manufacturing	9%	4%	11%	4%	3%	11%	12%	9%	11%	8%	13%
Wholesale trade	2%	2%	3%	2%	2%	3%	3%	2%	3%	2%	2%
Retail trade	11%	14%	13%	11%	14%	12%	13%	10%	11%	11%	11%
Transportation, warehousing, utilities	4%	4%	4%	3%	4%	4%	4%	3%	4%	3%	4%
Information	2%	2%	2%	3%	2%	2%	2%	1%	2%	3%	1%
Finance, insurance, real estate	7%	6%	6%	9%	8%	7%	7%	6%	9%	12%	4%
Professional services	13%	12%	9%	12%	11%	10%	10%	10%	11%	16%	9%
Educational, health care, social assistance	28%	25%	27%	18%	18%	28%	28%	29%	26%	22%	25%
Arts, entertainment, recreation, accommodation, food services	9%	12%	9%	12%	11%	11%	10%	13%	9%	8%	16%
Other services, except public administration	4%	5%	4%	5%	5%	5%	5%	4%	5%	5%	3%
Public administration	4%	5%	4%	5%	4%	4%	4%	4%	4%	2%	5%
Total:	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: U.S. Census Bureau 2018b

Table F.1-5: At-Place Employment, By Industry (2016)

	Massachusetts					Rhode Island			Connecticut		
	Total	Barnstable County	Bristol County	Dukes County	Nantucket County	Total	Providence County	Washington County	Total	Fairfield County	New London County
Agriculture, forestry, fishing	< 0.1	0.1%	0.1%	< 0.1	< 0.1	< 0.1	< 0.1	0.1%	< 0.1	< 0.1	< 0.1
Mining, quarrying, oil and gas	< 0.1	< 0.1	< 0.1	0.0%	< 0.1	< 0.1	< 0.1	0.1%	0.1%	< 0.1	< 0.1
Utilities	0.4%	0.3%	0.3%	< 0.1	< 0.1	0.3%	0.4%	0.2%	0.5%	0.2%	1.2%
Construction	4.0%	7.1%	4.7%	13.2%	17.5%	4.1%	4.1%	3.8%	3.8%	3.1%	3.5%
Manufacturing	6.8%	2.6%	12.9%	1.8%	1.0%	9.2%	8.5%	17.2%	10.1%	7.7%	12.8%
Wholesale trade	4.4%	1.9%	7.3%	0.9%	0.4%	4.7%	4.6%	6.8%	4.8%	5.8%	2.4%
Retail trade	11.5%	20.7%	17.0%	20.0%	18.0%	11.3%	9.2%	15.6%	12.2%	11.8%	14.2%
Transportation and warehousing	2.6%	2.9%	3.2%	3.9%	3.2%	2.6%	2.3%	2.0%	2.8%	2.2%	3.3%
Information	3.5%	1.6%	1.4%	2.5%	1.9%	1.6%	1.6%	1.1%	2.5%	3.3%	1.6%
Finance and insurance	5.8%	3.0%	2.3%	4.0%	2.5%	6.3%	7.0%	2.3%	8.2%	10.9%	2.0%
Real estate	1.4%	1.9%	0.9%	2.9%	2.3%	1.2%	1.2%	0.9%	1.3%	1.7%	0.7%
Professional services	8.7%	6.4%	3.0%	4.1%	3.9%	5.5%	4.8%	3.7%	6.9%	9.2%	7.8%
Management	3.0%	1.1%	2.9%	< 0.1	< 0.1	2.4%	3.2%	1.5%	2.2%	3.4%	0.4%
Administrative, business support, waste management	6.2%	3.8%	4.5%	6.5%	9.4%	5.8%	6.0%	2.9%	5.6%	6.2%	1.9%
Educational services	6.7%	1.9%	2.4%	0.9%	1.9%	6.9%	8.7%	1.2%	5.0%	3.3%	2.9%
Health care and social assistance	19.8%	21.3%	21.0%	14.3%	10.9%	20.4%	22.2%	19.4%	18.6%	15.9%	16.3%
Arts, entertainment, and recreation	1.9%	2.5%	1.8%	6.6%	3.7%	2.5%	2.6%	3.3%	1.9%	2.6%	1.7%
Accommodation and food services	9.2%	15.5%	10.4%	12.7%	16.8%	11.1%	9.6%	14.1%	9.5%	8.2%	23.9%
Other services (ex. public admin)	3.9%	5.1%	3.8%	4.9%	5.7%	4.0%	3.9%	3.7%	4.0%	4.3%	3.5%
Industries not classified	<0.1%	0.1%	< 0.1	0.1%	0.1%	0.0%	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total for all sectors	100%	100.0%	100.0%	100.0%	100.0%	100%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: U.S. Census Bureau 2018b

Table F.1-6: Number of Establishments by Industry (2016)

	Massachusetts					Rhode Island			Connecticut		
	Total	Barnstable County	Bristol County	Dukes County	Nantucket County	Total	Providence County	Washington County	Total	Fairfield County	New London County
Agriculture, forestry, fishing	344	51	102	1	1	39	8	14	78	18	12
Mining, quarrying, oil and gas	74	6	5	0	1	15	7	6	73	11	5
Utilities	275	9	17	3	2	39	23	8	133	31	12
Construction	18,618	1,192	1,555	205	295	3,114	1,627	520	7,962	2,266	530
Manufacturing	6,528	189	630	22	15	1,370	884	147	4,070	812	171
Wholesale trade	7,679	191	607	15	7	1,337	739	147	4,219	1,317	171
Retail trade	24,345	1,498	2,147	201	154	3,776	2,015	524	12,590	3,391	1,041
Transportation and warehousing	3,874	138	369	33	16	696	435	77	1,678	480	104
Information	3,722	138	173	16	15	476	260	57	1,749	603	98
Finance and insurance	9,588	310	531	28	19	1,414	781	139	6,008	2,333	270
Real estate	7,161	357	436	73	60	1,094	617	143	3,238	1,098	198
Professional services	21,630	758	1,032	63	59	3,048	1,698	332	9,186	3,415	535
Management	1,277	25	74	1	2	207	152	11	717	274	21
Administrative, business support, waste management	10,827	682	704	86	120	1,764	915	270	5,320	1,861	314
Educational services	3,162	107	153	11	12	412	246	45	1,443	510	86
Health care and social assistance	19,054	802	1,434	57	33	3,289	1,957	388	10,993	3,004	797
Arts, entertainment, and recreation	3,395	244	222	43	26	553	224	131	1,719	613	134
Accommodation and food services	17,450	1,118	1,240	144	120	3,092	1,649	475	8,580	2,407	712
Other services (ex. public admin)	18,048	755	1,345	79	54	2,901	1,647	353	9,504	2,631	642
Industries not classified	580	26	23	6	3	49	24	7	156	59	12
Total for all sectors	177,631	8,596	12,799	1,087	1,014	28,685	15,908	3,794	89,416	27,134	5,865

Source: U.S. Census Bureau 2018b

Table F.1-7: Annual Payroll by Industry ($1,000) (2016)

	Massachusetts					Rhode Island			Connecticut		
	Total	**Barnstable County**	**Bristol County**	**Dukes County**	**Nantucket County**	**Total**	**Providence County**	**Washington County**	**Total**	**Fairfield County**	**New London County**
Agriculture, forestry, fishing	40,408	4,661	6,279	NA	NA	7,898	669	4,399	14,893	10,097	1,492
Mining, quarrying, oil and gas	79,600	NA	2,568	0	NA	9,938	6,473	3,177	62,439	2,913	1,018
Utilities	1,387,301	27,807	80,558	NA	NA	128,449	106,497	12,904	857,848	136,856	141,586
Construction	9,685,684	319,563	585,036	50,322	58,037	1,151,850	752,390	89,198	4,021,613	949,767	228,972
Manufacturing	15,640,974	129,146	1,740,600	7,152	2,666	2,273,430	1,156,369	464,688	11,374,908	2,668,412	1,081,868
Wholesale trade	12,360,548	86,113	1,117,134	2,591	1,819	1,460,378	891,056	238,144	6,071,401	2,674,366	167,793
Retail trade	10,964,299	487,540	915,677	52,778	48,021	1,448,304	734,369	205,967	5,550,869	1,708,315	422,999
Transportation and warehousing	4,066,006	96,521	294,003	9,735	8,161	451,279	238,973	29,660	1,950,929	553,480	130,115
Information	12,674,083	56,718	190,146	6,444	5,442	486,386	305,624	29,619	3,489,872	1,400,000	79,856
Finance and insurance	25,994,804	166,698	269,951	14,350	8,447	2,275,390	1,662,069	74,459	18,977,275	10,670,752	141,815
Real estate	3,132,918	65,117	73,441	10,943	11,351	251,026	152,924	15,716	1,140,093	532,606	29,800
Professional services	30,853,796	324,221	332,481	14,488	14,773	1,515,406	872,822	103,231	9,857,911	4,266,711	989,666
Management	11,975,614	50,176	474,500	NA	NA	867,072	717,141	64,794	4,550,539	2,578,797	29,545
Administrative, business support, waste management	9,858,768	148,376	332,819	25,755	40,837	937,588	620,907	59,739	3,635,512	1,556,611	68,279
Educational services	9,542,479	50,435	131,658	2,098	3,598	1,056,523	853,426	15,874	3,520,781	594,925	115,795
Health care and social assistance	32,968,746	806,994	1,870,454	51,463	32,219	3,999,837	2,885,745	331,280	13,685,070	3,610,921	770,224
Arts, entertainment, and recreation	2,208,871	74,102	75,663	18,665	17,597	311,633	187,908	39,906	762,814	370,559	57,554
Accommodation and food services	6,713,011	398,376	354,158	48,711	55,935	959,293	476,146	142,081	3,123,722	805,060	697,636
Other services (ex. public admin)	4,569,545	131,041	212,198	11,562	15,301	557,713	349,227	48,806	2,003,854	640,543	92,087
Industries not classified	29,745	1,891	828	399	229	1,442	562	175	6,304	2,931	1,105
Total for all sectors	204,747,200	3,429,556	9,060,152	329,705	330,788	20,150,835	12,971,297	1,973,817	94,658,647	35,734,622	5,249,205

Source: U.S. Census Bureau 2018b

NA = not available; withheld by the U.S. Census Bureau to avoid disclosing data for individual companies

