Construction and Operations Plan

Lease Area OCS-A 0534

Volume I Text

June 2022

Submitted by
Park City Wind LLC

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Rd
Sterling, VA 20166

Prepared by
Epsilon Associates, Inc.

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In Association with:

Baird & Associates	JASCO Applied Sciences
Biodiversity Research Institute	Public Archaeology Laboratory, Inc.
Capitol Air Space Group	RPS
Geo SubSea LLC	Saratoga Associates
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June 2022

Summary of New England Wind Facilities and Activities

SUMMARY OF NEW ENGLAND WIND FACILITIES AND ACTIVITIES

S-1 Overview

New England Wind is the proposal to develop offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0534 along with associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities. Lease Area OCS-A 0534 is within the Massachusetts Wind Energy Area identified by BOEM, following a public process and environmental review, as suitable for wind energy development. Park City Wind LLC, a wholly owned subsidiary of Avangrid Renewables, LLC, is the Proponent of this Construction and Operations Plan (COP) and will be responsible for the construction, operation, and decommissioning of New England Wind.

New England Wind's offshore renewable wind energy facilities are located immediately southwest of Vineyard Wind 1, which is located in Lease Area OCS-A 0501. New England Wind will occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 in the event that Vineyard Wind 1 does not develop "spare" or extra positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534. For the purposes of the COP, the Southern Wind Development Area (SWDA) is defined as all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501, as shown in Figure 1.1-1 of COP Volume I.

New England Wind will be developed in two Phases with a maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions. Phase 1, also known as Park City Wind will be developed immediately southwest of Vineyard Wind 1. Phase 2, also known as Commonwealth Wind, will be located southwest of Phase 1 and occupy the remainder of the SWDA. Each Phase of New England Wind will be developed and permitted using a Project Design Envelope (the "Envelope"). This allows the Proponent to properly define and bracket the characteristics of each Phase for the purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection of key components (e.g. WTGs, foundations, submarine cables, and ESPs). To assess potential impacts and benefits to various resources, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established (see Section 3 of COP Volume III).

The SWDA may be 411–453 square kilometers (km^2) (101,590–111,939 acres) in size depending upon the final footprint of the Vineyard Wind 1 project. At this time, the Proponent does not intend to develop the two positions in the separate aliquots located along the northeastern boundary of Lease Area OCS-A 0501 as part of New England Wind. The SWDA (excluding the two separate aliquots that are closer to shore) is just over 32 kilometers (km) (20 miles [mi]) from the southwest corner of Martha's Vineyard and approximately 38 km (24 mi) from Nantucket.[1] In accordance with US Coast Guard (USCG) recommendations, the WTGs and ESP(s) in the SWDA

[1] Within the SWDA, the closest WTG is approximately 34 km (21 mi) from Martha's Vineyard and 40 km (25 mi) from Nantucket.

will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (1.85 km) spacing between positions. This uniform grid layout provides 1 NM wide corridors in the east-west and north-south directions as well as 0.7 NM (1.3 km) wide corridors in the northwest-southeast and northeast-southwest directions.

Four or five offshore export cables—two cables for Phase 1 and two or three cables for Phase 2—will transmit electricity from the SWDA to shore.[2] Unless technical, logistical, grid interconnection, or other unforeseen issues arise, all New England Wind offshore export cables will be installed within a shared Offshore Export Cable Corridor (OECC) that will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel toward landfall sites in the Town of Barnstable (see Figure 2.3-1 of COP Volume I).[3] The OECC for New England Wind is largely the same OECC proposed in the approved Vineyard Wind 1 COP, but it has been widened to the west along the entire corridor and to the east in portions of Muskeget Channel. The two Vineyard Wind 1 offshore export cables will also be installed within the New England Wind OECC. To avoid cable crossings, the Phase 1 cables are expected to be located to the west of the Vineyard Wind 1 cables and, subsequently, the Phase 2 cables are expected to be installed to the west of the Phase 1 cables.

Each Phase of New England Wind will have a separate onshore transmission system located in the Town of Barnstable.[4] The Phase 1 onshore facilities will ultimately include one of two potential landfall sites, one of two potential Onshore Export Cable Routes, one new onshore substation, and one of two potential Grid Interconnection Routes, which are identified in Figure 2.4-1 of COP Volume I. Phase 2 will include one or two landfall sites, one or two Onshore Export Cable Routes, one or two onshore substation sites, and one or two Grid Interconnection Routes. The potential landfall sites, Onshore Export Cable Routes, and Grid Interconnection Routes are illustrated on Figure 2.4-1 of COP Volume I. The Phase 2 onshore substation site(s) will be located generally along the Phase 2 onshore routes identified in Figure 2.4-1 of COP Volume I.

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[2] With the rapid advancement of WTG technology, it is possible that an additional offshore export cable could be needed for New England Wind. If used, the additional cable would remain within the existing offshore export cable corridor or variants assessed and would not exceed the impacts analyzed for each corridor or variant.

[3] As described further in Section 4.1.3 of COP Volume I, the Proponent has identified two variations of the Phase 2 OECC in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC.

[4] One or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise. Under this scenario, Phase 2 could include one onshore transmission system in Barnstable and/or an onshore transmission system(s) in proximity to the second grid interconnection point (see Section 4.1.4 of COP Volume I).

New England Wind has significant environmental benefits. The electricity generated by the WTGs, which do not emit air pollutants, will displace electricity generated by fossil fuel power plants and significantly reduce emissions from the ISO New England (ISO-NE) electric grid over the lifespan of New England Wind. New England Wind is expected to reduce carbon dioxide equivalent (CO_2e) emissions from the ISO-NE electric grid by approximately 3.93 million tons per year (tpy), or the equivalent of taking 775,000 cars off the road.[5] New England Wind will significantly decrease the region's reliance on fossil fuels and enhance the reliability and diversity of regional energy supply. In addition to these important environmental and energy reliability benefits, New England Wind is expected to result in significant long-term economic benefits and high-quality jobs.

S-2 Organization of the COP

The COP describes all planned activities and facilities associated with the construction and operation of each Phase of New England Wind. The COP is comprised of three volumes:

- Volume I provides a detailed description of New England Wind's location, offshore and onshore facilities, and construction, O&M, and decommissioning activities. Phase 1 is described in Section 3 of Volume I and Phase 2 is described separately in Section 4.

- Volume II provides a comprehensive analysis of the data collected during geophysical and geotechnical surveys conducted for New England Wind.

- Volume III details the benefits and potential impacts of both Phases to physical, atmospheric, biological, economic, cultural, and historic resources based on the "maximum design scenario" for each resource.

The remainder of this section summarizes the facilities and activities for each Phase as described in Volume I. Potential environmental impacts and avoidance, minimization, and mitigation measures are summarized in Section 4 of Volume III.

S-3 Phase 1 of New England Wind

Phase 1 of New England Wind, also known as Park City Wind, will deliver power to one or more Northeastern states and/or to other offtake users, including but not limited to 804 MW of power to the ISO-NE electric grid to meet the Proponent's obligations under long-term contracts with Connecticut electric distribution companies. Assuming the necessary permits are issued and financial close is achieved, construction of Phase 1 would likely begin in late 2023 onshore and 2025 offshore. The Envelope for Phase 1 is summarized in Table S-1.

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5 The avoided emissions analysis conservatively assumes a minimum total capacity for both Phases of New England Wind of approximately 2,000 MW; however, it is likely that benefits will be greater than those reported. The analysis is based on Northeast Power Coordinating Council (NPCC) New England 2018 emission rates from EPA's Emissions & Generation Resource Integrated Database eGRID2018(v2) released in March 2020. See Section 5.1.2.2 of COP Volume III for additional details.

Table S-1 Phase 1 of New England Wind Design Envelope Summary

Layout and Size of Phase 1

- 41–62 wind turbine generators (WTGs) installed
- One or two electrical service platforms (ESPs) installed
- Windfarm layout in E-W & N-S grid pattern with 1 NM (1.85 km) spacing between WTG/ESP positions
- Area of Phase 1 SWDA: 150–231 km^2 (37,066–57,081 acres)

WTGs

- 41–62 WTGs
- Maximum rotor diameter of 285 m (935 ft)
- Maximum tip height of 357 m (1,171 ft)
- Minimum tip clearance of 27 m (89 ft)
- Installation with a jack-up vessel, anchored vessel, or dynamic positioning (DP) vessel and components likely supplied by feeder vessels

WTG Foundations

- Each WTG installed on a monopile or piled jacket foundation
- Scour protection may be used around all foundations
- Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets
- Installation with a jack-up vessel, anchored vessel, or DP vessel and components potentially supplied by feeder vessels

ESPs (Topside and Foundation)

- One or two ESP(s)
- Each ESP installed on a monopile or jacket foundation (ESPs installed on monopiles may be co-located)
- Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets
- Scour protection may be installed around the foundations
- Installation with a jack-up vessel, anchored vessel, or DP vessel

Inter-Array & Inter-Link Cables

- 66–132 kV inter-array cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft)
- Maximum total inter-array cable length of ~225 km (~121 NM)
- Up to one 66–275 kV inter-link cable buried at a target depth of 1.5–2.5 m (5–8 ft)
- Maximum total inter-link cable length of ~20 km (~11 NM)
- Example layout identified, not finalized
- Pre-lay grapnel run and pre-lay survey
- Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow
- Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial

Offshore Export Cables

- Two 220–275 kV offshore export cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft)
- Maximum total offshore export cable length of ~202 km (~109 NM)
- Cables installed in one Offshore Export Cable Corridor
- Pre-lay grapnel run, pre-lay survey, and possibly boulder clearance
- Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow, possibly with dredging in some locations to achieve burial depth
- Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial

Note: Elevations are relative to Mean Lower Low Water (MLLW).

S-3.1 Phase 1 Construction and Installation

S-3.1.1 Wind Turbine Generators

Phase 1 will consist of 41–62 WTGs oriented in a 1 x 1 NM layout. The potential footprint of Phase 1 within the SWDA includes a portion of Lease Area OCS-A 0501 (see Figure 3.1-4 of COP Volume I) in the event that Vineyard Wind 1 does not develop some or all of its 10 spare positions and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534. Similarly, the potential footprint of Phase 1 overlaps with the potential footprint of Phase 2 to account for the range in the number of WTGs that may be developed for Phase 1 (see Figure 3.1-4 of COP Volume I).

The WTG parameters for Phase 1 are provided in Table S-1 and shown on Figure 3.2-1 of COP Volume I. The WTGs will be no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey in color; the Proponent anticipates that the WTGs will be painted off-white/light grey to reduce their visibility against the horizon. The WTGs will include one or two levels of red flashing aviation obstruction lights in accordance with Federal Aviation Administration (FAA) and/or BOEM requirements. The Proponent expects to use an Aircraft Detection Lighting System (ADLS) that automatically activates all aviation obstruction lights when aircraft approach the Phase 1 WTGs, subject to BOEM approval. Each WTG will be maintained as a Private Aid to Navigation (PATON) and will contain marine navigation lighting and marking in accordance with the USCG's PATON marking guidance for offshore wind facilities in First District-area waters.

The WTGs will be installed using jack-up vessels, anchored vessels, or dynamic positioning (DP) vessels along with necessary support vessels and supply vessels. The tower will first be erected followed by the nacelle and finally the hub, inclusive of the blades. Alternatively, the nacelle and hub could be installed in a single operation followed by the installation of individual blades.

S-3.1.2 Wind Turbine Generator Foundations

At this time, the Proponent expects to use all monopiles for the Phase 1 WTG foundations. However, a combination of monopiles and/or piled jackets may be used, pending the outcome of a foundation feasibility analysis. The monopiles will have a maximum diameter of 12 m (39 ft) and will be driven into the seabed to a maximum penetration depth of 55 m (180 ft). The dimensions for each Phase 1 WTG foundation type are shown on Figures 3.2-2 and 3.2-3 of COP Volume I. Scour protection consisting of rock material will be used for the larger diameter monopiles, but may or may not be needed for the smaller diameter piles used for jacket foundations.