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F.2. Environmental Justice

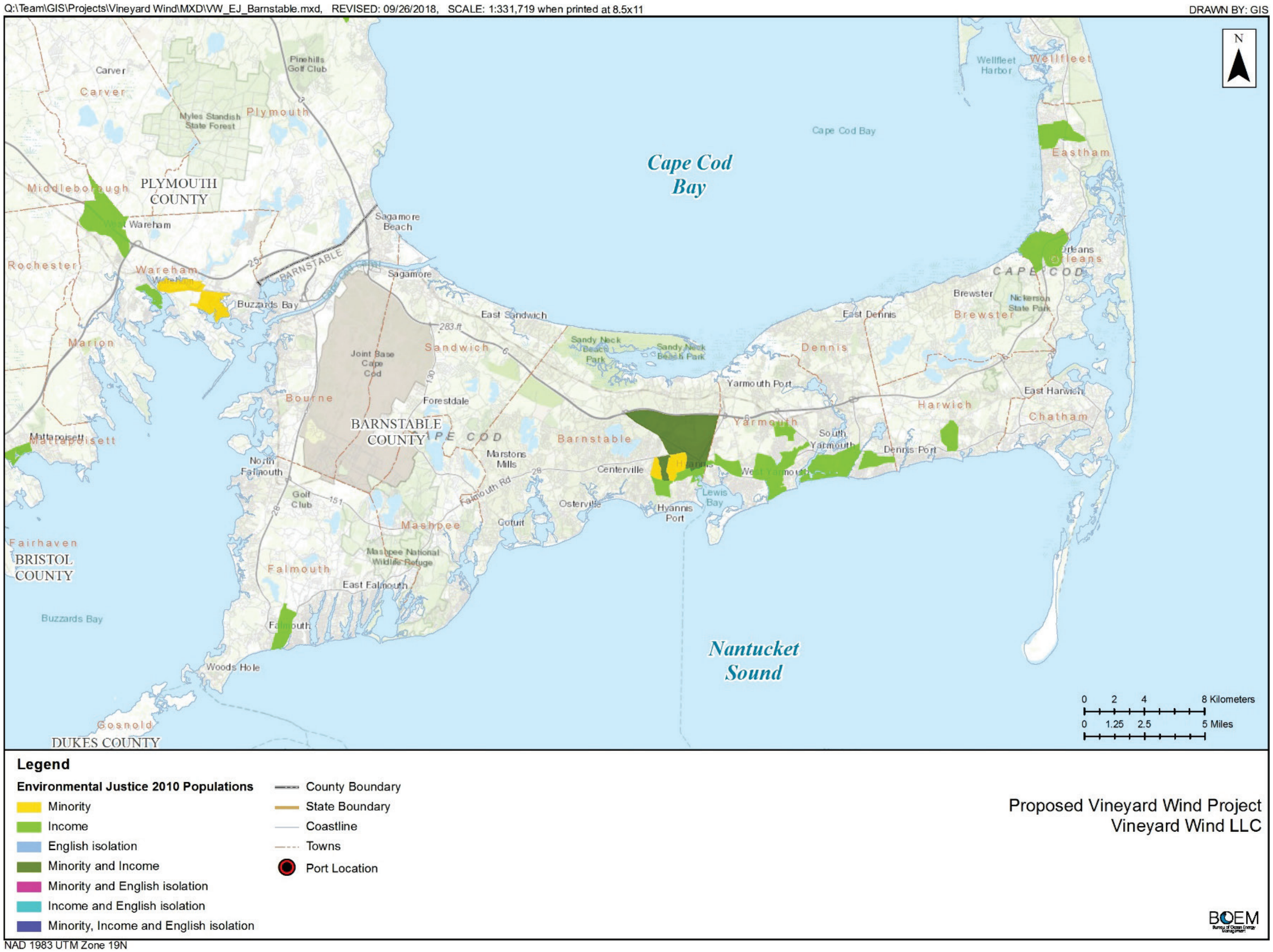

Figure F.2-1: Environmental Justice Populations in Barnstable County, Massachusetts (2010)

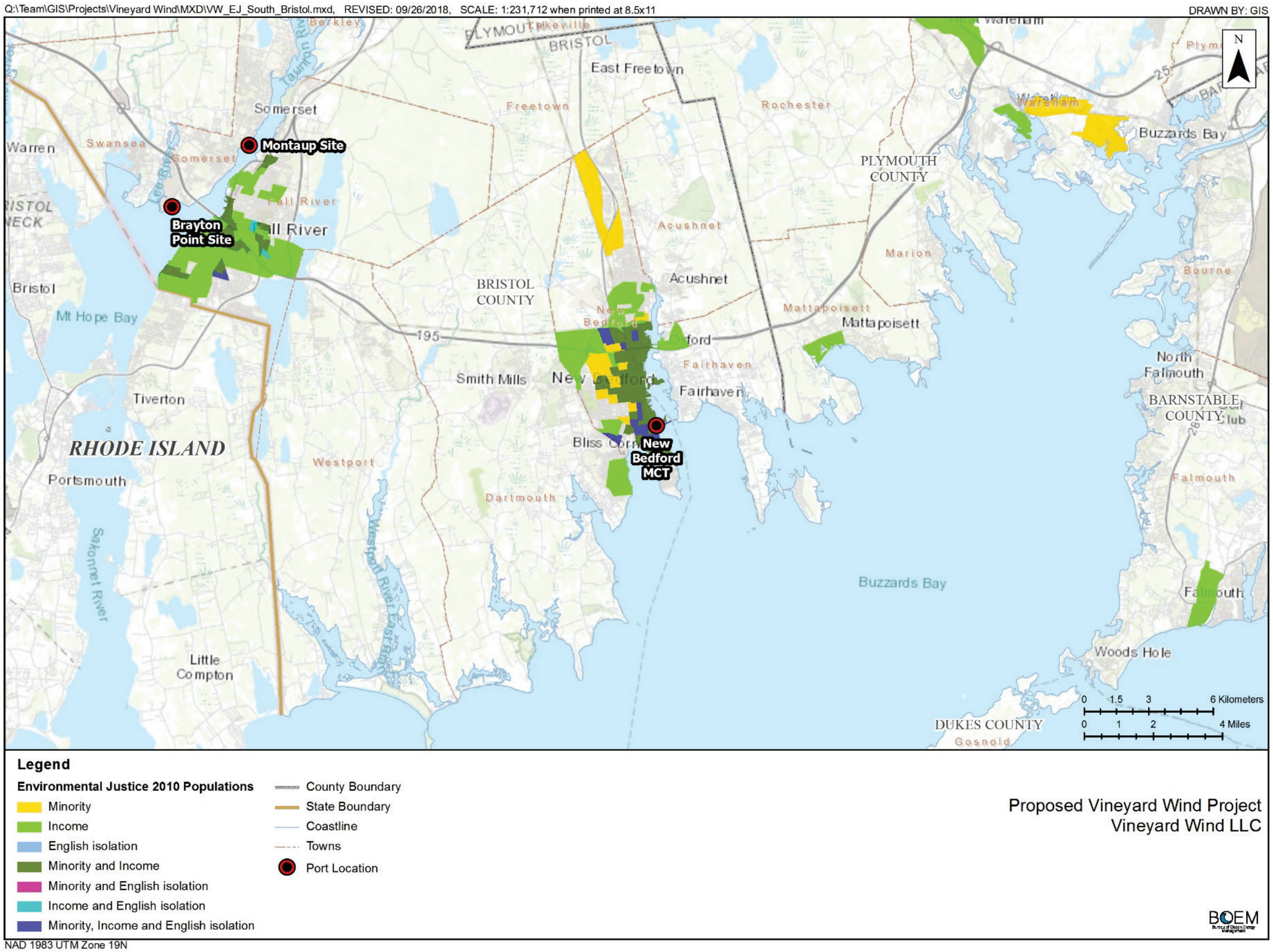

Figure F.2-2: Environmental Justice Populations in Southern Bristol County, Massachusetts (2010)

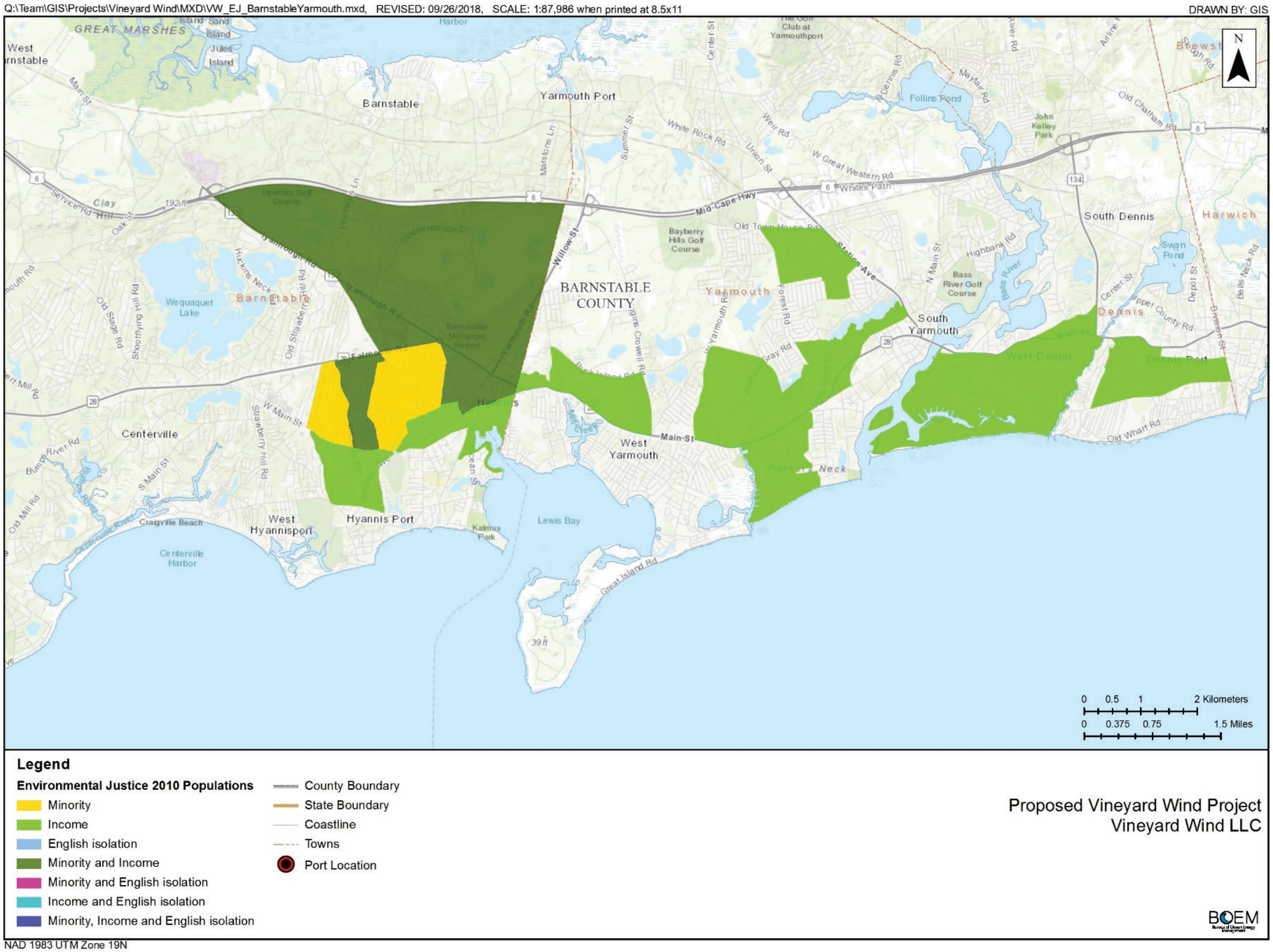

Figure F.2-3: Environmental Justice Populations in Barnstable and Yarmouth, Massachusetts (2010)

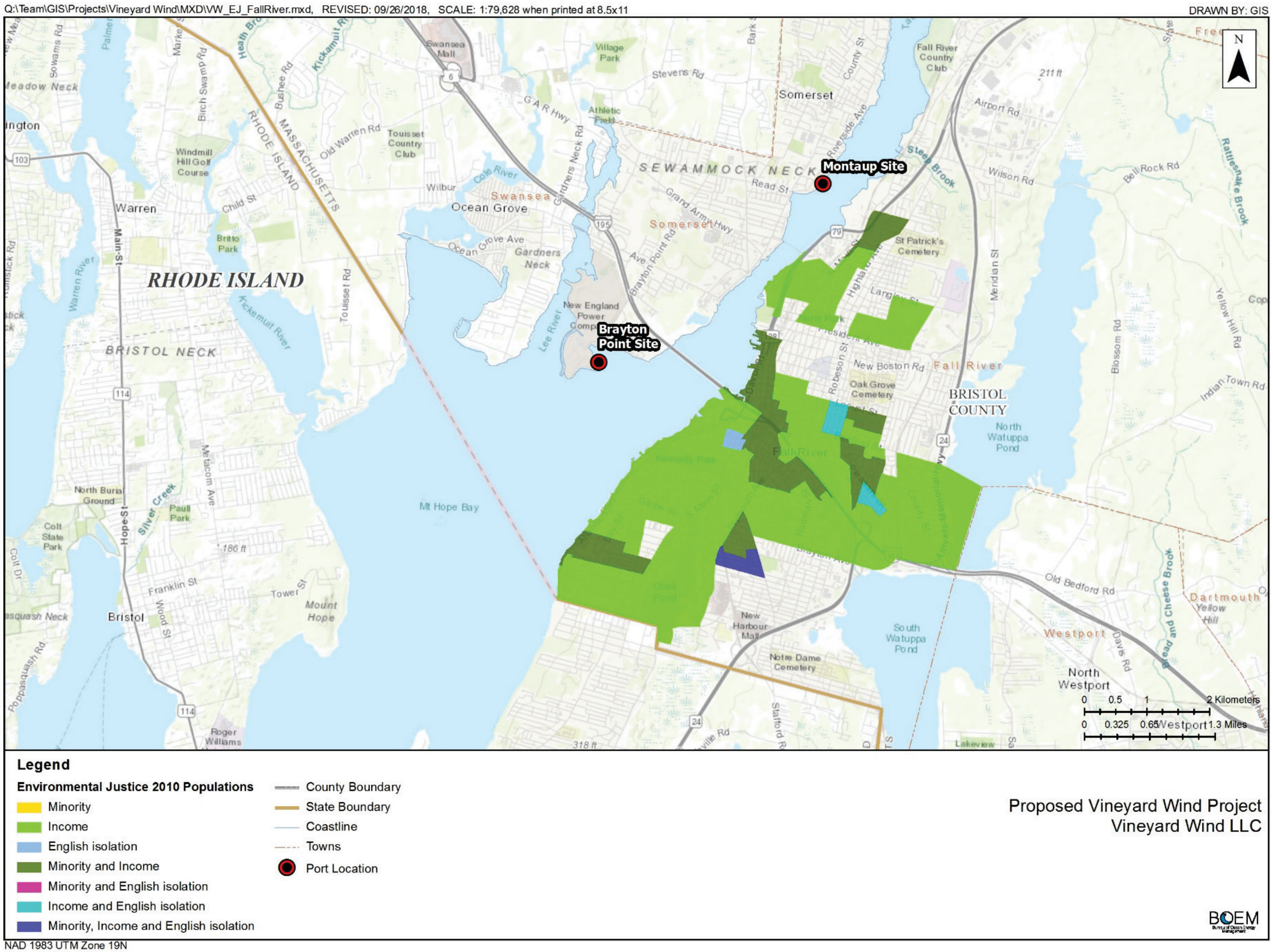

Figure F.2-4: Environmental Justice Populations in Fall River, Massachusetts (2010)

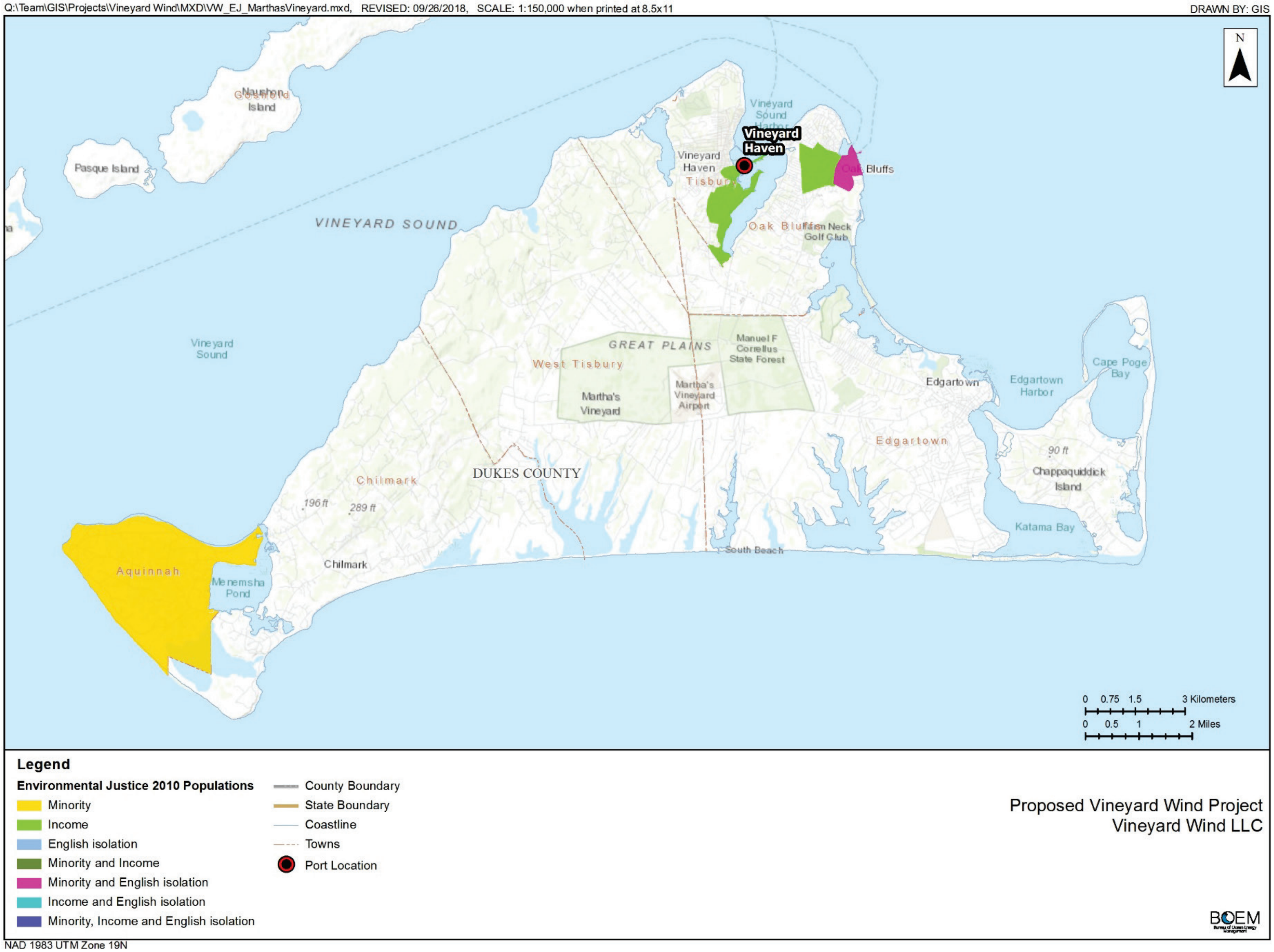

Figure F.2-5: Environmental Justice Populations in Martha's Vineyard, Massachusetts (2010)