The foundations are expected to be installed by one or two DP, anchored, or jack-up vessels, along with necessary support vessels and supply vessels. Pile driving would begin with a "soft-start" (i.e. the hammer energy level will be gradually increased) to ensure the pile remains vertical and allow any motile marine life to leave the area before pile driving intensity is increased. It is anticipated that a maximum of two monopiles or one complete piled jacket (3–4 piles) can be driven into the seabed per day.

S-3.1.3 Electrical Service Platforms

One or two ESP(s) will serve as the common interconnection point(s) for the Phase 1 WTGs. The ESP(s) will be supported by either a monopile or piled jacket foundation (with 3–12 piles) that may be surrounded by scour protection, if needed. If two ESPs are used, they may be located at two separate positions or co-located at one of the potential ESP positions shown on Figure 3.1-4 of COP Volume I (co-located ESPs would be smaller structures installed on monopile foundations). The approximate size and design of the ESP topside and foundation are depicted in Figures 3.2-6 and 3.2-7 of COP Volume I. If necessary, the ESP(s) will include an aviation obstruction lighting system in compliance with FAA and/or BOEM requirements, which would be activated by ADLS, subject to BOEM approval. The ESP(s) will include marine navigation lighting and marking similar to the lighting and marking described for the WTGs. ESP foundation and topside installation may be performed by a DP, anchored, or jack-up vessel. ESP foundation installation is similar to WTG foundation installation described above. Following topside installation, the ESP(s) will be commissioned.

S-3.1.4 Offshore Export Cables

Phase 1 includes two offshore export cables, which will transmit electricity from the Phase 1 ESP(s) to the selected landfall site. Each offshore export cable is expected to be comprised of a three-core 220–275 kV high voltage alternating current (HVAC) cable and one or more fiber optic cables. Between the Phase 1 ESP(s) and the northwestern corner of the SWDA, the offshore export cables may be installed in any area of the SWDA. From the northwestern corner of the SWDA, the Phase 1 offshore export cables will be installed within the OECC to reach either the Craigville Public Beach Landfall Site or the Covell's Beach Landfall Site (see Figure 3.1-6 of COP Volume I). The maximum length of offshore export cables (assuming two cables) is ~202 km (~109 NM).

Prior to cable laying, a pre-lay grapnel run and pre-lay survey will be performed to clear obstructions and inspect the route. Large boulders along the route may need to be relocated and some dredging of the upper portions of sand waves may be required prior to cable laying to achieve sufficient burial depth below the stable sea bottom. Each offshore export cable will be installed beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft). Offshore export cable laying is expected to be performed primarily via simultaneous lay and bury using jetting techniques or mechanical plow. However, other specialty techniques may be used in certain areas to ensure sufficient burial depth (see Section 3.3.1.3.6 of COP Volume I). To facilitate cable installation, anchored vessels may be used along the entire length of the offshore export cables. While the Proponent intends to avoid or minimize the need for cable protection to the greatest extent feasible, it is conservatively estimated that approximately 6% of the offshore export cables within the OECC could require cable protection.

S-3.1.5 Inter-Array and Inter-Link Cables

Strings of multiple WTGs will be connected to the Phase 1 ESP(s) via 66–132 kV inter-array cables. The maximum anticipated length of the Phase 1 inter-array cables is approximately 225 km (121 NM). In addition, if two ESPs are used, the ESPs may be connected together by an up to ~20 km (~11 NM) long 66–275 kV inter-link cable. The Phase 1 inter-array and inter-link cable layout will be designed and optimized during the final design of Phase 1.

The inter-array and inter-link cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft), likely using jetting techniques. However, in some cases, a mechanical plow may be better suited to certain site-specific conditions and other specialty techniques may be used more rarely. The Proponent conservatively estimates that up to 2% of the total length of the inter-array and inter-link cables could require cable protection.

S-3.1.6 Landfall Site and Onshore Export Cables

The offshore export cables will make landfall within paved parking areas at either the Craigville Public Beach Landfall Site or the Covell's Beach Landfall Site in the Town of Barnstable. The ocean to land transition at either landfall site will be made using horizontal directional drilling (HDD), which will avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. From the landfall site, the onshore export cables would follow one of two approximately 6.5–10.5 km (4.0–6.5 mi) potential Onshore Export Cable Routes (with variants) in the Town of Barnstable to the new onshore substation (see Figure 3.2-11 of COP Volume I).

The onshore export cables will be primarily installed in an underground duct bank (i.e. an array of plastic conduits encased in concrete) along the selected Onshore Export Cable Route; the duct bank will typically be within public roadway layouts although portions of the duct bank may be within existing utility rights-of-way (ROWs).

S-3.1.7 Onshore Substation and Grid Interconnection

Phase 1 will require the construction of a new onshore substation on a 0.027 km^2 (6.7 acre) privately-owned parcel located at 8 Shootflying Hill Road. From the onshore substation, grid interconnection cables will be installed within an underground duct bank along one of two potential Grid Interconnection Routes (with variants) to the grid interconnection point at Eversource's existing West Barnstable Substation. The Proponent may construct an access road to the onshore substation site on 6 Shootflying Hill Road, which is adjacent the onshore substation site. The Proponent may also use an approximately 0.011 km^2 (2.8 acre) parcel of land, assessor map parcel #214-001 ("Parcel #214-001"), located immediately southeast of the West Barnstable Substation for a segment of the grid interconnection cables and/or to house some onshore substation equipment (see Figure 3.1-2 of COP Volume I).

S-3.1.8 Port Facilities

The Proponent has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used for frequent crew transfer, offloading/loading shipments of components, storage, preparing components for installation, and potentially some component fabrication and assembly. In addition, some components, materials, and vessels could come from Canadian and European ports. See Section 3.2.2.5 of COP Volume I for a complete list of possible ports that may be used for major construction staging. It is not expected that all the ports identified would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.

S-3.2 Phase 1 Operations and Maintenance

The Phase 1 WTGs will be designed to operate without attendance by any operators. Continuous monitoring will be conducted remotely using a supervisory control and data acquisition (SCADA) system. Routine preventive maintenance and proactive inspections (e.g. multi-beam echosounder inspections, side scan sonar inspections, magnetometer inspections, depth of burial inspections, etc.) will be performed for all offshore facilities.

To execute daily O&M activities offshore, the Proponent expects to use a service operation vessel (SOV) to provide offshore accommodations and workspace for O&M workers. Daughter craft and/or crew transfer vessels (CTVs) would be used to transfer crew to and from shore. Although less likely, if an SOV is not used, several CTVs and helicopters would be used to frequently transport crew to and from the offshore facilities. In addition to the SOV, CTVs, and/or daughter craft, other larger support vessels (e.g. jack-up vessels) may be used infrequently to perform some routine maintenance and repairs (if needed).

The Proponent expects to use one or more facilities in support of Phase 1 O&M activities. For Phase 1, the Proponent will likely establish a long-term SOV O&M base in Bridgeport, Connecticut. Current plans anticipate that CTVs and/or the SOV's daughter craft would operate out of Vineyard Haven on Martha's Vineyard and/or New Bedford Harbor. Although the Proponent plans to locate the Phase 1 O&M facilities in Bridgeport, Vineyard Haven, and/or New Bedford Harbor, the Proponent may use other ports listed in Table 3.2-8 of COP Volume I to support O&M activities.

S-3.3 Phase 1 Decommissioning

As currently envisioned, the decommissioning process for Phase 1 is essentially the reverse of the installation process. Decommissioning of the offshore facilities is broken down into several steps:

- Retirement in place (if authorized by BOEM) or removal of the offshore cable system (i.e. inter-array, inter-link, and offshore export cables) and any associated cable protection.

- Dismantling and removal of WTGs. Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids and chemicals, which would be brought to port for proper disposal and/or recycling.

- Cutting and removal of foundations and removal of scour protection. In accordance with BOEM's removal standards (30 CFR § 585.910(a)), the foundations would likely be cut at least 4.5 m (15 ft) below the mudline; the portion below the cut will likely remain in place.

- Removal of ESP(s). The ESP(s) and their foundations will be disassembled in a similar manner as the WTGs. Before removing the ESP(s), the offshore export cables, inter-array cables, and inter-link cables would be disconnected.

The onshore facilities could be retired in place or retained for future use. The extent of onshore decommissioning is subject to discussions with the Town of Barnstable on the approach that best meets the Town's needs and has the fewest environmental impacts.

S-4 Phase 2 of New England Wind

Phase 2 of New England Wind, also known as Commonwealth Wind, will deliver power to one or more Northeastern states and/or to other offtake users, including 1,232 MW of power to the ISO-NE electric grid to meet the Proponent's obligations under long-term contracts with Massachusetts electric distribution companies. Phase 2 may be developed as one or more projects. The full build-out of Phase 2 development is largely dependent on market conditions and the advancement of WTG technology. It is likely that a portion of Phase 2 construction could begin immediately following Phase 1[6] with the remainder following by a number of years. The Envelope for Phase 2 is summarized in Table S-2.

S-4.1 Phase 2 Construction and Installation

S-4.1.1 Wind Turbine Generators

Phase 2 will occupy the remainder of the SWDA that is not developed for Phase 1. As described in Section S-3.1.1, the potential footprint of Phase 2 within the SWDA overlaps with the potential footprint of Phase 1 to account for the range in the number of WTGs that may be developed for Phase 1 (see Figure 4.1-4 of COP Volume I). Depending on the final footprint of Phase 1, the total number of WTG/ESP positions expected to be available for Phase 2 ranges from 64 to 88. Up to 88 of those positions may be used for WTGs. The Phase 2 WTGs will be oriented in a 1 x 1 NM layout. The WTG parameters for Phase 2 are provided in Table S-2 and shown on Figure 4.2-1 of COP Volume I.

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6 In this scenario, each major construction activity would be sequential for the two Phases (e.g. Phase 2 foundation installation would immediately follow Phase 1 foundation installation). However, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g. Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). There will be no concurrent/simultaneous pile driving of foundations.

Table S-2 Phase 2 of New England Wind Design Envelope Summary

Layout and Size of Phase 2	WTGs	WTG Foundations
• 64–88 total wind turbine generator (WTG) and electrical service platform (ESP) positions expected to be available ○ Up to 88 WTGs installed ○ Up to 3 ESPs installed • Windfarm layout in E-W & N-S grid pattern with 1 NM (1.85 km) spacing between positions • Area of Phase 2 SWDA: 222–303 km^2 (54,857–74,873 acres)	• Up to 88 WTGs • Maximum rotor diameter of 285 m (935 ft) • Maximum tip height of 357 m (1,171 ft) • Minimum tip clearance of 27 m (89 ft) • Installation likely with a jack-up vessel, anchored vessel, or dynamic positioning (DP) vessel and components potentially supplied by feeder vessels	• Each WTG installed on a monopile, jacket, or bottom-frame foundation • Scour protection may be used around all foundations • Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets and bottom-frames • Installation likely with a jack-up vessel, anchored vessel, or DP vessel and components potentially supplied by feeder vessels
ESP(s) (Topside and Foundation)	**Inter-Array & Inter-Link Cables**	**Offshore Export Cables**
• Up to 3 ESPs • Each ESP installed on a monopile or jacket foundation (ESPs installed on monopiles may be co-located) • Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets • Scour protection may be installed around the foundations • Installation likely with a jack-up vessel, anchored vessel, or DP vessel	• 66–132 kV inter-array cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-array cable length of ~325 km (~175 NM) • 66–345 kV inter-link cables buried at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-link cable length of ~60 km (~32 NM) • Example layout identified, not finalized • Pre-lay grapnel run and pre-lay survey • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial	• Two or three 220–345 kV high voltage alternating current (HVAC) cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Cables installed in an Offshore Export Cable Corridor (OECC) with potential variations • Maximum total offshore export cable length of ~356 km (~192 NM) • Pre-lay grapnel run, pre-lay survey, and possibly boulder clearance • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow, possibly with dredging in some locations to achieve burial depth • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial

Note: Elevations are relative to Mean Lower Low Water (MLLW).

Unless BOEM and FAA guidance is modified before Phase 2 proceeds, the WTGs will be no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey in color; the Proponent anticipates that the WTGs will be painted off-white/light grey to reduce their visibility against thehorizon. Unless current guidance is modified by the FAA and BOEM, the WTGs will include one or two levels of red flashing aviation obstruction lights. The Proponent expects to use the same or similar approaches used for Vineyard Wind 1 and/or Phase 1, including the use of an ADLS that is activated automatically by approaching aircraft. Each WTG will be maintained as a PATON and will contain marine navigation lighting and marking in accordance with the USCG's PATON marking guidance for offshore wind facilities in First District-area waters.