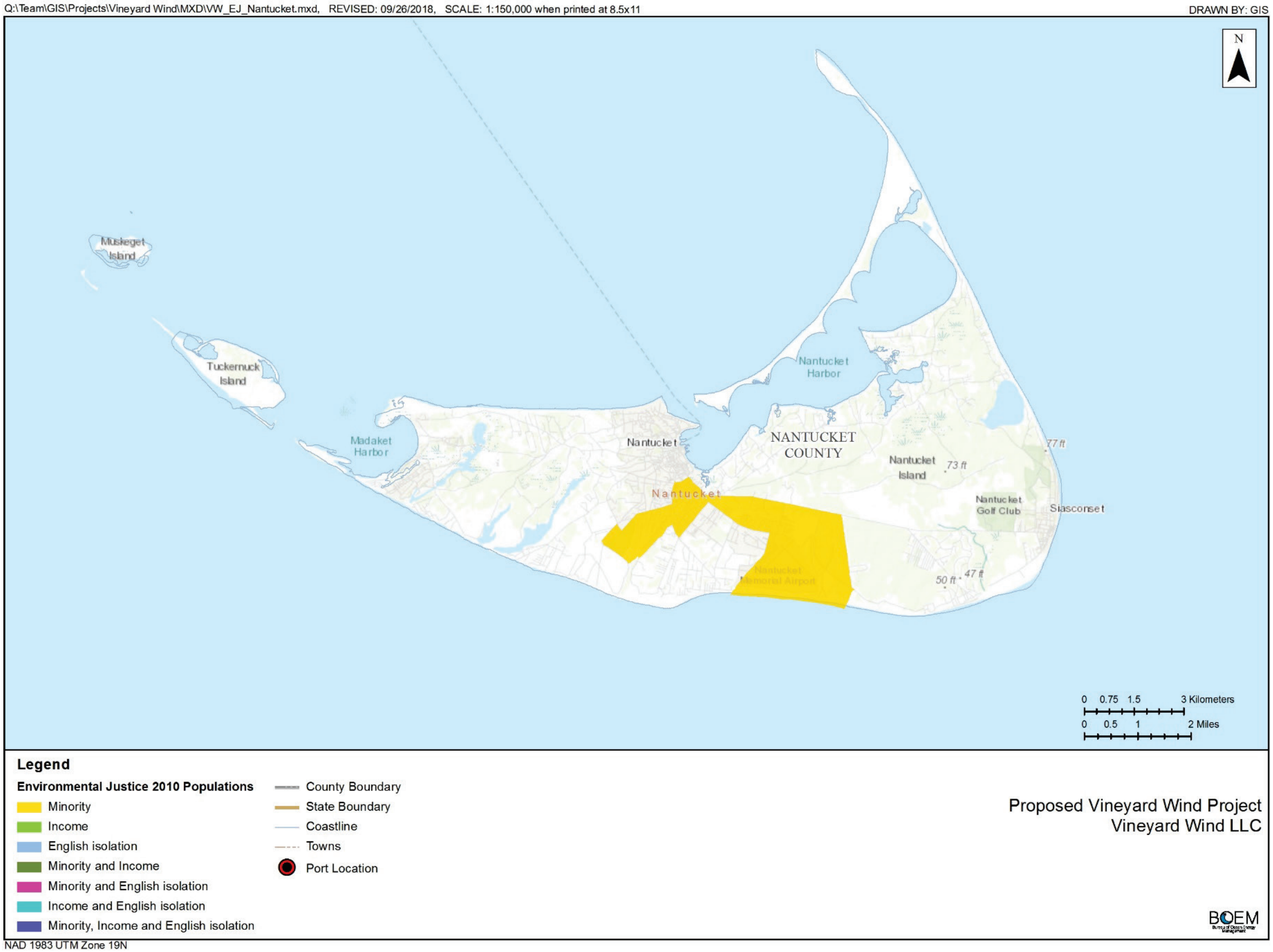

Figure F.2-6: Environmental Justice Populations in Nantucket, Massachusetts (2010)

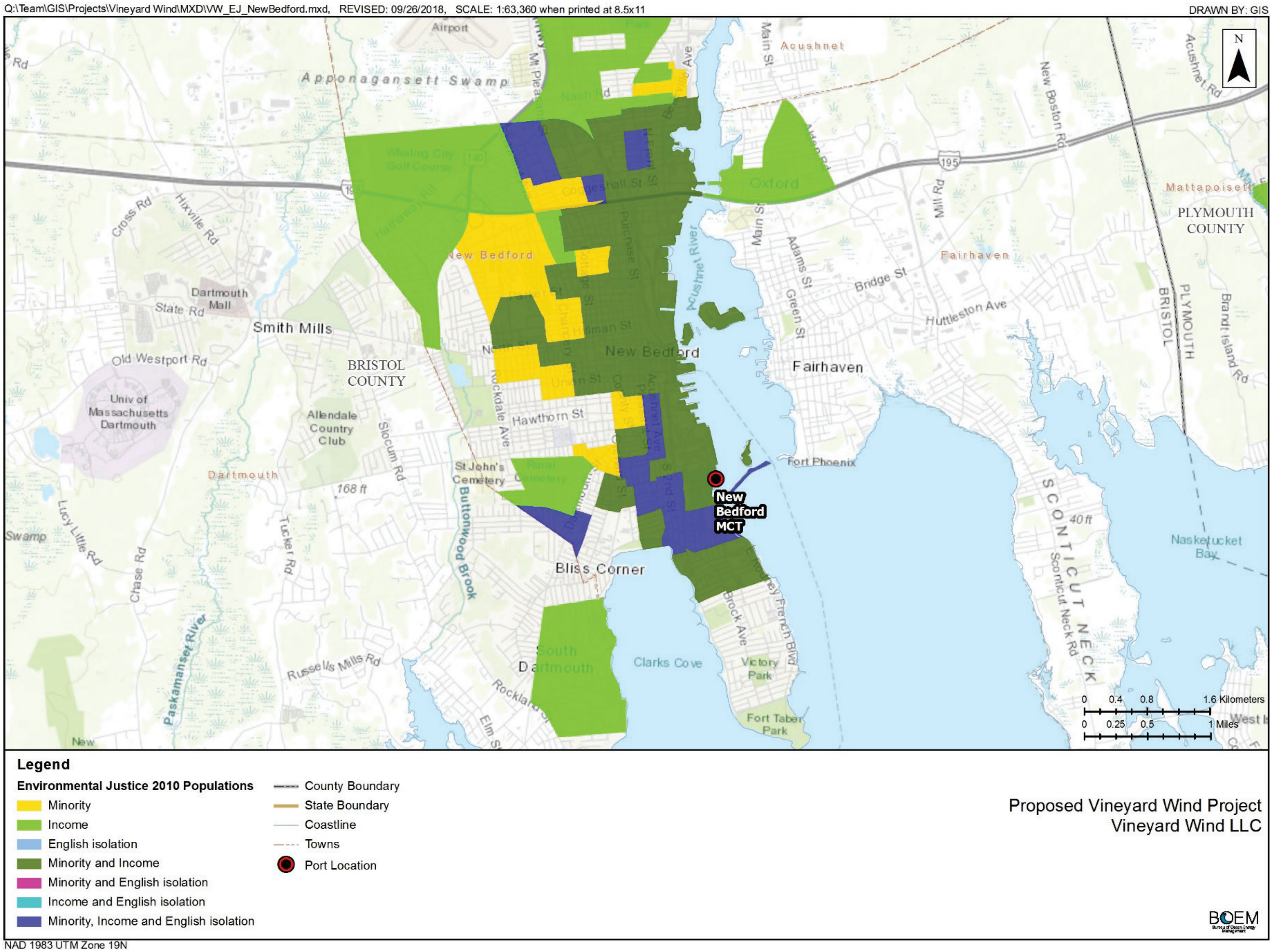

Figure F.2-7: Environmental Justice Populations in New Bedford, Massachusetts (2010)

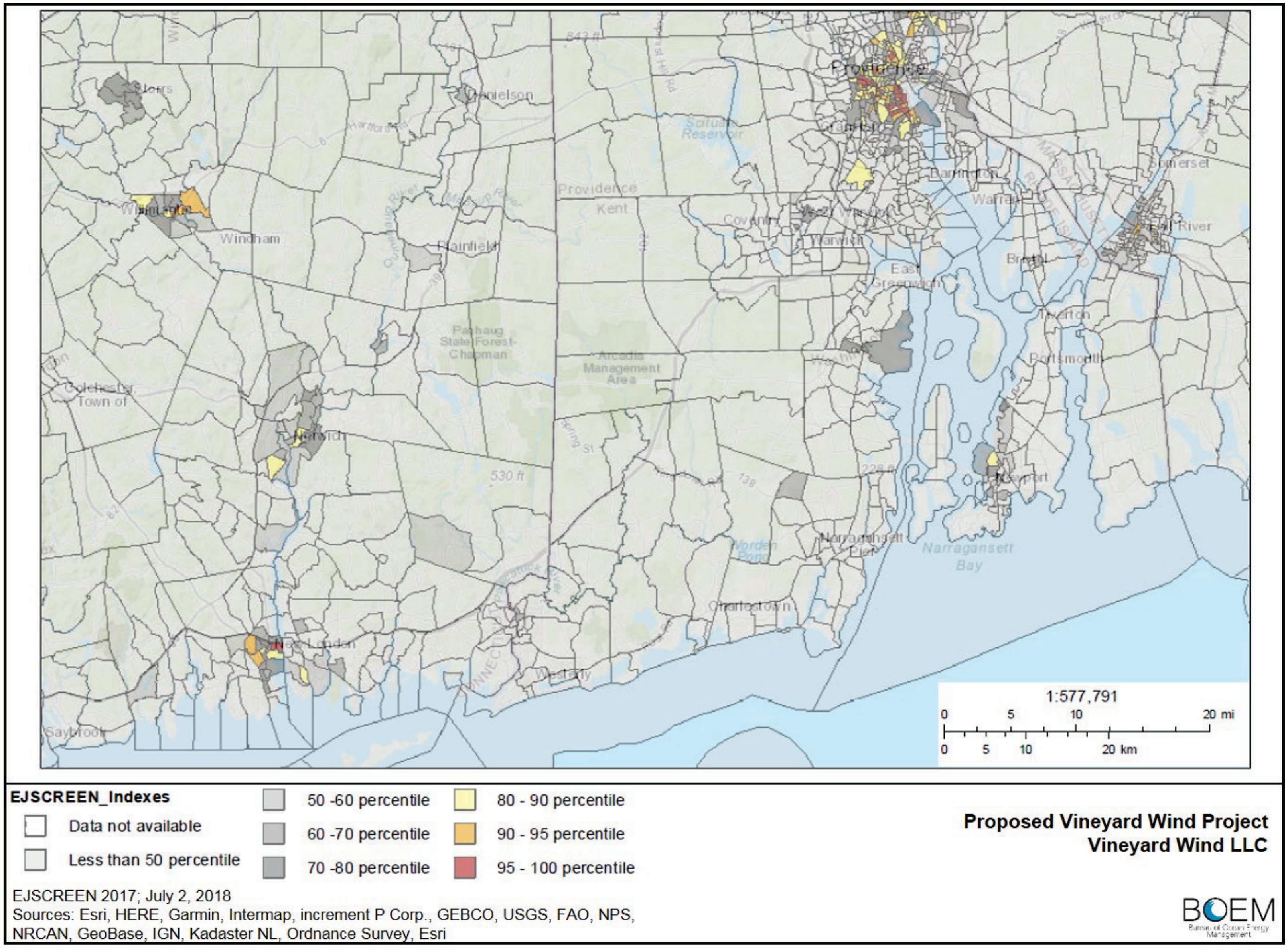

Figure F.2-8: Environmental Justice Populations in Rhode Island and Connecticut (2015)