The WTGs are expected to be installed using jack-up vessels, anchored vessels, or DP vessels along with necessary support vessels and supply vessels. The tower will first be erected followed by the nacelle and finally the hub, inclusive of the blades. Alternatively, the nacelle and hub could be installed in a single operation followed by installation of individual blades.

S-4.1.2 Wind Turbine Generator Foundations

Commercial and technical considerations at the time Phase 2 is ready to proceed will determine the types of WTG foundations used for Phase 2. Monopiles, jackets (with piles or suction buckets), bottom-frame foundations (with piles or suction buckets), or a combination of those foundation types may be used for Phase 2 pending the outcome of a foundation feasibility analysis.

If used, monopiles would have a maximum diameter of 13 m (43 ft) and would be driven into the seabed to a maximum depth of 55 m (180 ft). The dimensions for each Phase 2 WTG foundation type are shown on Figures 4.2-2 through 4.2-6 of COP Volume I. Scour protection consisting of rock material may be placed around the foundations; it is anticipated that scour protection will be needed for the larger diameter monopiles and suction buckets, but may or may not be needed for the smaller diameter piles used for jacket and bottom-frame foundations.

The foundations are expected to be installed by one or two DP, anchored, or jack-up vessels, along with necessary support vessels and supply vessels. Pile driving will begin with a "soft-start" to ensure the pile remains vertical and allow any motile marine life to leave the area before pile driving intensity is increased. It is anticipated that a maximum of two monopiles, one complete piled jacket (3–4 piles), or one complete piled bottom-frame (3 piles) can be driven into the seabed per day. If suction buckets are used, pumps attached to the top of each bucket would pump water and air out of the space between the suction buckets and seafloor, pushing the buckets down into the seafloor.

S-4.1.3 Electrical Service Platforms

Up to three ESP(s) will serve as the common interconnection point(s) for the Phase 2 WTGs. The ESP(s) would be supported by a monopile, piled jacket (with 3–12 piles), or suction bucket jacket foundation, which may be surrounded by scour protection, if needed. If two or three ESPs are used, they may be located at separate positions or two of the ESPs may be co-located at one of the potential ESP positions shown on Figure 4.1-4 of COP Volume I (co-located ESPs would be smaller structures installed on monopile foundations). The approximate size and design of the ESP(s) are depicted in Figures 4.2-10 through 4.2-12 of COP Volume I. The ESP(s) will include an aviation obstruction lighting system in compliance with FAA and/or BOEM requirements in effect at the time Phase 2 proceeds, if necessary. The aviation obstruction lights would be activated by ADLS (or similar), subject to BOEM approval. Marine navigation lighting and marking on each ESP will follow USCG and BOEM regulations and guidance in effect at the time Phase 2 proceeds.

ESP foundation and topside installation may be performed by a DP, anchored, or jack-up vessel. ESP foundation installation is similar to WTG foundation installation described above. Following topside installation, the ESP(s) will be commissioned. As an alternative to installing separate ESP(s) situated on their own foundation(s), the Phase 2 ESP(s) could potentially be integrated onto a WTG foundation, which entails placing ESP equipment on one or more expanded WTG foundation platforms (see Figure 4.2-9 of COP Volume I).

S-4.1.4 Offshore Export Cables

Two or three 220–345 kV HVAC offshore export cables will transmit electricity from the Phase 2 ESP(s) to the selected landfall site(s). Between the Phase 2 ESP(s) and the northwestern corner of the SWDA, the offshore export cables may be installed in any area of the SWDA. The Proponent intends to install all Phase 2 offshore export cables within the OECC that travels from the northwestern corner of the SWDA to the Dowses Beach Landfall Site and/or Wianno Avenue Landfall Site in the Town of Barnstable (see Figure 4.1-6 of COP Volume I). Under this scenario, the maximum length of Phase 2 offshore export cables (assuming three cables) is ~356 km (~192 NM). However, as described further in Section 4.1.3 of COP Volume I, the Proponent has also identified two variations of the Phase 2 OECC in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC.

Prior to cable laying, a pre-lay grapnel run and pre-lay survey are expected to be performed to clear obstructions and inspect the route. Large boulders along the route may need to be relocated and some dredging of the upper portions of sand waves may be required prior to cable laying to achieve sufficient burial depth below the stable sea bottom. Each offshore export cable will be installed beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft). Offshore export cable laying is expected to be performed primarily via simultaneous lay and bury using jetting techniques (e.g. jet plow or jet trenching) or mechanical plow. However, other specialty techniques may be used in certain areas to ensure sufficient burial depth (see Section 4.3.1.3.6 of COP Volume I). To facilitate cable installation, anchored vessels may be used along the entire length of the offshore export cables. While the Proponent intends to avoid or minimize the need for cable protection to the greatest extent feasible, it is conservatively estimated that approximately 6% of the offshore export cables within the OECC could require cable protection.

S-4.1.5 Inter-Array and Inter-Link Cables

Strings of multiple WTGs will be connected to the Phase 2 ESP(s) via 66–132 kV inter-array cables. The maximum anticipated length of the Phase 2 inter-array cables is approximately 325 km (175 NM). In addition, the Phase 2 ESPs may be connected to each other (if two or three ESPs are used) or to a Phase 1 ESP by 66–345 kV inter-link cables. The maximum total length of inter-link cables for Phase 2 is ~60 km (~32 NM). The Phase 2 inter-array and inter-link cable layout is highly dependent upon the final number of Phase 2 WTGs and the location and number of ESPs. The design and optimization of the inter-array and inter-link cable system will occur during the final design of Phase 2.

The inter-array and inter-link cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft). Based on currently available technologies, the inter-array and inter-link cables will likely be installed using jetting techniques. However, in some cases, a mechanical plow may be better suited to certain site-specific conditions and other specialty techniques may be used more rarely. The Proponent conservatively estimates that up to 2% of the total length of the inter-array and inter-link cables could require cable protection.

S-4.1.6 Landfall Site(s), Onshore Cable Route(s), Onshore Substation(s), and Grid Interconnection

The Phase 2 offshore export cables will come ashore at the Dowses Beach Landfall Site and/or Wianno Avenue Landfall Site in Barnstable, unless technical, logistical, grid interconnection, or other unforeseen issues arise that preclude the Proponent from installing one or more Phase 2 offshore export cables within the OECC and a second grid interconnection point is needed (see Section 4.1.3.3 of COP Volume I). The ocean to land transition at the Dowses Beach Landfall Site will be made using HDD, which will avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. HDD or open trenching may be used at the Wianno Avenue Landfall Site.

Upon making landfall, the onshore export cables would follow one or two Onshore Export Cable Routes to one or two new onshore substations. Grid interconnection cables installed along one or two Grid Interconnection Routes would connect the Phase 2 onshore substation(s) to the grid interconnection point at Eversource's existing 345 kV West Barnstable Substation. The onshore export and grid interconnection cables are expected to be installed underground within public roadway layouts and utility ROWs. From each landfall site to the grid interconnection point, the maximum combined length of the Phase 2 Onshore Export Cable Route and Grid Interconnection Route is up to 17 km (10.6 mi). The properties needed for the Phase 2 onshore substation site(s) have not yet been secured, but the site(s) will be located generally along the potential onshore routes illustrated on Figure 4.1-2 of COP Volume I.

In the event that one or more Phase 2 offshore export cables deliver power to a second grid interconnection point, Phase 2 could include one onshore transmission system in Barnstable (using either the Dowses Beach Landfall Site or Wianno Avenue Landfall Site) and/or an onshore transmission system(s) in proximity to the second grid interconnection point. See Section 4.1.4 of COP Volume I for additional details.

S-4.1.7 Port Facilities

The Proponent has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used for frequent crew transfer, offloading/loading shipments of components, storage, preparing components for installation, and potentially some component fabrication and assembly. In addition, some components, materials, and vessels could come from Canadian and European ports. See Section 4.2.2.5 of COP Volume I for a complete list of possible ports that may be used for major Phase 2 construction staging activities. It is not expected that all the ports identified would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.

S-4.2 Phase 2 Operations and Maintenance

The Phase 2 WTGs will be designed to operate without attendance by any operators. Continuous monitoring is typically conducted remotely using a SCADA system. Routine preventive maintenance and proactive inspections (e.g. multi-beam echosounder inspections, side scan sonar inspections, magnetometer inspections, depth of burial inspections, etc.) will be performed for all offshore facilities.

Once Phase 2 becomes operational, the Proponent expects to use an SOV to provide offshore accommodations and workspace for O&M workers. Under this scenario, daughter craft and/or CTVs would be used to transfer crew to and from shore. If an SOV or similar accommodation vessel is not used, several CTVs and helicopters could be used to frequently transport crew to and from the offshore facilities. In addition to the SOV, CTVs, and/or daughter craft, other larger support vessels (e.g. jack-up vessels) may be used infrequently to perform some routine maintenance and repairs (if needed).

In support of O&M activities for Phase 2, the Proponent will likely use O&M facilities in Bridgeport, Vineyard Haven, and/or New Bedford Harbor. The O&M facilities may include management and administrative team offices, a control room, office and training space for technicians and engineers, warehouse space for parts and tools, and/or pier space for vessels used during O&M. The Proponent may use any of the ports listed in Table 4.2-8 of COP Volume I to support O&M activities.

S-4.3 Phase 2 Decommissioning

As currently envisioned, the decommissioning process for Phase 2 is essentially the reverse of the installation process. Decommissioning of the offshore facilities is broken down into several steps:

- Retirement in place (if authorized by BOEM) or removal of the offshore cable system (i.e. inter-array, inter-link, and offshore export cable[s]) and any associated cable protection.

- Dismantling and removal of WTGs. Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids and chemicals, which would be brought to port for proper disposal and/or recycling.

- Cutting and removal of foundations and removal of scour protection. In accordance with BOEM's removal standards (30 CFR § 585.910(a)), the foundations would likely be cut at least 4.5 m (15 ft) below the mudline; the portion below the cut will likely remain in place. Suction buckets (if used) are anticipated to be removed by injecting water into the space between the suction bucket and seafloor to reduce the suction pressure that holds the foundation in place.

- Removal of ESP(s). The ESP(s) and their foundations are expected to be disassembled in a similar manner as the WTGs. Before removing the ESP(s), the offshore export cables, inter-array cables, and inter-link cables would be disconnected.

The onshore facilities could be retired in place or retained for future use. The extent of onshore decommissioning is subject to discussions with the Town of Barnstable on the approach that best meets the Town's needs and has the fewest environmental impacts.

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LIST OF ACRONYMS

ADLS	Aircraft Detection Lighting System
AIS	Automatic Identification System
BOEM	Bureau of Ocean Energy Management
CAA	Clean Air Act
Call	Call for Information and Nominations
CFR	Code of Federal Regulations
CIP	Copenhagen Infrastructure Partners
cm	Centimeters
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COP	Construction and Operations Plan
CPTs	Cone penetrometer tests
CRMC	Rhode Island Coastal Resources Management Council
CTV	Crew transfer vessel
CVA	Certified Verification Agent
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZM	Massachusetts Office of Coastal Zone Management
DEEP	Connecticut Department of Energy and Environmental Protection
DMF	Massachusetts Division of Marine Fisheries
DP	Dynamic positioning
DPU	Massachusetts Department of Public Utilities
DPW	Department of Public Works
DRI	Development of Regional Impact
DTS	Distributed Temperature System
EA	Environmental Assessment
EEA	Executive Office of Energy and Environmental Affairs
eGRID	Environmental Protection Agency's Emissions & Generation Resource Integrated Database
EFSB	Energy Facility Siting Board
ENF	Environmental Notification Form
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
ESA	Endangered Species Act
ESP	Electrical service platform
FAA	Federal Aviation Administration
FDR	Facility Design Report
FIR	Fabrication and Installation Report
FL	Fisheries Liaisons
FPVC	Flexible polyvinyl chloride

LIST OF ACRONYMS (CONTINUED)

FR	Fisheries Representatives
FONSI	Finding of No Significant Impact
ft	Feet
ft^2	Square feet
gal	Gallons
GIS	Gas-insulated substation
G.L.	General Law
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HSE	Health, safety, and environmental
HVAC	High voltage alternating current
IACC	Inter-Array Cable Corridors
IHA	Incidental Harassment Agreement
IMO	International Maritime Organization
ISO-NE	ISO New England
kJ	Kilojoules
km	Kilometers
km^2	Square kilometers
kV	Kilovolt
L	Liters
LID	Low-Impact Development
LOA	Letter of Authorization
m	meters
m^2	Square meters
MA	Massachusetts
MA WEA	Massachusetts Wind Energy Area
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MBTA	Migratory Bird Treaty Act
MBUAR	Massachusetts Board of Underwater Archaeological Resources
MEPA	Massachusetts Environmental Policy Act
MHC	Massachusetts Historical Commission
MHHW	Mean Higher High Water
mi	Miles
MLLW	Mean Lower Low Water
MRASS	Mariner Radio Activated Sound Signals

LIST OF ACRONYMS (CONTINUED)

MSD	Marine sanitization device
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MTBM	Microtunnel boring machine
MVC	Martha's Vineyard Commission
MW	Megawatt
NEFMC	New England Fishery Management Council
NEPA	National Environmental Policy Act
NHESP	Natural Heritage and Endangered Species Program
NHPA	National Historic Preservation Act
NM	Nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxide
NOI	Notice of Intent
NPCC	Northeast Power Coordinating Council
NPDES	National Pollutant Discharge Elimination System
NYSERDA	New York State Energy Research and Development Authority
O&M	Operations and Maintenance Facilities
OCS	Outer Continental Shelf
OECC	Offshore Export Cable Corridor
OEM	Original Equipment Manufacturers
OSRP	Oil Spill Response Plan
PATON	Private Aid to Navigation
PMP	Probable Maximum Precipitation
PPA	power purchase agreement
ProvPort	Port of Providence
PVC	Polyvinyl chloride
QP	Queue Position
RFI	Request for Interest
RI	Rhode Island
RI DEM	Rhode Island Department of Environmental Management
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
RNA	Rotor Nacelle Assembly
ROD	Record of Decision
RODA	Responsible Offshore Development Alliance
ROSA	Responsible Offshore Science Alliance
ROTV	Remotely operated towed vehicle
ROV	Remotely operated vehicle
ROW	Right-of-way

LIST OF ACRONYMS (CONTINUED)

SAP	Site Assessment Plan
SATVs	Service accommodation vessels
SCADA	Supervisory control and data acquisition
SF_6	Sulfur hexafluoride
SFH	Shootflying Hill
SOV	Service operation vessel
SWDA	Southern Wind Development Area
TBD	To be determined
TBF	To be filed
TP	Transition piece
tpy	Tons per year
TSHD	Trailing suction hopper dredge
US	United States
USACE	US Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
UXO	Unexploded ordnance
VGP	Vessel General Permit
VHF	Very High Frequency
WTG	Wind turbine generator
XLPE	Cross-linked polyethylene

STANDARD TERMINOLOGY

The following table defines standard terms that are used to throughout this Construction and Operations Plan (COP) to describe the elements of New England Wind.

Standard Term	Definition
New England Wind	The proposed development of offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0534 in two Phases comprised of up to 130 total wind turbine generator (WTG) and electrical service platform (ESP) positions. New England Wind also includes associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities.
Phase 1 of New England Wind	The first portion of New England Wind that will be developed is Phase 1, which is also known as Park City Wind. Phase 1 will deliver power to one or more Northeastern states and/or to other offtake users, including but not limited to 804 megawatts (MW) of power to Connecticut through interconnection to the ISO New England (ISO-NE) electric grid in West Barnstable, Massachusetts.
Phase 2 of New England Wind	The second portion of New England Wind that will be developed, which is also known as Commonwealth Wind. Phase 2 will be developed as one or more projects. Phase 2 will occupy the remainder of the Southern Wind Development Area (SWDA) that is not developed as part of Phase 1.
Vineyard Wind 1	Vineyard Wind 1 LLC's 800 MW project located in Lease Area OCS-A 0501. Vineyard Wind 1 was also formerly known as 501 North.
Project Design Envelope	The Project Design Envelope (the "Envelope") identifies a reasonable range of design parameters for each Phase of New England Wind, which allows the Proponent to properly define and bracket the characteristics of each Phase for the purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection and purchase of key components.
Offshore Geographical Terms	
Southern Wind Development Area (SWDA)	The entirety of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501 that will be developed as part of New England Wind in the event that Vineyard Wind 1 does not develop "spare" positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534.
Offshore Export Cable Corridor (OECC)	The corridor identified for routing both the Phase 1 and Phase 2 offshore export cables between the SWDA and the landfall sites. The New England Wind OECC will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel toward landfall sites in the Town of Barnstable.

STANDARD TERMINOLOGY (CONTINUED)

Standard Term	Definition
Offshore Geographical Terms (Continued)	
Phase 2 OECC Western Muskeget Variant	A variation of the Phase 2 OECC that travels along the western side of Muskeget Channel. The Proponent would exercise the option to install one or two Phase 2 offshore export cables within the Western Muskeget Variant, which was included and approved as part of the Vineyard Wind 1 OECC, if detailed engineering or other technical issues arise demonstrating that installation of all Phase 2 cables within a portion of the OECC in the Muskeget Channel area is not feasible.
Phase 2 OECC South Coast Variant	A variation of the Phase 2 OECC that diverges from the OECC at the northern boundary of Lease Area OCS-A 0501 and travels west-northwest to the state waters boundary near Buzzards Bay. The Proponent would employ the South Coast Variant if technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 export cables from interconnecting at the West Barnstable Substation.
Inter-Array Cable Corridors (IACCs)	The corridors identified for installing the inter-array cables, which are within the SWDA.
Lease Area OCS-A 0534	The BOEM lease area that will be developed for New England Wind.
Lease Area OCS-A 0501	The BOEM lease area held by Vineyard Wind 1 LLC that will be developed for Vineyard Wind 1. The southwest portion of Lease Area OCS-A 0501 may be developed as part of New England Wind in the event that “spare” or extra positions included in Lease Area OCS-A 0501 are not developed for Vineyard Wind 1 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534.
aliquot	Lease Area OCS-A 0534 includes two separate aliquots, which are each 1/64th of a BOEM Outer Continental Shelf (OCS) Lease Block, located along the northeastern boundary of Lease Area OCS-A 0501. Although the aliquots are a part of the SWDA, at this time, the Proponent does not intend to develop the two positions in these separate aliquots as part of New England Wind.
Offshore Development Area	The offshore area where New England Wind’s offshore facilities are physically located, which includes the SWDA and OECC.
Massachusetts Wind Energy Area (MA WEA) or Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA)	The areas off the coast of Massachusetts and Rhode Island designated by BOEM for wind energy development.
Offshore Development Region	The broader offshore geographic region that could be affected by New England Wind-related activities, which is defined specific to each resource.
Onshore Geographical Terms	
Onshore Export Cable Routes	The onshore routes within which the onshore export cables will be installed.
onshore substation site	A parcel of land where an onshore substation will be located.

STANDARD TERMINOLOGY (CONTINUED)

Standard Term	Definition
Onshore Geographical Terms (Continued)	
Grid Interconnection Routes	The onshore transmission routes that connect the onshore substations to the grid interconnection point.
Onshore Development Areas	Each Phase has a separate Onshore Development Area. For each Phase, the Onshore Development Area consists of the areas where the onshore facilities could be physically located, which includes the landfall sites, Onshore Export Cable Routes, onshore substation site(s), Grid Interconnection Routes, and grid interconnection point.
Onshore Development Region	The broader onshore geographic region that could be affected by New England Wind-related activities, which is defined specific to each resource.
Offshore Facilities	
offshore facilities	All offshore infrastructure (WTGs, ESPs, etc.).
wind turbine generator (WTG)	An offshore wind turbine located in the SWDA that will generate renewable, clean electricity.
electrical service platform (ESP)	An offshore substation located in the SWDA, which contains transformers and other electrical gear.
foundation	A steel (or possibly concrete) structure that supports a WTG or ESP and is secured or driven into the seabed. Foundations may be monopiles, jackets, and/or bottom-frame foundations.
monopile	A type of foundation consisting of a single, hollow cylindrical steel pile that is driven into the seabed.
transition piece (TP)	A part of the foundation structure that is installed between the monopile and WTG tower and contains secondary structures such as boat landing(s), internal and external platforms, and various electrical equipment needed during installation and operation.
jacket	A type of foundation with three to six legs that are secured to the seafloor using piles or suction buckets at the base of each leg.
bottom-frame	A type of foundation with triangular space-frame type structure that can be secured to the seafloor using driven piles or suction buckets.
scour protection	Rock or other protection placed around the base of a foundation to prevent sediment erosion.
inter-array cables	Submarine transmission cables that connect groups of WTGs to an ESP.
inter-link cable	A submarine transmission cable that may be used to connect ESPs together.
offshore export cable	The portion of the export cable that is located offshore beneath the seafloor, which connects the ESPs to the landfall sites.
offshore cable system	All offshore transmission cables (inter-array cables, inter-link cables, and offshore export cables).
cable protection	Rock, gabion rock bags, concrete mattresses, half-shell pipes, or other protection placed over an offshore cable to prevent damage to the cable.

STANDARD TERMINOLOGY (CONTINUED)

Standard Term	Definition
Onshore Facilities	
onshore facilities	All onshore infrastructure (onshore substations, onshore export cables, etc.).
landfall sites	The shoreline sites where the offshore export cables transition onshore.
transition vault	A type of splice vault where the offshore export cable is transitioned to the onshore export cable.
onshore export cable	The portion of the export cable that is located onshore underground and connects the landfall site to the onshore substation.
grid interconnection cables	The underground onshore cables that connect the onshore substation to the grid interconnection point.
duct bank	The underground structure that houses onshore export cables and typically consists of plastic pipes encased in concrete.
splice vault	An underground concrete "box" where segments of the onshore cables are joined together.
utility right-of-way (ROW)	Corridors that contain existing electric transmission lines or other utilities.
onshore substation	A landside substation constructed for New England Wind that contains transformers and other electrical gear.
West Barnstable Substation	Eversource's existing 345 kV substation in West Barnstable, which is the grid interconnection point for both Phases of New England Wind.
port facilities	Facilities and infrastructure located within/adjacent to a port that will be used by the Proponent during construction and operation of New England Wind.
operations and maintenance (O&M) facilities	All onshore buildings and infrastructure used to support O&M activities.
construction staging area	An onshore area to be used for unloading and loading equipment, final equipment assembly, etc.

Section 1.0

New England Wind Overview

1.0 NEW ENGLAND WIND OVERVIEW

1.1 Introduction

New England Wind is the proposal to develop offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0534 along with associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities. New England Wind will be developed in two Phases with a maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions. Four or five offshore export cables will transmit electricity generated by the WTGs to onshore transmission systems in the Town of Barnstable, Massachusetts. Figure 1.1-1 provides an overview of New England Wind. Park City Wind LLC, a wholly owned subsidiary of Avangrid Renewables, LLC, is the Proponent of this Construction and Operations Plan (COP) and will be responsible for the construction, operation, and decommissioning of New England Wind.

New England Wind's offshore renewable wind energy facilities are located immediately southwest of Vineyard Wind 1, which is located in Lease Area OCS-A 0501. New England Wind will occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 in the event that Vineyard Wind 1 does not develop "spare" or extra positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534. For the purposes of the COP, the Southern Wind Development Area (SWDA) is defined as all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501, as shown in Figure 1.1-1.

The SWDA may be approximately 411–453 square kilometers (km^2) (101,590–111,939 acres) in size depending upon the final footprint of Vineyard Wind 1. At this time, the Proponent does not intend to develop the two positions in the separate aliquots located along the northeastern boundary of Lease Area OCS-A 0501 as part of New England Wind (see Figure 1.1-1). The SWDA (excluding the two separate aliquots that are closer to shore) is just over 32 kilometers (km) (20 miles [mi]) from the southwest corner of Martha's Vineyard and approximately 38 km (24 mi) from Nantucket.[7] The WTGs and ESPs in the SWDA will be oriented in an east-west, north-south grid pattern with one nautical mile (NM) (1.85 km) spacing between positions.