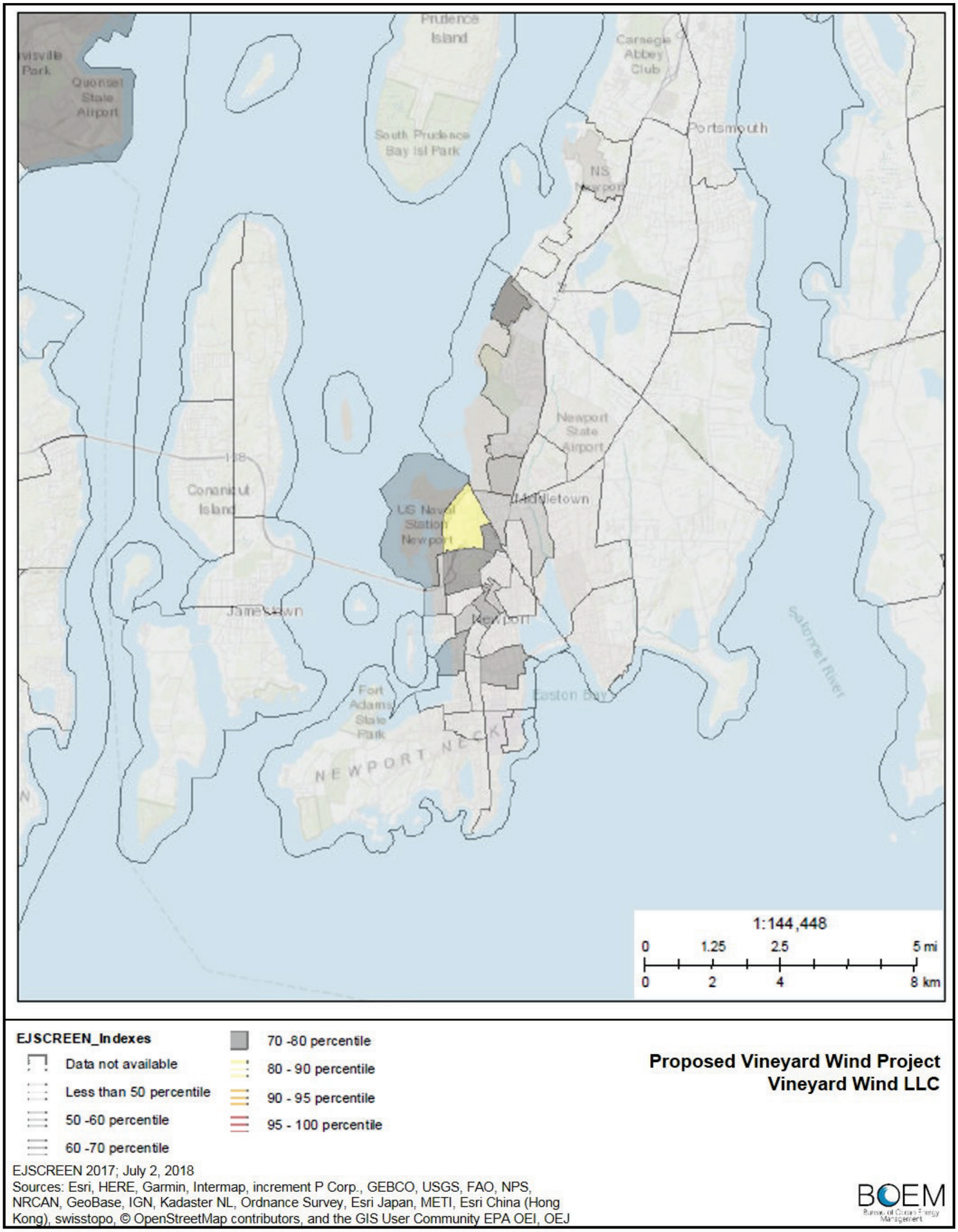

Figure F.2-9: Environmental Justice Populations in Newport, Rhode Island (2015)

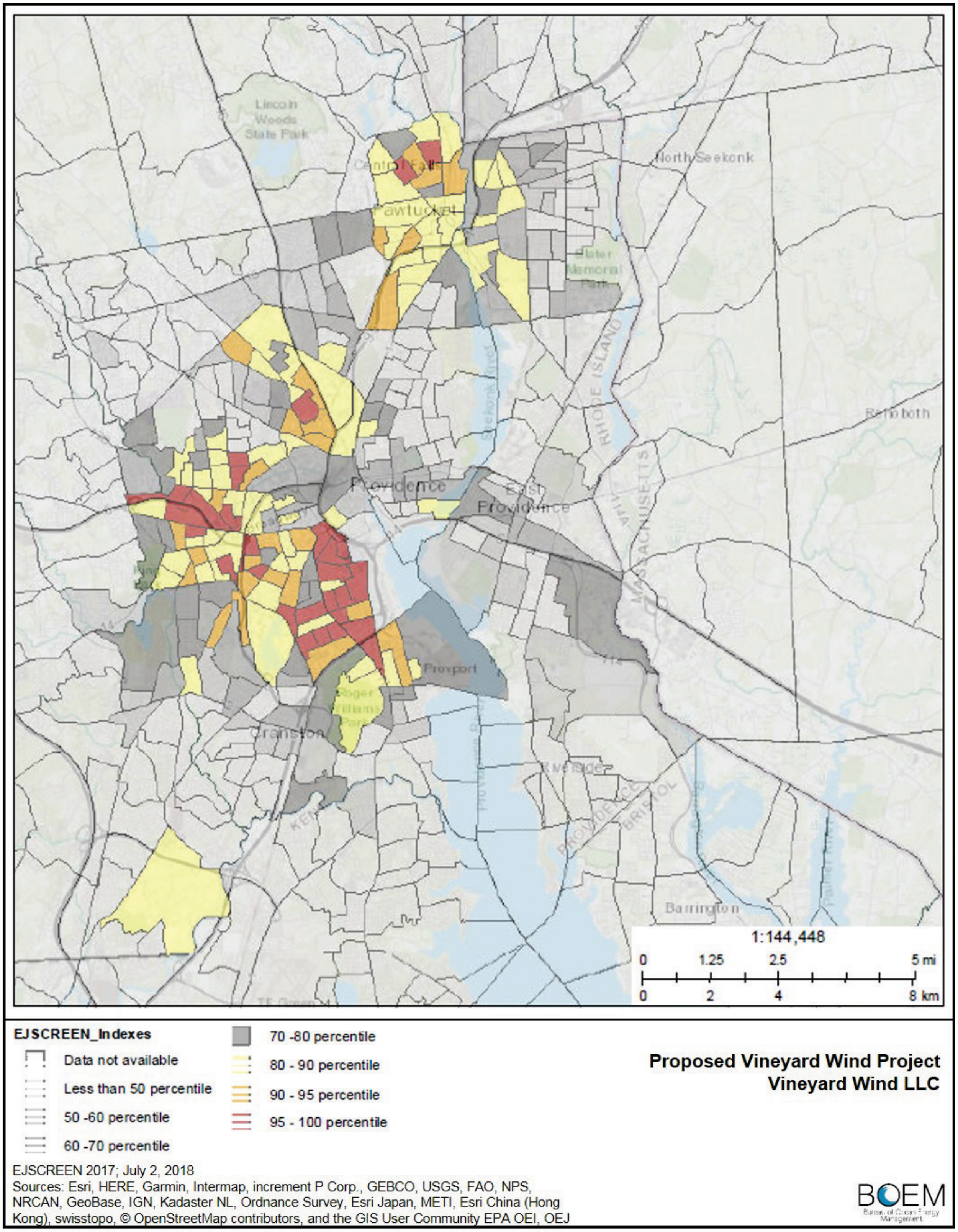

Figure F.2-10: Environmental Justice Populations in Providence, Rhode Island (2015)

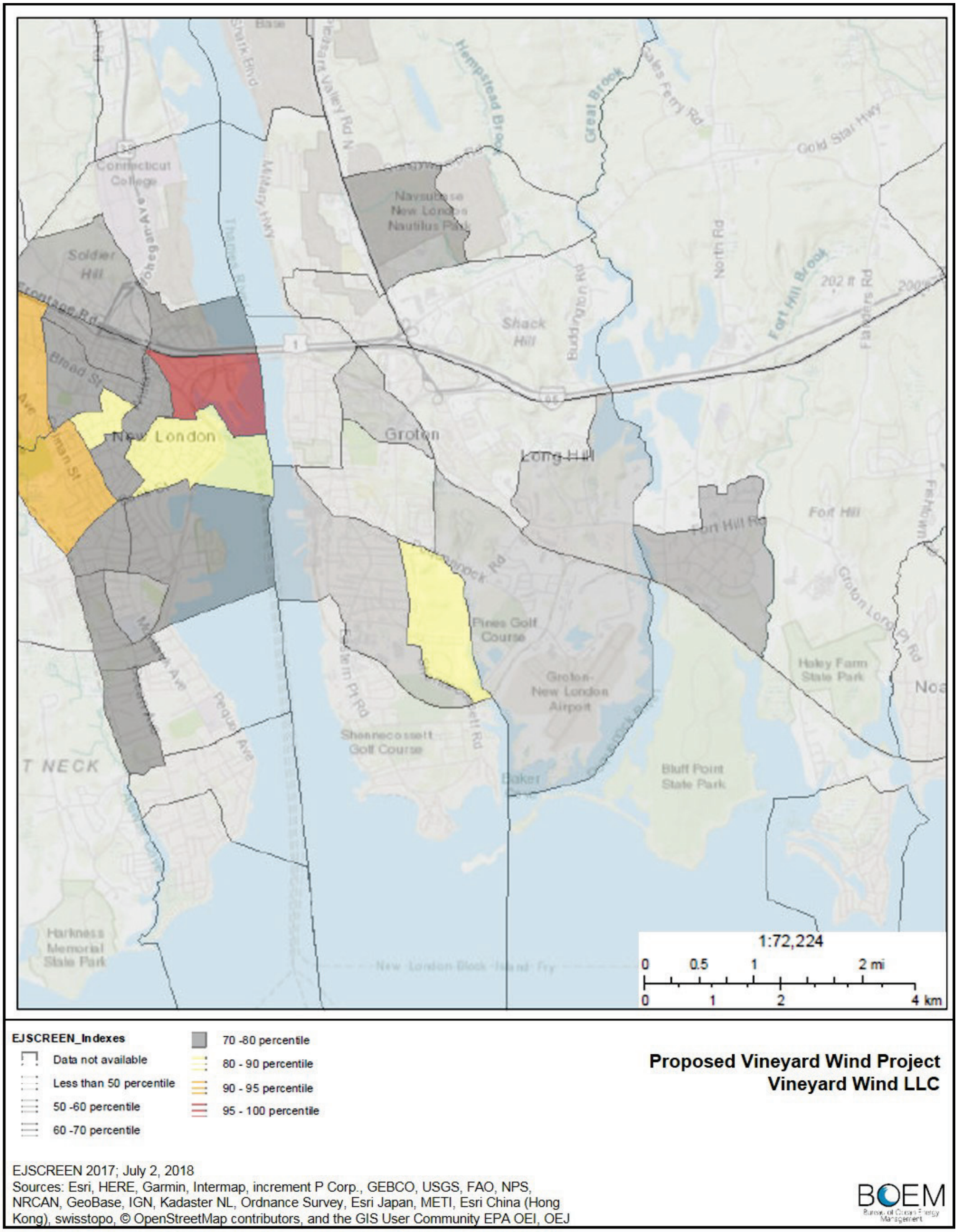

Figure F.2-11: Environmental Justice Populations in New London, Connecticut (2015)