Each Phase of New England Wind will be developed and permitted using a Project Design Envelope (the "Envelope"). This allows the Proponent to properly define and bracket the characteristics of each Phase for the purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection of key components, such as the WTGs, foundations, offshore cables, and ESPs. To assess potential impacts and benefits to various resources, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established considering the Envelope parameters for

[7] Within the SWDA, the closest WTG is approximately 34 km (21 mi) from Martha's Vineyard and 40 km (25 mi) from Nantucket.

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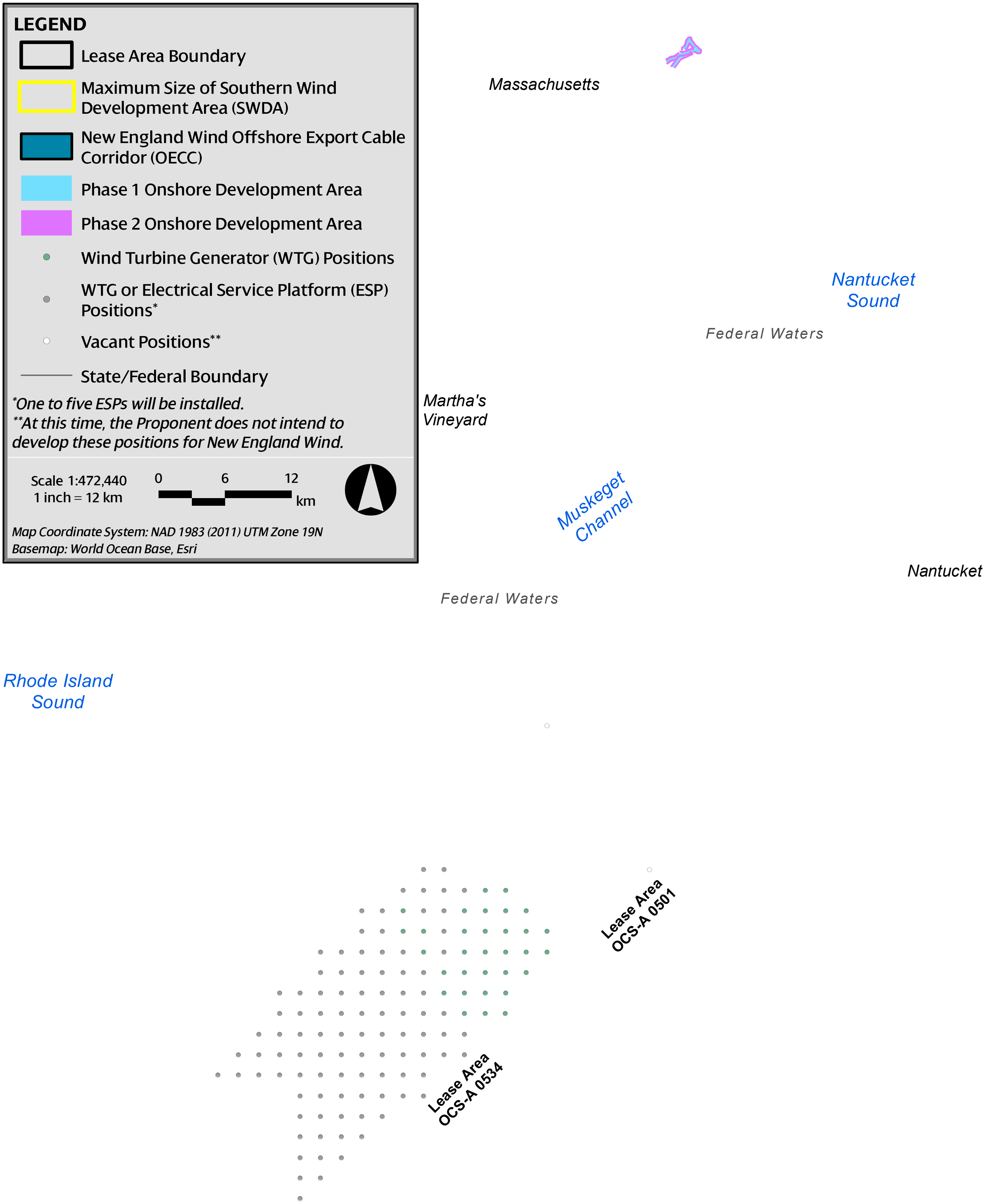

Figure 1.1-1

New England Wind Overview

each Phase that has the potential to cause the greatest effect. For some resources, this approach overestimates potential environmental impacts as the maximum design scenario is not the scenario that the Proponent is likely to employ.

Phase 1 of New England Wind

Phase 1, also known as Park City Wind, will be developed immediately southwest of the Vineyard Wind 1 project. The Phase 1 Envelope allows for 41 to 62 WTGs and one or two ESP(s). Depending upon the capacity of the WTGs, Phase 1 will occupy 150–231 km^2 (37,066–57,081 acres) of the SWDA. The Phase 1 Envelope includes two WTG foundation types: monopiles and piled jackets. Strings of WTGs will connect with the ESP(s) via a submarine inter-array cable transmission system. The ESP(s) will include step-up transformers that increase the voltage of power generated by the WTGs prior to transmission and other electrical equipment. The ESP(s) will also be supported by a monopile or jacket foundation. Two high-voltage alternating current (HVAC) offshore export cables up to 101 km (54 NM) in length (per cable) installed within the SWDA and an Offshore Export Cable Corridor (OECC) will transmit electricity from the ESP(s) to a landfall site at the Craigville Public Beach or Covell's Beach in the Town of Barnstable. Underground onshore export cables, located principally in roadway layouts, will connect the landfall site to a new Phase 1 onshore substation in Barnstable. Grid interconnection cables will then connect the Phase 1 onshore substation to the ISO New England (ISO-NE) electric grid at Eversource's existing 345 kilovolt substation in West Barnstable.

Phase 2 of New England Wind

Phase 2, also known as Commonwealth Wind, will be immediately southwest of Phase 1 and will occupy the remainder of the SWDA. Phase 2 may include one or more projects, depending on market conditions. The footprint and total number of WTG and ESP positions in Phase 2 depends upon the final footprint of Phase 1; Phase 2 is expected to contain 64 to 88 WTG/ESP positions (up to three positions will be occupied by ESPs) within an area ranging from 222–303 km^2 (54,857–74,873 acres). The Phase 2 Envelope includes three general WTG foundation types: monopiles, jackets (with piles or suction buckets), or bottom-frame foundations (with piles or suction buckets). Inter-array cables will transmit electricity from the WTGs to the ESP(s). The ESP(s) will also be supported by a monopile or jacket foundation (with piles or suction buckets).

Two or three HVAC offshore export cables, each with a maximum length of 116–124 km (63–67 NM) per cable, will transmit power from the ESP(s) to shore. Unless technical, logistical, grid interconnection, or other unforeseen issues arise, all Phase 2 offshore export cables will be installed within the same OECC as the Phase 1 cables from the northwestern corner of the SWDA to within approximately 2–3 km (1–2 mi) of shore, at which point the OECC for Phase 2 will diverge to reach the Dowses Beach Landfall Site and/or Wianno Avenue Landfall Site in Barnstable.[8] Underground onshore export cables, located primarily within in roadway layouts, will connect the landfall site(s) to one or two new onshore substations in the Town of Barnstable. Grid interconnection cables will then connect the onshore substation site(s) to the West Barnstable Substation.[9]

For both Phases, to support construction and operation activities, the Proponent will use a combination of North Atlantic ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and/or Canada.

1.2 Applicant's Purpose and Need

The purpose of New England Wind is to generate commercially sustainable offshore wind energy from Lease Area OCS-A 0534 located in the federally designated Massachusetts Wind Energy Area (MA WEA) to meet New England's need for clean, renewable energy. New England Wind will be developed in two phases that will deliver approximately 2,600 MW of clean energy to New England. New England Wind has already secured multiple Power Purchase Agreements (PPAs) that combined will deliver 2,036 MW of power to the ISO-NE electric grid under agreements with Connecticut and Massachusetts entities in accordance with the states' respective renewable energy requirements. Opportunities for New England Wind to deliver additional power to the ISO-NE electric grid are anticipated.

New England Wind will make an important contribution to meeting established renewable energy targets, enhancing energy security by increasing the reliability and diversity of the energy supply, reducing greenhouse gas emissions, and achieving significant health and environmental benefits. It will also generate large numbers of well-paying jobs and provide significant economic benefits to Connecticut, Massachusetts, and the New England region.

1.3 Plans for Phased Development

New England Wind will be developed in two Phases. Phase 1, also known as Park City Wind, will be located immediately southwest of Vineyard Wind 1. Phase 2, also known as Commonwealth Wind, will be located southwest of Phase 1 and occupy the remainder of the SWDA. Phase 2 may be developed as one or more projects, depending on market conditions. The timing of Phase 2

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8 As described further in Section 4.1.3, the Proponent has identified two variations of the Phase 2 OECC in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC.

9 One or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise. Under this scenario, Phase 2 could include one onshore transmission system in Barnstable and/or an onshore transmission system(s) in proximity to the second grid interconnection point (see Section 4.1.4).

development is uncertain and largely dependent upon market conditions. It is possible that Phase 2 construction could begin immediately following Phase 1[10] or could follow completion of Phase 1 construction by a number of years.

In accordance with BOEM guidance, New England Wind is being developed and permitted using a Project Design Envelope (the "Envelope") with each Phase having a separate Envelope. This allows the Proponent to properly define and bracket the characteristics of each Phase for the purposes of environmental review and permitting while maintaining a reasonable degree of flexibility with respect to the selection and purchase of key components (e.g. WTGs, ESP(s), foundations, offshore cables).[11] As the Proponent continues to bid into competitive power procurement processes, this flexible approach is particularly important to ensure that its projects can take advantage of rapidly advancing technology and produce cost-effective results for ratepayers.

Volume I presents the maximum Envelope for each Phase separately. However, as described in COP Volume III, due to the range of buildout scenarios for Phases 1 and 2, the sum of the maximum design scenarios for Phase 1 and Phase 2 does not equal the total maximum design scenario of New England Wind. The maximum design scenario used to assess the impacts and benefits of New England Wind is described in more detail in Section 3 of COP Volume III.

1.4 Organization of the COP

This COP is submitted in accordance with Title 30 of the Code of Federal Regulations (CFR) Part 585 (30 CFR § 585). The COP describes the construction and operation of each Phase of New England Wind, covering all planned facilities, including onshore and support facilities, and all anticipated project easements needed for New England Wind. It also describes the activities related to each Phase including construction, commercial operations, maintenance, and decommissioning. It demonstrates that the Proponent is prepared to conduct the proposed activities in each Phase in accordance with all applicable regulations and that New England Wind is safe, does not unreasonably interfere with other uses of the Outer Continental Shelf (OCS), does not cause undue harm to the environment or objects of historical or archeological significance, and will use the best available technology.

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10 In this scenario, each major construction activity would be sequential for the two Phases (e.g. Phase 2 foundation installation would immediately follow Phase 1 foundation installation). However, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g. Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). There will be no concurrent/simultaneous pile driving of foundations.

11 The evolution of offshore wind technology toward less expensive and more efficient concepts often outpaces the speed of permitting processes. As BOEM recognized in its National Offshore Wind Strategy, the envelope concept allows for optimized projects once permitting is complete while ensuring a comprehensive review of the project by regulators and stakeholders.

The COP is comprised of three volumes:

- Volume I provides a detailed description of the construction and operation of each Phase of New England Wind:
  - Section 2 provides a more general discussion of the location and siting of New England Wind (both Phases 1 and 2).
  - Section 3 describes Phase 1's location, offshore and onshore facilities, support facilities, construction activities, O&M activities, conceptual decommissioning plan, and health, safety, and environmental (HSE) protection measures. Section 3 also describes the environmental and technical considerations that factored into the siting and design of Phase 1.
  - Section 4 describes Phase 2's location, offshore and onshore facilities, support facilities, construction activities, O&M activities, conceptual decommissioning plan, and HSE protection measures. Section 4 also describes the environmental and technical considerations that factored into the siting and design of Phase 2.
  - Section 5 describes the permitting process and stakeholder outreach for both Phases of New England Wind.
- Volume II describes the geophysical and geotechnical surveys conducted for New England Wind and provides a comprehensive analysis of the data collected.
- Volume III details the benefits and potential impacts to physical, atmospheric, biological, economic, cultural, and historic resources based on the "maximum design scenario" for each resource. Volume III also identifies measures to avoid, minimize, and mitigate impacts from New England Wind.

1.4.1 Guide to Location of Required Information for COP

Table 1.4-1 lists BOEM's COP regulations and where the corresponding information can be found in this COP. Table 1.4-2 lists all information that will be submitted to BOEM after the submission of the COP.

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d)

Requirement	Location in COP
30 CFR §585.105(a)	
1) Design your projects and conduct all activities in a manner that ensures safety and will not cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components to the extent practicable; and take measures to prevent unauthorized discharge of pollutants including marine trash and debris into the offshore environment.	Section 1.5 of Volume I Section 3 of Volume I Section 4 of Volume I Appendix I-B Appendix I-E Appendix I-F Section 4 of Volume III Section 5 of Volume III Section 6 of Volume III Section 8 of Volume III Appendix III-F Appendix III-M Appendix III-P Appendix III-Q Appendix III-R
30 CFR §585.621(a-g)	
a) The project will conform to all applicable laws, implementing regulations, lease provisions, and stipulations or conditions of the lease.	Section 1.4 (Table 1.4-1) of Volume I Section 1.5 (Table 1.5-1) of Volume I Section 3 of Volume I Section 4 of Volume I Section 5 (Table 5.1-1) of Volume I Appendix I-E
b) The project will be safe.	Section 1.5 of Volume I Section 3.3.4 of Volume I Section 4.3.4 of Volume I Appendix I-B
c) The project will not unreasonably interfere with other uses of the OCS, including those involved with National security or defense.	Section 7.5 of Volume III Section 7.6 of Volume III Section 7.8 of Volume III Section 7.9 of Volume III Appendix III-E Appendix III-I Appendix III-J Appendix III-N
d) The project will not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archeological significance.	Section 4 of Volume III Section 5 of Volume III Section 6 of Volume III Section 7 of Volume III Volume II-D Appendix III-B Appendix III-F Appendix III-G

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.621(a-g) (Continued)	
	Appendix III-H.a Appendix III-H.b Appendix III-I Appendix III-J Appendix III-M
e) The project will use the best available and safest technology.	Section 1.5 of Volume I Section 3.1.1 of Volume I Section 3.2.3 of Volume I Section 4.1.1 of Volume I Section 4.2.3 of Volume I Appendix I-B Appendix I-E
f) The project will use best management practices.	Section 4 of Volume III
g) The project will use properly trained personnel.	Section 3.3.2 of Volume I Section 3.3.4 of Volume I Section 4.3.2 of Volume I Section 4.3.4 of Volume I Appendix I-B
30 CFR §585.626(a)	
(1) Shallow Hazards	
(i) Shallow faults;	Section 3.2 (Table 3.2-1) of Volume II-A
(ii) Gas seeps or shallow gas;	Section 3.2 (Table 3.2-1) of Volume II-A
(iii) Slump blocks or slump sediments;	Section 3.2 (Table 3.2-1) of Volume II-A
(iv) Hydrates; or	Section 3.2 (Table 3.2-1) of Volume II-A
(v) Ice scour of seabed sediments	Section 3.2 (Table 3.2-1) of Volume II-A
(2) Geological survey relevant to the design and siting of facility	
(i) Seismic activity at your proposed site;	Section 4.1 (Table 4.1-1) of Volume II-A
(ii) Fault zones;	Section 4.1 (Table 4.1-1) of Volume II-A
(iii)The possibility and effects of seabed subsidence; and	Section 4.1 (Table 4.1-1) of Volume II-A
(iv) The extent and geometry of faulting attenuation effects of geological conditions near your site.	Section 4.1 (Table 4.1-1) of Volume II-A
(3) Biological	
(i) A description of the results of biological surveys used to determine the presence of live bottoms, hard bottoms, and topographic features, and surveys of other marine resources such as fish populations (including migratory populations), marine mammals, sea turtles, and sea birds.	Section 5 of Volume II-A Section 6 of Volume III Appendix III-C Appendix III-F Appendix III-M

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.626(a) (Continued)	
(4) Geotechnical Survey	
(i) The results of a testing program used to investigate the stratigraphic and engineering properties of the sediment that may affect the foundations or anchoring systems for your facility.	Section 2.1.2.2 of Volume II-A (summary) Appendix F of Volume II-A Appendix N of Volume II-B Appendix V of Volume II-B Appendix AG of Volume II-C
(ii) The results of adequate in situ testing, boring, and sampling at each foundation location, to examine all important sediment and rock strata to determine its strength classification, deformation properties, and dynamic characteristics.	Section 2.1.2.2 of Volume II-A (summary) Appendix F of Volume II-A Appendix N of Volume II-B Appendix V of Volume II-B Appendix AG of Volume II-C
(iii) The results of a minimum of one deep boring (with soil sampling and testing) at each edge of the project area and within the project area as needed to determine the vertical and lateral variation in seabed conditions and to provide the relevant geotechnical data required for design.	Section 2.1.2.2 of Volume II-A (summary) Appendix F of Volume II-A Appendix N of Volume II-B Appendix V of Volume II-B Appendix AG of Volume II-C
(5) Archeological Resources	
(i) A description of the historic and prehistoric archaeological resources, as required by the National Historic Preservation Act (NHPA) (16 U.S.C. 470 et. seq.), as amended.	Volume II-D (marine) Section 7.3 of Volume III (terrestrial and marine) Section 7.4 of Volume III (visual) Appendix III-G (terrestrial) Appendix III-H.b (visual)
(6) Overall Site Investigation	
(i) Scouring of the seabed;	Section 3.2 (Table 3.2-1 and Section 3.2.2) of Volume II-A Section 4.1 (Table 4.1-1) of Volume II-A
(ii) Hydraulic instability;	Section 4.1 (Table 4.1-1) of Volume II-A
(iii) The occurrence of sand waves;	Section 3.2 (Section 3.2-1) of Volume II-A Section 4.1 (Table 4.1-1) of Volume II-A
(iv) Instability of slopes at the facility location;	Section 3.2 (Table 3.2-1) of Volume II-A Section 4.1 (Table 4.1-1) of Volume II-A
(v) Liquefaction, or possible reduction of sediment strength due to increased pore pressures;	Section 4.1 (Table 4.1-1) of Volume II-A
(vi) Degradation of subsea permafrost layers;	Section 4.1 (Table 4.1-1) of Volume II-A
(vii) Cyclic loading;	Section 4.1 (Table 4.1-1 and Section 4.1.2) of Volume II-A
(viii) Lateral loading;	Section 4.1 (Table 4.1-1 and Section 4.1.2) of Volume II-A

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.626(a) (Continued)	
(6) Overall Site Investigation	
(ix) Dynamic loading;	Section 4.1 (Table 4.1-1) of Volume II-A
(x) Settlements and displacements;	Section 4.1 (Table 4.1-1) of Volume II-A
(xi) Plastic deformation and formation collapse mechanisms; and	Section 4.1 (Table 4.1-1) of Volume II-A
(xii) Sediment reactions on the facility foundations or anchoring systems.	Section 4.1 (Table 4.1-1) of Volume II-A
30 CFR §585.626(b)	
(1) Contact information	Section 1.6.1 of Volume I
(2) Designation of operator, if applicable	Section 1.6.2 of Volume I
(3) The construction and operation concept	Section 3.1.1 of Volume I Section 4.1.1 of Volume I
(4) Commercial lease stipulations and compliance	Section 1.5 of Volume I
(5) A location plat	Section 3.1.1.2 (Figure 3.1-1 and Figure 3.1-2) of Volume I Section 4.1.1.2 (Figure 4.1-1 and Figure 4.1-2) of Volume I
(6) General structural and project design, fabrication, and installation	Section 2 of Volume I Section 3 of Volume I Section 4 of Volume I Appendix I-E
(7) All cables and pipelines, including cables on project easements	Section 2.3 of Volume I Section 3.1.3 of Volume I Section 3.2.1.5 of Volume I Section 3.2.1.6 of Volume I Section 3.2.2.2 of Volume I Section 3.2.2.4 of Volume I Section 3.3.1.3 of Volume I Section 3.3.1.6 of Volume I Section 3.3.1.8 of Volume I Section 3.3.1.10 of Volume I Section 3.3.2.3 of Volume I Section 3.3.3 of Volume I Section 4.1.3 of Volume I Section 4.2.1.5 of Volume I Section 4.2.1.6 of Volume I Section 4.3.1.3 of Volume I Section 4.3.1.6 of Volume I Section 4.3.2.3 of Volume I Section 4.3.3 of Volume I

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.626(b) (Continued)	
(8) A description of the deployment activities	Section 3.2.3 of Volume I Section 3.3.1 of Volume I Section 3.3.4 of Volume I Section 4.2.3 of Volume I Section 4.3.1 of Volume I Section 4.3.4 of Volume I
(9) A list of solid and liquid wastes generated	Section 3.3.4.4 (Table 3.3-5) of Volume I Section 4.3.4.4 (Table 4.3-6) of Volume I
(10) A listing of chemical products used (if stored volume exceeds Environmental Protection Agency Reportable Quantities)	Section 3.3.4.4 (Table 3.3-6) of Volume I Section 4.3.4.4 (Table 4.3-7) of Volume I
(11) A description of any vessels, vehicles, and aircraft you will use to support your activities	Section 3.2.2.6 of Volume I Section 3.3.1.12 (Table 3.3-1) of Volume I Section 3.3.2.6 of Volume I Section 4.2.2.6 of Volume I Section 4.3.1.12 (Table 4.3-1) of Volume I Section 4.3.2.6 of Volume I Section 5.1 of Volume III Section 7.8 of Volume III Appendix III-B Appendix III-I
(12i) A general description of the operating procedures and systems under normal conditions	Section 3.3.2 of Volume I Section 4.3.2 of Volume I Appendix I-B
(12ii) A general description of the operating procedures and systems in the case of accidents or emergencies, including those that are natural or manmade.	Section 3.3.2.4 of Volume I Section 4.3.2.4 of Volume I Appendix I-B Appendix I-F Section 8 of Volume III
(13) Decommissioning and site clearance procedures	Section 3.3.3 of Volume I Section 4.3.3 of Volume I
(14i) A listing of all Federal, State, and local authorizations, approvals, or permits that are required to conduct the proposed activities, including commercial operations. The list should contain U.S. Coast Guard, U.S. Army Corps of Engineers, and any authorizations pertaining to energy gathering, transmission or distribution (e.g. interconnection authorizations).	Section 5 (Table 5.1-1) of Volume I

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.626(b) (Continued)	
(14ii) A listing of all Federal, State, and local authorizations, approvals, or permits that are required to conduct the proposed activities, including commercial operations, along with a statement indicating whether you have applied for or obtained such authorization, approval, or permit.	Section 5 (Table 5.1-1) of Volume I
(15) Your proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts	Section 4 (Table 4.2-1) of Volume III Section 5 of Volume III Section 6 of Volume III Section 7 of Volume III Section 8 of Volume III Appendix III-F Appendix III-M Appendix III-R
(16) Information you incorporate by reference	Section 6 of Volume I Section 9 of Volume III
(17) A list of agencies and persons with whom you have communicated, or with whom you will communicate, regarding potential impacts associated with your proposed activities	Section 5.1 (Table 5.1-1) of Volume I Section 5.2 (Table 5.2-1) of Volume I Section 5.3 of Volume I
(18) Reference	Section 6 of Volume I Section 9 of Volume III
(19) Financial assurance	Section 3.3.3.5 of Volume I Section 4.3.3.5 of Volume I
(20) CVA nominations for reports required in subpart G of this part	Section 3.2.3.2 of Volume I Section 4.2.3.2 of Volume I Appendix I-C Appendix I-D
(21) Construction schedule	Section 1.3 of Volume I Section 3.1.1.3 (Figure 3.1-3) of Volume I Section 3.3.1.1 of Volume I Section 4.1.1.3 (Figure 4.1-3) of Volume I Section 4.3.1.1 of Volume I
(22) Air quality information	Section 5.1 of Volume III Appendix III-B
(23) Other information	Section 1 of Volume I Section 3 of Volume III Section 4 of Volume III