F.3. References

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APPENDIX G

Project Design Envelope and Maximum-Case Scenario

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APPENDIX G. PROJECT DESIGN ENVELOPE AND MAXIMUM-CASE SCENARIO

Vineyard Wind LLC (Vineyard Wind) would implement a Project Design Envelope (PDE) concept. This concept allows Vineyard Wind to define and bracket proposed Project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility for selection and purchase of Project components such as wind turbine generators (WTGs), foundations, submarine cables, and offshore substations.[1]

The Bureau of ocean Energy Management's (BOEM) invited Vineyard Wind and other lessees to submit Construction and Operation Plans (COPs) using the PDE concept–providing sufficiently detailed information within a reasonable range of parameters to analyze a "maximum-case scenario" within those parameters for each affected environmental resource. BOEM identified and verified that the maximum-case scenario based on the PDE provided by Vineyard Wind, and analyzed in this Draft Environmental Impact Statement (EIS) could reasonably occur if approved. This approach is intended to provide flexibility for lessees and allow BOEM to analyze environmental impacts in a manner that minimizes the need for subsequent environmental and technical reviews. In addition, the PDE approach may enable BOEM to expedite review by beginning National Environmental Policy Act (NEPA) evaluations of COPs before a lessee has finalized all of its design decisions.

This Draft EIS assesses the impacts of the reasonable range of Project designs that are described in the Vineyard Wind COP by using the "maximum-case scenario" process. The maximum-case scenario analyzes the aspects of each design parameter that would result in the greatest impact for each physical, biological, and socioeconomic resource. This Draft EIS evaluates potential impacts of the Proposed Action and each alternative using the maximum-case scenario to assess the design parameters or combination of parameters for each environmental resource. This Draft EIS considers the interrelationship between aspects of the PDE rather than simply viewing each design parameter independently. For example, since Vineyard Wind is only proposing up to an 800-megawatts (MW) facility with turbines ranging from 8 to 10 MW, this Draft EIS does not analyze 100 10-MW turbines because this would result in a 1,000-MW project. This Draft EIS also analyzes the cumulative impacts of the maximum-case scenario alongside other reasonably foreseeable past, present, and future actions.

Certain resources may have multiple maximum-case scenarios, and the most impactful design parameters may not be the same for all resources. For example, larger (10 MW) WTGs could be more impactful for aviation (because they are taller), whereas smaller (8 MW) WTGs could be more impactful to cultural resources, visual resources, birds, and bats. This appendix presents a detailed table outlining the most impacting design parameter by resource area.

[1] Additional information and guidance related to the PDE concept can be found here: https://www.boem.gov/Draft-Design-Envelope-Guidance/.

Table G-1: Proposed Action Design Envelope Parameters

Capacity and Arrangement		
Wind Facility Capacity	Approximately 800 MW [a]	
Wind Turbine Generator Foundation Arrangement Envelope	Up to 100 monopiles	Up to 10 may be jacket foundations
Wind Turbine Generators	**Minimum Turbine Size**	**Maximum Turbine Size**
Turbine Generation Capacity	8 MW	10 MW
Number of Turbine Positions [b]	106	88
Number of Turbines Installed	100	80
Total Tip Height	627 ft (191 m) MLLW [c]	696 ft (212 m) MLLW [c]
Hub Height	358 ft (109 m) MLLW [c]	397 ft (121 m) MLLW [c]
Rotor Diameter	538 ft (164 m) MLLW [c]	591 ft (180 m) MLLW [c]
Tip Clearance	89 ft (27 m) MLLW [c]	102 ft (31 m) MLLW [c]
Platform Level/Interface Level Height for Monopile	62 ft (19 m) MLLW [c]	75 ft (23 m) MLLW [c]
Tower Diameter for WTG	20 ft (6 m)	28 ft (8.5 m)
Monopile Foundations	**Minimum Foundation Size**	**Maximum Foundation Size**
Diameter	25 ft (7.5 m)	34 ft (10.3 m)
Pile footprint	490 ft^2 (45.5 m^2)	908 ft^2 (84.3 m^2)
Height between Seabed and MLLW (water depth)	121 ft (37 m)	162 ft (49.5 m)
Penetration	66 ft (20 m)	148 ft (45 m)
Transition Piece Tower Diameter	20 ft (6 m)	28 ft (8.5 m)
Transition Piece Length	59 ft (18 m)	98 ft (30 m)
Platform Level/Interface Level Height	64 ft (19.5 m)	74 ft (22.5 m)
Number of Piles/Foundation	1	1
Number of Piles Driven/Day within 24 hours [d]	1	2
Typical Foundation Time to Pile Drive [e]	approximately 3 hours	approximately 3 hours
Hammer size	4,000 kJ	4,000 kJ
Jacket (Pin Piles) Foundation	**Minimum Foundation Size**	**Maximum Foundation Size**
Diameter for WTG and ESP	5 ft (1.5 m)	10 ft (3 m)
Jacket Structure Height for WTG	180 ft (55 m)	262 ft (80 m)
Jacket Structure Height for ESP	180 ft (55 m)	213 ft (65 m)
Platform Level/Interface Level Height for WTG and ESP	74 ft (22.5 m) MLLW	94 ft (28.5 m) MLLW
Pile Penetration for WTG	98 ft (30 m)	197 ft (60 m)
Pile Penetration for ESP	98 ft (30 m)	246 ft (75 m)
Pile Footprint for WTG	59 ft (18 m)	115 ft (35 m)
Pile Footprint for ESP	59 ft (18 m)	248 ft (45 m)
Number of Piles/Foundation	3 to 4	3 to 4
Number of Piles Driven/Day within 24 Hours [d]	1 (up to 4 pin piles)	1 (up to 4 pin piles)
Typical Foundation Time to Pile Drive [e]	approximately 3 hours	approximately 3 hours
Hammer Size	3,000 kJ	3,000 kJ
Scour Protection for Foundations	**Minimum**	**Maximum**
Scour Protection Area at Each Monopile WTG and ESP	up to 16,146 ft^2 (1,500 m^2)	up to 22,600 ft^2 (2,100 m^2)
Scour Protection Volume at Each Monopile WTG and ESP	up to 52,972 ft^3 (1,500 m^3)	up to 127,133 ft^3 (3,600 m^3)
Scour Protection Area at Each Jacket WTG	up to 13,993 ft^2 (1,300 m^2)	up to 19,375 ft^2 (1,800 m^2)
Scour Protection Volume at Each Jacket WTG	up to 45,909 ft^3 (1,300 m^3)	up to 91,818 ft^3 (2,600 m^3)
Scour Protection Area at Each Jacket ESP	up to 13,993 ft^2 (1,300 m^2)	up to 26,900 ft^2 (2,500 m^2)
Scour Protection Volume at Each Jacket ESP	up to 45,909 ft^3 (1,300 m^3)	up to 134,196 ft^3 (3,800 m^3)

Electrical Service Platform (ESP)		
Dimensions	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)
Number of Conventional ESPs	1 (800 MW)	2 (400 MW each)
Number of Transformers per ESP	1	2
Foundation Type	Monopile	Jacket
Number of Piles/Foundation	1	3 to 4
Maximum Height		218 ft (66.5 m) MLLW
Inter-Array Cable (66 kV)	**Minimum**	**Maximum**
Number of Foundations per Inter-Array Cable	6	10
Inter-Array Cable Length		171 mi (275 km)
Protection Method (rock placement, concrete mattresses, half-shell)		Up to 10% of route
Target Burial Depth	5 ft (1.5 m)	8 ft (2.5 m)
Export and Inter-Link Cable (220 kV)	**Minimum**	**Maximum**
Number of Export Cables within Corridor		2
Burial Depth	5 ft (1.5 m)	8 ft (2.5 m)
Maximum Length of Export Cable (assuming two cables)		98 mi (158 km)
Typical separation distance of Export Cable (assuming two cables)		328 ft (100 m)
Total Corridor Width for Export Cable (two cables) [f]	2,657 ft (810 m)	3,280 ft (1,000 m)
Protection Method (rock placement, concrete mattresses, half-shell)		Up to 10% of route
Maximum Length of Inter-Link Cable		6.2 mi (10 km)
Export Cables Dredging (width corridor per cable)		65.6 ft (20 m)
Export Cables Total Dredging Area		up to 69 acres (0.28 km^2)
Export Cables Total Dredging Volume		up to 214,500 cy (164,000 m^3)
Landfall and Onshore Components	**Option 1, Western Route**	**Option 2, Eastern Route**
Landfall Sites	Covell's Beach (Barnstable)	New Hampshire Avenue (Yarmouth)
Landfall Transition Method	HDD	HDD, Direct Bury via Open Cut
Length of Onshore Cable	5.4 mi (9 km)	6 mi (10 km)

cy = cubic yards; ESP = electrical service platform; ft = foot; ft2 = square feet; ft3 = cubic feet; HDD = horizontal directional drilling; kJ = kilojoule; km = kilometer; km2 = square kilometers; kV = kilovolt; m = meter; m2 = square meters; m3 = cubic meters; mi = mile; MLLW = mean lower low water; MW = megawatt; WTG = wind turbine generator

[a] Vineyard Wind's Proposed Action is for an approximately 800-MW offshore wind energy project. This Draft EIS evaluates the potential impacts of a facility up to 800 MW to ensure that it covers projects constructed with a smaller capacity.
[b] Additional WTG positions allow for spare turbine locations or additional capacity to account for environmental or engineering challenges.
[c] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.
[d] Work would not be performed concurrently. No drilling is anticipated; however, it may be required if a large boulder or refusal is met. If drilling is required, a rotary drilling unit would be mobilized or vibratory hammering would be used.
[e] Vineyard Wind has estimated that typical pile driving for a monopile is expected to take less than approximately 3 hours to achieve the target penetration depth, and that pile driving for the jacket foundation would take approximately 3 hours to achieve the target penetration depth. Different hammer sizes are used for installation of the monopile and jacket foundations.
[f] Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and would directly disturb an approximately 6.4-foot (2-meter) wide corridor.