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.627(a)	
(1) Hazard information	Section 3 of Volume II-A Section 4 of Volume II-A Appendix III-A Appendix III-P Appendix III-Q
(2) Water quality	Appendix I-F Section 5.2 of Volume III Appendix III-A
(3)(i) Benthic communities	Section 5 of Volume II-A Section 6.5 of Volume III Appendix III-F
(3)(ii) Marine mammals	Section 6.7 of Volume III Appendix III-M
(3)(iii) Sea turtles	Section 6.8 of Volume III Appendix III-M
(3)(iv) Coastal and marine birds	Section 6.2 of Volume III Section 6.4 of Volume III Appendix III-C Appendix III-R
(3)(v) Fish and shellfish	Section 6.5 of Volume III Section 6.6 of Volume III Appendix III-F Appendix III-M
(3)(vi) Plankton	Section 6.6 of Volume III Appendix III-F
(3)(vii) Seagrasses	Section 5.2.2 of Volume II-A Section 6.4 of Volume III Appendix III-F
(3)(viii) Plant life	Section 6.1 of Volume III Section 6.4 of Volume III
(4) Threatened or endangered species	Section 6 of Volume III Appendix III-C Appendix III-D Appendix III-M Appendix III-R

Table 1.4-1 Construction and Operations Plan Requirements for Commercial Leases Pursuant to 30 CFR §585.105(a), 621 (a-g), 626(a) and (b), 627(a-d) (Continued)

Requirement	Location in COP
30 CFR §585.627(a) (Continued)	
(5) Sensitive biological resources or habitats	Section 5.2 of Volume II-A (marine-benthic) Section 6 of Volume III Appendix III-C Appendix III-D Appendix III-F Appendix III-M Appendix III-R
(6) Archaeological resources	Volume II-D (marine) Section 7.3 of Volume III (terrestrial and marine) Section 7.4 of Volume III (visual) Appendix III-G (terrestrial) Appendix III-H.b (visual)
(7) Social and economic resources	Section 7 of Volume III Appendix III-E Appendix III-H.a Appendix III-H.b Appendix III-L Appendix III-N Appendix III-O
(8) Coastal and marine uses	Section 7.5 of Volume III Section 7.6 of Volume III Section 7.7 of Volume III Section 7.8 of Volume III Section 7.9 of Volume III Appendix III-E Appendix III-I Appendix III-N
(9) Consistency certification	Appendix III-S
(10) Other resources, conditions, and activities	Section 5.1 of Volume III Section 6.3 of Volume III Section 7.9 of Volume III Appendix III-B Appendix III-J Appendix III-K Appendix III-U
30 CFR §585.627(b)	
Consistency certification	Appendix III-S
30 CFR §585.627(c)	
Oil spill response plan	Appendix I-F
30 CFR §585.627(d)	
Safety management system	Appendix I-B

Table 1.4-2 Information to Be Provided After COP Submission

Information	Expected Submission Date
Supplemental geophysical, geotechnical, and biological data for the Phase 2 OECC South Coast Variant	April 2022
Deep geotechnical data	Departure request for deep geotechnical data approved by BOEM on April 22, 2021
Phase 2 Certified Verification Agent (CVA) nomination	Departure request for Phase 2 CVA nomination approved by BOEM on April 28, 2021
Request for cable easement(s) per 30 CFR Parts 585.200 and 585.620	Prior to the Record of Decision (exact timing to be determined pending ongoing consultation with BOEM)

1.5 Commercial Lease Stipulations and Compliance

Table 1.5-1 demonstrates compliance with the stipulations in Lease OCS-A 0534.

Table 1.5-1 Commercial Lease Stipulations and Compliance

Stipulation	Compliance
Section 4(a): The lessee must make all rent payments to the Lessor in accordance with applicable regulations in 30 CFR Part 585, unless otherwise specified in Addendum "B".	The Proponent has made and will continue to make all rent payments in accordance with applicable regulations, unless otherwise specified in Addendum "B."
Section 4(b): The Lessee must make all operating fee payments to the Lessor in accordance with applicable regulations in 30 CFR Part 585, as specified in Addendum "B".	The Proponent will make all operating fee payments in accordance with applicable regulations.
Section 5: The Lessee may conduct those activities described in Addendum "A" only in accordance with a Site Assessment Plan (SAP) or Construction and Operations Plan (COP) approved by the Lessor. The Lessee may not deviate from an approved SAP or COP except as provided in applicable regulations in 30 CFR Part 585.	The Proponent will conduct activities as described in the COP.
Section 7: The Lessee must conduct, and agrees to conduct, all activities in the leased area in accordance with an approved SAP or COP, and with all applicable laws and regulations.	The Proponent will conduct all activities in the leased area in accordance with the COP and all applicable laws and regulations.
Section 10: The Lessee must provide and maintain at all times a surety bond(s) or other form(s) of financial assurance approved by the Lessor in the amount specified in Addendum "B".	The Proponent will provide the necessary financial assurances as described in Sections 3.3.3.5 and 4.3.3.5.
Section 13: Unless otherwise authorized by the Lessor, pursuant to the applicable regulations in 30 CFR Part 585, the Lessee must remove or decommission all facilities,	Preliminary decommissioning plans are described in Sections 3.3.3.4 and 4.3.3.4. The decommissioning will be in accordance with the applicable regulations.

Table 1.5-1 Commercial Lease Stipulations and Compliance (Continued)

Stipulation	Compliance
projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP, or approved Decommissioning Application, and applicable regulations in 30 CFR Part 585.	
Section 14: The Lessee must (a) Maintain all places of employment for activities authorized under this lease in compliance with occupational safety and health standards and, in addition, free from recognized hazards to employees of the Lessee or of any contractor or subcontractor operating under this lease; (b) Maintain all operations within the leased areas in compliance with regulations in 30 CFR Part 585 and orders from the Lessor and other Federal agencies with jurisdiction, intended to protect persons, property and the environment on the OCS; and (c) Provide any requested documents and records, which are pertinent to occupational or public health, safety, or environmental protection, and allow prompt access, at the site of any operation or activity conducted under this lease, to any inspector authorized by the Lessor or other Federal agency with jurisdiction.	(a) The Proponent will maintain all places of employment in compliance with applicable standards. (b) The Proponent will maintain all operations in the leased area in compliance with applicable regulations. (c) The Proponent will provide any requested documents and records.
Section 15: The Lessee must comply with the Department of the Interior's non-procurement debarment and suspension regulations set forth in 2 CFR Parts 180 and 1400 and must communicate the requirement to comply with these regulations to persons with whom it does business related to this lease by including this requirement in all relevant contracts and transactions.	The Proponent will comply with the applicable Department and suspension regulations.
Section 16: During the performance of this lease, the Lessee must fully comply with paragraphs (1) through (7) of section 202 of Executive Order 11246, as amended (reprinted in 41 CFR 60-1.4(a)), and the implementing regulations, which are for the purpose of preventing employment discrimination against persons on the basis of race, color, religion, sex, or national origin.	The Proponent will fully comply with paragraphs (1) through (7) of section 202 of Executive Order 11246, as amended.
Addendum "B", Section III (Payments): Unless otherwise authorized by the Lessor in accordance with the applicable regulations in 30 CFR Part 585, the Lessee must make payments as described below.	The Proponent will make payments as stipulated in Addendum "B", Section III.

1.6 Company Overview

Park City Wind LLC (the “Proponent”) is a wholly owned subsidiary of Avangrid Renewables, LLC (Avangrid Renewables). The Proponent’s team includes scientists, engineers, and managers with decades of experience developing offshore and onshore wind projects throughout the US, Europe, and Southeast Asia. The Proponent is supported by numerous expert consultants and partners to ensure a well-rounded team with the skillsets required to develop and operate offshore wind projects in the US.

Many of the Proponent’s staff, consultants, and partners were heavily involved in the development of the Vineyard Wind 1 project, which is a joint venture of Avangrid Renewables and Copenhagen Infrastructure Partners. Vineyard Wind 1 is the most advanced commercial-scale offshore wind project in the United States (US). Permitting for Vineyard Wind 1 is complete and onshore construction of Vineyard Wind 1 commenced in 2021. The Proponent’s experience with the offshore wind permitting process for Vineyard Wind 1, at both the federal level and in Massachusetts, serves as a solid foundation for a successful permitting strategy for New England Wind.

The Proponent also benefits from the expertise and management capabilities of its owner, Avangrid Renewables, and its affiliates. Avangrid Renewables is the third largest developer of onshore wind projects in the US and strives to lead the nation’s transformation to a sustainable, competitive, and clean energy future. The company is headquartered in Portland, Oregon and has regional offices in Boston, Philadelphia, Chicago, and Austin as well as a project office in the City of Virginia Beach. Avangrid Renewables has more than 8,490 MW of owned and controlled wind, solar, and thermal generation, of which 7,734 MW is installed wind capacity, including four onshore wind projects in New England. Avangrid Renewables also began developing the Kitty Hawk Offshore Wind Project located in Lease Area OCS-A 0508 off the coast of North Carolina in 2017.

Avangrid Renewables is wholly owned by AVANGRID, Inc., which is listed on the New York Stock Exchange as AGR. AVANGRID has two primary lines of business: Avangrid Networks and Avangrid Renewables. Avangrid Networks owns eight electric and natural gas utilities, serving 3.3 million customers in New York and New England. AVANGRID supports the United Nations’ Sustainable Development Goals and was awarded Compliance Leader Verification by Ethisphere, a prestigious third-party verification of its ethics and compliance program.

AVANGRID’s majority shareholder is Iberdrola S.A. (Iberdrola). Iberdrola is an energy pioneer with one of the largest renewable asset bases of any company in the world, including more than 32,000 MW of renewable energy spread across a dozen countries. The Proponent will be supported by personnel from AVANGRID’s and Iberdrola’s affiliates, such as Avangrid Networks, ScottishPower Renewable Energy Ltd. (ScottishPower Renewables), and Iberdrola Renovables SAS (Iberdrola Renovables). These affiliates have substantial expertise in offshore and onshore wind development, transmission project development, finance, construction, and operations.

Iberdrola's first offshore wind project, West on Duddon Sands, was a joint venture between Iberdrola's subsidiary Scottish Power and Ørsted. This 389 MW project located in the UK has been fully operational since 2014. Wikinger followed shortly after as Iberdrola's first solo project. Wikinger is a 350 MW project based in the German Baltic Sea and became fully operational in 2017. East Anglia ONE, the company's largest project completed to date, became fully operational in July 2020 with an installed capacity of 714 MW. Iberdrola recently started construction of the 496 MW Saint-Brieuc project off the coast of France along with the 476 MW Baltic Eagle project in the German Baltic Sea.

1.6.1 Contact Information

The point of contact for New England Wind is Saygin (Sy) Oytan. His contact information is provided below:

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(971) 269-8929
sy.oytan@avangrid.com

1.6.2 Designation of Operator

The operator for each Phase of New England Wind will be Park City Wind LLC.

Section 2.0

New England Wind Siting and Location

2.0 NEW ENGLAND WIND SITING AND LOCATION

2.1 Massachusetts Wind Energy Area Siting History

The Bureau of Ocean Energy Management (BOEM) has evaluated areas along the Atlantic coast with respect to their potential suitability for offshore wind development via a public stakeholder and desktop screening[12] process, which began in 2009. The location of the Massachusetts offshore wind lease areas, including Lease Areas OCS-A 0534 and OCS-A 0501, was determined through a multi-step process that involved significant public input over a period of approximately six years (BOEM 2020).

The process began with the formation of the Massachusetts Intergovernmental Renewable Energy Task Force ("Massachusetts Task Force"), which is composed of representatives from many federal, state, tribal, and local government agencies, as well as public stakeholder meetings. Based on deliberation and consultation with the Massachusetts Task Force,[13] BOEM published a Request for Interest (RFI) on December 29, 2010 an approximately 7,628 square kilometer (km^2) (1,884,920 acre) area offshore Massachusetts to consider for wind energy development, referred to as the "RFI Area." This RFI requested expressions of commercial interest from potential wind energy developers, as well as any information from the public relevant to determining the suitability of the RFI Area for offshore wind development. After the initial round of responses to the RFI, BOEM announced a second public comment period, which closed on April 18, 2011 (see 76 FR 14682). Ten companies responded to the RFI and 260 public comments were received.