Table G-2: Design Parameters Consistent for All Scenarios

Project Element	Description
Foundation Construction Method	Pile driving
Foundation and Wind Turbine Generator (WTG) Installation Vessel Type	Jack-up vessel, vessel on dynamic positioning with feeder barges
Electrical Service Platform Installation Vessel Type	Jack-up vessel, vessel on dynamic positioning with feeder barges, specialized crane vessel
Inter-array Cable Installation Method (includes a pre-lay grapnel run)	Jetting or jet plow but could use mechanical plow, mechanical trenching
Inter-array Cable Installation Vessel Type	Jack-up vessel, vessel on dynamic positioning with feeder barges
Export Cable Installation Method (includes a pre-lay grapnel run)	Jet plow, mechanical plow, mechanical trenching, dredging in some locations to achieve burial depth
Export Cable Installation Vessel Type	Anchored vessel, vessel on dynamic positioning with feeder barges
WTG Coloring	RAL 9010 Pure White or RAL 7035 Light Grey
Federal Aviation Administration (FAA) Obstruction Lighting	Two synchronized L-864 aviation red flashing obstruction lights—WTG nacelle; 30 flashes per minute will be used for air navigation lighting
FAA Obstruction Lighting Method	Aircraft Detection Lighting System that is activated automatically by approaching aircraft; system that automatically adjusts lighting intensity to accommodate visibility conditions
United States Coast Guard (USCG) Lighting	Two yellow flashing lights, each turbine approximately 20–23 meters above mean lower low water; will be visible at 2 and/or 5 nautical miles
Navigational Boating Warning Tools	Sound signals and automatic identification system transponders
Landfall Transition	Underground concrete transition vaults
Onshore Cable Construction Protection	Underground duct banks of polyvinyl chloride pipes encased in concrete

Table G-3: Project Design Envelope Maximum-Case Scenario per Resource

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Wind Facility Capacity [a]	800 MW	800 MW	NA	800 MW	NA	800 MW	800 MW	800 MW	800 MW	800 MW	800 MW	800 MW	NA	800 MW	800 MW
WTG Foundation Arrangement Envelope	NA	NA	NA	Evaluate both scenarios	NA	Evaluate both scenarios	Evaluate both scenarios	Evaluate both scenarios	NA	Evaluate both scenarios	NA	Evaluate both scenarios	NA	Evaluate both scenarios	NA
WTGs and Foundation															
Turbine Size	NA	8 MW due to more turbines	NA	8 MW due to more turbines	NA	NA	NA	8 MW due to more surface occupancy	8 MW due to more turbines	8 MW due to the more turbines	8 MW due to more turbines	8 MW due to more surface occupancy	NA	8 MW due to more potential for collision	10 MW due to total height
Number of Turbine Positions [b]	106 due to total number of trips required for construction	106 due to the total potential sediment disturbance, spills	NA	106 due to more potential for collision and more air space being occupied	NA	106 due to the total potential surface disturbance	106 due to more potential for loss of area and change of habitat	106 due to more potential for noise and loss of area	106	106 due to more potential effects on resources	106 due to more potential for loss of area and change of habitat	106 due to more potential for collision and loss of area	NA	106 due to more potential for collision/ allisions	106 due to total number potential hazards
Number of Turbines Installed	100	100	NA	100	NA	100	100	100	100	100	100	100	NA	100	100
Tip Height [c]	NA	NA	NA	627 ft (191 m) MLLW	NA	NA	NA	NA	696 ft (212 m) MLLW	627 ft (191 m) MLLW	696 ft (212 m) MLLW	627 ft (191 m) MLLW	NA	627 ft (191 m) MLLW	696 ft (212 m) MLLW
Hub Height [c]	NA	NA	NA	358 ft (109 m) MLLW	NA	NA	NA	NA	397 ft (121 m) MLLW	358 ft (109 m) MLLW	397 ft (121 m) MLLW	358 ft (109 m) MLLW	NA	358 ft (109 m) MLLW	397 ft (121 m) MLLW
Rotor Diameter [c]	NA	NA	NA	538 ft (164 m) MLLW	NA	NA	NA	NA	591 ft (180 m) MLLW	538 ft (164 m) MLLW	591 ft (180 m) MLLW	538 ft (164 m) MLLW	NA	538 ft (164 m) MLLW	591 ft (180 m) MLLW [c]
Tip Clearance [c]	NA	NA	NA	89 ft (27 m) MLLW	NA	NA	NA	NA	102 ft (31 m) MLLW	89 ft (27 m) MLLW	102 ft (31 m) MLLW	89 ft (27 m) MLLW	NA	89 ft (27 m) MLLW	102 ft (31 m) MLLW
Platform Level/ Interface Level Height for Monopile [c]	NA	NA	NA	62 ft (19 m) MLLW	NA	NA	NA	NA	75 ft (23 m) MLLW	62 ft (19 m) MLLW	75 ft (23 m) MLLW	62 ft (19 m) MLLW	NA	62 ft (19 m) MLLW	75 ft (23 m) MLLW
Tower Diameter for WTG	NA	28 ft (8.5 m)	NA	NA	NA	NA	NA	NA	NA	28 ft (8.5 m)	28 ft (8.5 m)	28 ft (8.5 m)	NA	28 ft (8.5 m)	28 ft (8.5 m)
Monopile Foundation															
Diameter	NA	34 ft (10.3 m)	NA	34 ft (10.3 m)	NA	34 ft (10.3 m)	34 ft (10.3 m)	34 ft (10.3 m)	NA	34 ft (10.3 m)	34 ft (10.3 m)	34 ft (10.3 m)	NA	34 ft (10.3 m)	NA
Pile Footprint	NA	908 ft^2 (84.3 m^2)	NA	908 ft^2 (84.3 m^2)	NA	908 ft^2 (84.3 m^2)	908 ft^2 (84.3 m^2)	908 ft^2 (84.3 m^2)	NA	908 ft^2 (84.3 m^2)	908 ft^2 (84.3 m^2)	908 ft^2 (84.3 m^2)	NA	908 ft^2 (84.3 m^2)	NA
Height between Seabed and MLLW (water depth)	NA	162 ft (49.5 m)	NA	162 ft (49.5 m)	NA	NA	NA	NA	NA	162 ft (49.5 m)	121 ft (37 m)	121 ft (37 m)	NA	121 ft (37 m)	162 ft (49.5 m)
Penetration	NA	148 ft (45 m)	NA	NA	NA	148 ft (45 m)	148 ft (45 m)	148 ft (45 m)	NA	148 ft (45 m)	NA	148 ft (45 m)	NA	148 ft (45 m)	NA
Transition Piece Tower Diameter	NA	28 ft (8.5 m)	NA	NA	NA	28 ft (8.5 m)	NA	NA	NA	28 ft (8.5 m)	28 ft (8.5 m)	28 ft (8.5 m)	NA	28 ft (8.5 m)	28 ft (8.5 m)
Transition Piece Length	NA	98 ft (30 m)	NA	98 ft (30 m)	NA	NA	NA	NA	NA	98 ft (30 m)	98 ft (30 m)	59 ft (18 m)	NA	59 ft (18 m)	98 ft (30 m)
Platform Level/Interface Level Height	NA	74 ft (22.5 m)	NA	74 ft (22.5 m)	NA	NA	NA	NA	NA	74 ft (22.5 m)	64 ft (19.5 m)	64 ft (19.5 m)	NA	64 ft (19.5 m)	74 ft (22.5 m)

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Number of Piles/Foundation	NA	1	NA	NA	NA	1	1	1	NA	1	1	1	NA	1	NA
Number of Piles Driven/Day within 24 hours [d]	NA	2	NA	NA	NA	2	2	2	NA	2	2	2	NA	2	NA
Hammer size for Monopile Foundation	NA	NA	NA	4,000 kJ	NA	4,000 kJ	4,000 kJ	4,000 kJ	NA	NA	4,000 kJ	4,000 kJ	NA	4,000 kJ	NA
Typical Foundation Time to Pile Drive [e]	NA	approximately 3 hours	NA	approximately 3 hours	NA	approximately 3 hours	approximately 3 hours	approximately 3 hours	NA	approximately 3 hours	approximately 3 hours	approximately 3 hours	NA	approximately 3 hours	NA
Scour Protection Area at Each Monopile WTG and ESP	NA	up to 22,600 ft^2 (2,100 m^2)	NA	up to 22,600 ft^2 (2,100 m^2)	NA	up to 22,600 ft^2 (2,100 m^2)	up to 22,600 ft^2 (2,100 m^2)	up to 22,600 ft^2 (2,100 m^2)	NA	up to 22,600 ft^2 (2,100 m^2)	up to 22,600 ft^2 (2,100 m^2)	up to 22,600 ft^2 (2,100 m^2)	NA	up to 22,600 ft^2 (2,100 m^2)	NA
Scour Protection Volume at Each Monopile WTG and ESP	NA	up to 127,133 ft^3 (3,600 m^3)	NA	up to 127,133 ft^3 (3,600 m^3)	NA	up to 127,133 ft^3 (3,600 m^3)	up to 127,133 ft^3 (3,600 m^3)	up to 127,133 ft^3 (3,600 m^3)	NA	up to 127,133 ft^3 (3,600 m^3)	up to 127,133 ft^3 (3,600 m^3)	up to 127,133 ft^3 (3,600 m^3)	NA	up to 127,133 ft^3 (3,600 m^3)	NA
Jacket (Pin Piles) Foundation															
Diameter for WTG and ESP	NA	10 ft (3 m)	NA	10 ft (3 m)	NA	10 ft (3 m)	10 ft (3 m)	10 ft (3 m)	NA	10 ft (3 m)	10 ft (3 m)	10 ft (3 m)	NA	10 ft (3 m)	NA
Jacket Structure Height for WTG	NA	262 ft (80 m)	NA	262 ft (80 m)	NA	NA	NA	NA	NA	262 ft (80 m)	180 ft (55 m)	180 ft (55 m)	NA	262 ft (80 m)	262 ft (80 m)
Jacket Structure Height for ESP	NA	NA	NA	213 ft (65 m)	NA	NA	NA	NA	NA	213 ft (65 m)	180 ft (55 m)	180 ft (55 m)	NA	213 ft (65 m)	213 ft (65 m)
Platform Level/Interface Level Height for WTG and ESP	NA	94 ft (28.5 m) MLLW	NA	94 ft (28.5 m) MLLW	NA	NA	NA	NA	NA	94 ft (28.5 m) MLLW	74 ft (22.5 m) MLLW	74 ft (22.5 m) MLLW	NA	94 ft (28.5 m) MLLW	94 ft (28.5 m) MLLW
Pile Penetration for WTG	NA	197 ft (60 m)	NA	197 ft (60 m)	NA	197 ft (60 m)	197 ft (60 m)	197 ft (60 m)	NA	197 ft (60 m)	NA	197 ft (60 m)	NA	197 ft (60 m)	NA
Pile Penetration for ESP	NA	246 ft (75 m)	NA	246 ft (75 m)	NA	246 ft (75 m)	246 ft (75 m)	246 ft (75 m)	NA	246 ft (75 m)	NA	246 ft (75 m)	NA	246 ft (75 m)	NA
Pile Footprint for WTG	NA	NA	NA	115 ft (35 m)	NA	115 ft (35 m)	115 ft (35 m)	115 ft (35 m)	NA	115 ft (35 m)	NA	115 ft (35 m)	NA	115 ft (35 m)	NA
Pile Footprint for ESP	NA	NA	NA	248 ft (45 m)	NA	248 ft (45 m)	248 ft (45 m)	248 ft (45 m)	NA	248 ft (45 m)	NA	248 ft (45 m)	NA	248 ft (45 m)	NA
Number of Piles/ Foundation	NA	3 to 4	NA	3 to 4	NA	3 to 4	3 to 4	3 to 4	NA	3 to 4	3 to 4	3 to 4	NA	3 to 4	NA
Number of Piles Driven/Day within 24 hours [d]	NA	2 (up to 8 pin piles)	NA	2 (up to 8 pin piles)	NA	2 (up to 8 pin piles)	2 (up to 8 pin piles)	2 (up to 8 pin piles)	NA	2 (up to 8 pin piles)	2 (up to 8 pin piles)	2 (up to 8 pin piles)	NA	2 (up to 8 pin piles)	NA
Hammer size for Jacket Foundation	NA	NA	NA	3,000 kJ	NA	3,000 kJ	3,000 kJ	3,000 kJ	NA	NA	3,000 kJ	3,000 kJ	NA	3,000 kJ	NA
Typical Jacket Time to Pile Drive	NA	less than approximately 3 hours	NA	less than approximately 3 hours	NA	less than approximately 3 hours	less than approximately 3 hours	less than approximately 3 hours	NA	less than approximately 3 hours	less than approximately 3 hours	less than approximately 3 hours	NA	less than approximately 3 hours	NA
Scour Protection Area at Each Jacket WTG	NA	up to 19,375 ft^2 (1,800 m^2)	NA	up to 19,375 ft^2 (1,800 m^2)	NA	up to 19,375 ft^2 (1,800 m^2)	up to 19,375 ft^2 (1,800 m^2)	up to 19,375 ft^2 (1,800 m^2)	NA	up to 19,375 ft^2 (1,800 m^2)	up to 19,375 ft^2 (1,800 m^2)	up to 19,375 ft^2 (1,800 m^2)	NA	up to 19,375 ft^2 (1,800 m^2)	NA

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Scour Protection Volume at Each Jacket WTG	NA	up to 91,818 ft^3 (2,600 m^3)	NA	up to 91,818 ft^3 (2,600 m^3)	NA	up to 91,818 ft^3 (2,600 m^3)	up to 91,818 ft^3 (2,600 m^3)	up to 91,818 ft^3 (2,600 m^3)	NA	up to 91,818 ft^3 (2,600 m^3)	up to 91,818 ft^3 (2,600 m^3)	up to 91,818 ft^3 (2,600 m^3)	NA	up to 91,818 ft^3 (2,600 m^3)	NA
Scour Protection Area at Each Jacket ESP	NA	up to 26,900 ft^2 (2,500 m^2)	NA	up to 26,900 ft^2 (2,500 m^2)	NA	up to 26,900 ft^2 (2,500 m^2)	up to 26,900 ft^2 (2,500 m^2)	up to 26,900 ft^2 (2,500 m^2)	NA	up to 26,900 ft^2 (2,500 m^2)	up to 26,900 ft^2 (2,500 m^2)	up to 26,900 ft^2 (2,500 m^2)	NA	up to 26,900 ft^2 (2,500 m^2)	NA
Scour Protection Volume at Each Jacket ESP	NA	up to 134,196 ft^3 (3,800 m^3)	NA	up to 134,196 ft^3 (3,800 m^3)	NA	up to 134,196 ft^3 (3,800 m^3)	up to 134,196 ft^3 (3,800 m^3)	up to 134,196 ft^3 (3,800 m^3)	NA	up to 134,196 ft^3 (3,800 m^3)	up to 134,196 ft^3 (3,800 m^3)	up to 134,196 ft^3 (3,800 m^3)	NA	up to 134,196 ft^3 (3,800 m^3)	NA
Electrical Service Platforms															
ESP Dimensions	NA	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	NA	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	NA	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	NA	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)
Number of ESPs	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	NA	Two ESPs due to more facilities occupying air and surface area	NA	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area	NA	Two ESPs due to more facilities occupying air and surface area	Two ESPs due to more facilities occupying air and surface area
Number of Transformers per ESP	NA	2	NA	2	NA	2	2	2	2	2	2	2	NA	2	2
ESP Foundation Type	NA	Jacket	NA	Jacket	NA	Jacket	Jacket	Jacket	Jacket	Jacket	Jacket	Jacket	NA	Jacket	Jacket
ESP Number of Piles/Foundation	NA	3 to 4	NA	3 to 4	NA	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4	NA	3 to 4	3 to 4
ESP Maximum Height	NA	NA	NA	218 ft (66.5 m) MLLW	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	218 ft (66.5 m) MLLW
Inter-array Cable (66 kV)															
Number of Foundations per Inter-Array	NA	6 to 10	NA	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	NA	6 to 10	NA
Inter-Array Cable Length	NA	171 mi (275 km)	NA	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	171 mi (275 km)	NA	171 mi (275 km)	NA
Target Burial Depth	NA	5 ft (1.5 m)	NA	NA	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	NA
Inter-array Cable Installation Method (includes a pre-lay grapnel run)	Evaluate all traffic	Dredging the entire route	NA	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	NA	Dredging the entire route	NA
Protection Method (rock placement, concrete mattresses, half-shell)	NA	up to 10% of inter-array route	NA	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	up to 10% of inter-array route	NA	up to 10% of inter-array route	NA

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Export and Inter-link Cable (220 kV)															
Number of Export Cables	NA	2	NA	NA	2	2	2	2	2	2	2	2	2	2	NA
Burial Depth	NA	5 ft (1.5 m)	NA	NA	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	NA
Maximum Length of Export Cable (assuming Two cables)	NA	98 mi (158 km)	NA	NA	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	98 mi (158 km)	NA
Typical separation distance of Export Cable (assuming two cables)	NA	492 ft (100 m)	NA	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	492 ft (100 m)	NA
Total Corridor Width for Export Cable (assuming two cables) [f]	NA	3,280 ft (1,000 m)	NA	NA	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	3,280 ft (1,000 m)	NA
Maximum Length of Inter-Link Cable	NA	6.2 mi (10 km)	NA	NA	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	6.2 mi (10 km)	NA
Export Cable Installation Method (includes a pre-lay grapnel run)	NA	Dredging the entire route	NA	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	Dredging the entire route	NA
Export Cables Dredging (width corridor per cable)	NA	66 ft (20 m)	NA	66 ft (20 m)	66 ft (20 m)	66 ft (20 m)	66 ft (20 m)	66 ft (20 m)	NA	66 ft (20 m)	NA	66 ft (20 m)	66 ft (20 m)	20 m (66 ft) wide corridor per cable	NA
Export Cables Total Dredging Area	NA	up to 69 acres (0.28 km^2)	NA	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)	NA	up to 69 acres (0.28 km^2)	NA	up to 69 acres (0.28 km^2)	up to 69 acres (0.28 km^2)	up to 279,400 m2 (69 acres)	NA
Export Cables Total Dredging Volume	NA	up to 214,500 cy (164,000 m^3)	NA	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	NA	up to 214,500 cy (164,000 m^3)	NA	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	up to 214,500 cy (164,000 m^3)	NA
Protection Method (rock placement, concrete mattresses, half-shell)	NA	Up to 10% of export route	NA	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	Up to 10% of export route	NA

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Onshore Components															
Landfall Locations	Evaluate all traffic	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA
Landfall Transition Method	NA	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA
Landfall Transition	NA	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	Both landfall locations need to be reviewed for impacts and compliance with applicable federal and state regulations	NA
Onshore Construction Location	NA	NA	NA	NA	NA	NA	NA	NA	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA
Onshore Dimensions	NA	NA	NA	NA	NA	NA	NA	NA	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA

Design Parameter	Air Quality	Water Quality	Terrestrial and Coastal Faunas	Birds and Bats	Coastal Habitat	Benthic Resources	Finfish, Invertebrates, and Essential Fish Habitat	Marine Mammals and Sea Turtles	Economics and Environmental Justice	Cultural, Historical, and Archaeological Resources	Recreation and Tourism	Commercial Fisheries and For-Hire Commercial Fishing	Land Use and Coastal Infrastructure	Navigation and Vessel Traffic	Other Uses
Onshore Export Cable Route	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA		NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations		Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA
Length of Onshore Cable	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA
Onshore Substation Site Location	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed, including listed species, for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	Both upland routes need to be reviewed for impacts and compliance with applicable federal and state regulations	NA	NA

AIS = Automatic identification system; BOEM = Bureau of Ocean Energy Management; cy = cubic yard; DP = dynamic positioning; ESP = electrical service platform; FAA = Federal Aviation Administration; ft = foot; ft^2 = square feet; kJ = kilojoule; km = kilometer; kV = kilovolt; m = meter; m^2 = square meters; m^3 = cubic meters; mi = mile; MLLW = mean lower low water; MW = megawatt; NA = not applicable; nm = nautical mile; USCG = United States Coast Guard; WTG = wind turbine generator

[a] Vineyard Wind's Proposed Action is for an approximately 800 MW offshore wind energy project. This EIS evaluates the potential impacts of a facility up to 800 MW to ensure that it covers projects constructed with a smaller capacity.

[b] Additional positions allow for spare turbine locations or additional capacity to account for electrical losses.

[c] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.

[d] Work would not be performed concurrently. No drilling is anticipated; however, it may be required if a large boulder or refusal is met. If drilling is required, a rotary drilling unit would be mobilized or vibratory hammering would be used.

[e] Vineyard Wind has estimated that typical pile driving for a monopile is expected to take less than approximately 3 hours to achieve the target penetration depth and that pile driving for the jacket foundation would take approximately 3 hours to achieve the target penetration depth. The hammer size used for installation of the monopile and jacket foundation differs.

[f] Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and would directly disturb an approximately 6.4-foot (2-meter) wide corridor.

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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 the 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 communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.