After careful consideration of the public comments, as well as input from the Massachusetts Task Force, BOEM extensively modified the RFI Area to address stakeholder concerns. For example, BOEM excluded Outer Continental Shelf (OCS) Lease Blocks east of the 70° longitude line to protect valuable fisheries resources. BOEM also excluded areas within 1.9 km (1 NM) of traffic separation schemes to address navigational concerns (see 77 FR 5820).

On February 6, 2012, BOEM published a "Call for Information and Nominations" ("Call") for areas within the revised RFI Area (the "Call Area"). The Call requested the submission of a nomination for a lease by those interested in potentially obtaining a commercial lease in the Call Area and allowed interested and affected parties to provide comments about site conditions, resources, or uses within the Call Area. That same month, BOEM also published a Notice of Intent (NOI) to prepare an Environmental Assessment (EA) for the Call Area. The comment period for the Call and NOI yielded 32 comments and 10 nominations of commercial interest.

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12 Conducted by the Department of Energy's National Renewable Energy Laboratory.

13 For example, the Commonwealth initially proposed a development buffer of 17 km (9 NM) from shore, but based on input from Massachusetts Task Force, BOEM revised the RFI Area to begin 22 km (12 NM) offshore to further reduce visual impacts.

In May 2012, BOEM publicly identified a Massachusetts Wind Energy Area (MA WEA). After careful consideration of the public comments on the Call, including those from the fishing community, BOEM excluded portions of the Call Area that were identified as important habitats that could be adversely affected if ultimately used for offshore wind energy development. Specifically, BOEM excluded an area of high fisheries value to reduce potential conflict with commercial and recreational fishing activities as well as an area of high sea duck concentration (BOEM 2012). These additional revisions resulted in the MA WEA being reduced in size, as compared to the original RFI Area, by approximately 60%.

BOEM's EA was made available for public review on November 12, 2012. Among other issues, the EA considered potential impacts to the endangered North Atlantic right whale (*Eubalaena glacialis*) and potential effects on viewsheds. Comments on the EA were considered by BOEM and the revised EA for the MA WEA was issued on June 4, 2014. As a result of the analysis presented in the revised EA, BOEM issued a "Finding of No Significant Impact," which concluded that reasonably foreseeable environmental effects associated with the commercial wind lease issuance and related activities would not significantly impact the environment.

On June 17, 2014, BOEM and Massachusetts announced that 3,002 km^2 (742,000 acres) comprising the MA WEA would be made available for commercial wind energy leasing. On January 29, 2015, BOEM held a competitive lease sale, conducted as an auction, for the lease areas within BOEM's MA WEA. Offshore MW LLC, which was subsequently renamed to Vineyard Wind LLC, won Lease Area OCS-A 0501 in the auction. In June 2021, Lease Area OCS-A 0501 was segregated into two lease areas: Lease Area OCS-A 0534 and Lease Area OCS-A 0501 (see Figures 2.1-1 and 2.1-2). Then, in late 2021, Lease Area OCS-A 0534 was assigned from Vineyard Wind LLC to Park City Wind LLC.

2.2 Southern Wind Development Area

As noted above and discussed in subsequent sections, the Southern Wind Development Area (SWDA) includes all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501. Lease Area OCS-A 0501 contains 10 "spare" or extra wind turbine generator (WTG) positions for Vineyard Wind 1. If some or all of those spare positions are not developed for Vineyard Wind 1, they will be assigned to Lease Area OCS-A 0534 and developed as part of New England Wind. Thus, the SWDA includes 120–130 WTG/electrical service platform (ESP) positions (see Figure 2.2-1).

The SWDA will be approximately 411–453 km^2 (101,590–111,939 acres) in size depending on the final footprint of Vineyard Wind 1. The SWDA includes two separate aliquots, which are each 1/64th of a BOEM Outer Continental Shelf (OCS) Lease Block, located along the northeastern boundary of Lease Area OCS-A 0501. Although these aliquots are a part of the SWDA, at this time, the Proponent does not intend to develop the two "vacant" positions located in these separate aliquots as part of New England Wind (see Figure 2.2-1). The SWDA (excluding the two separate aliquots that are closer to shore) is just over 32 km (20 miles [mi]) from the southwest corner of

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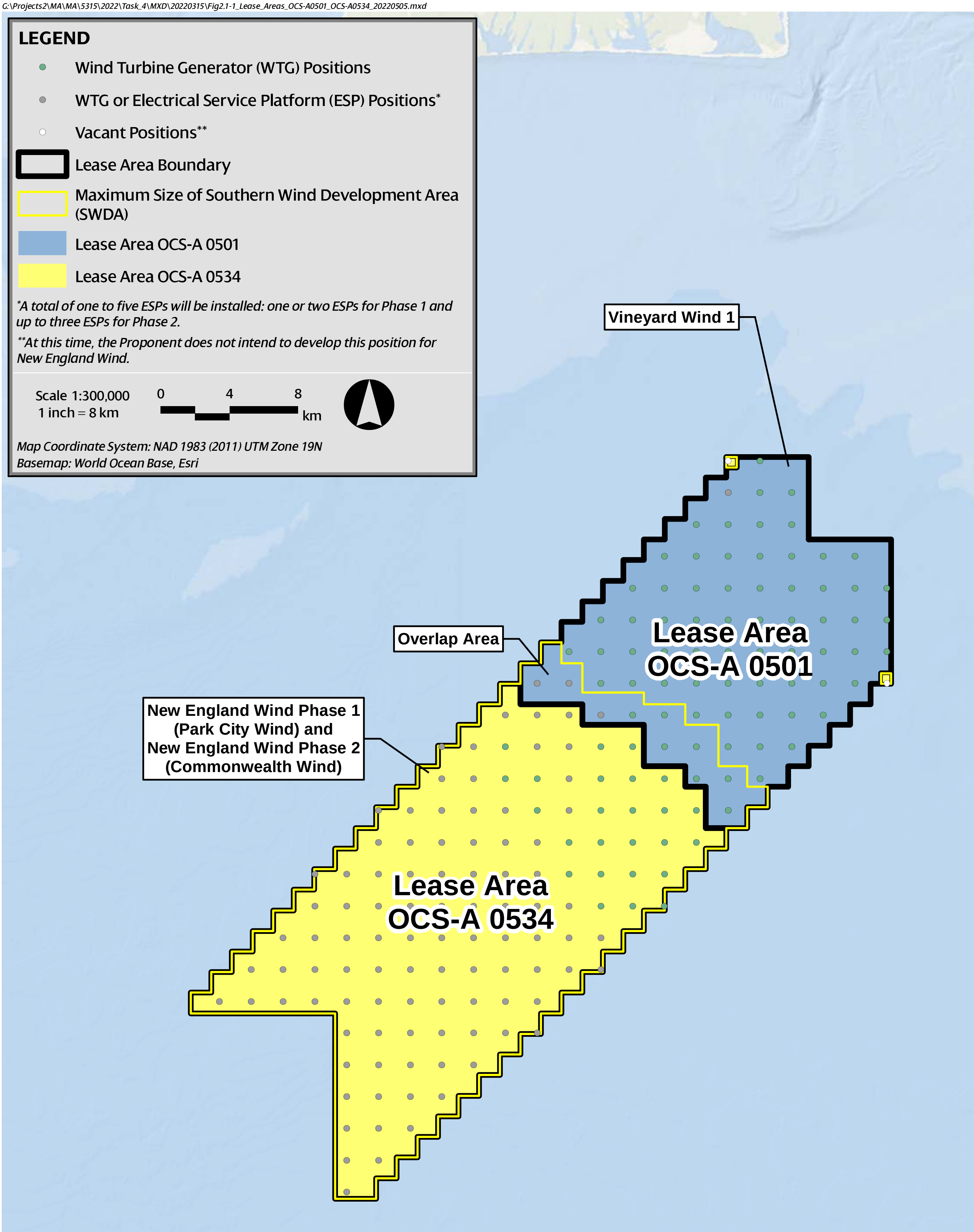

New England Wind
AVANGRID RENEWABLES

Figure 2.1-1

Lease Areas OCS-A 0501 and OCS-A 0534

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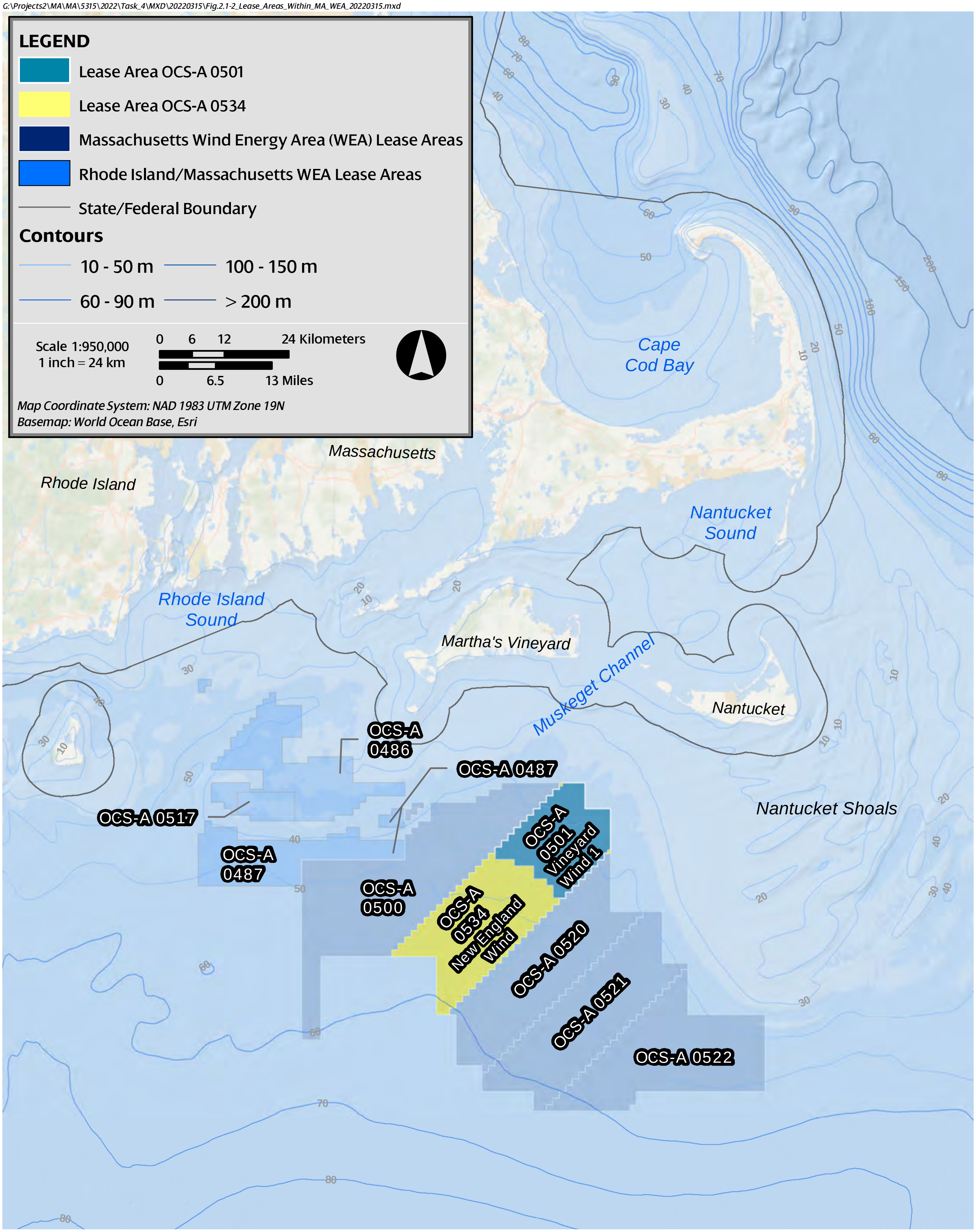

New England Wind
AVANGRID RENEWABLES

Figure 2.1-2
Massachusetts Wind Energy Area

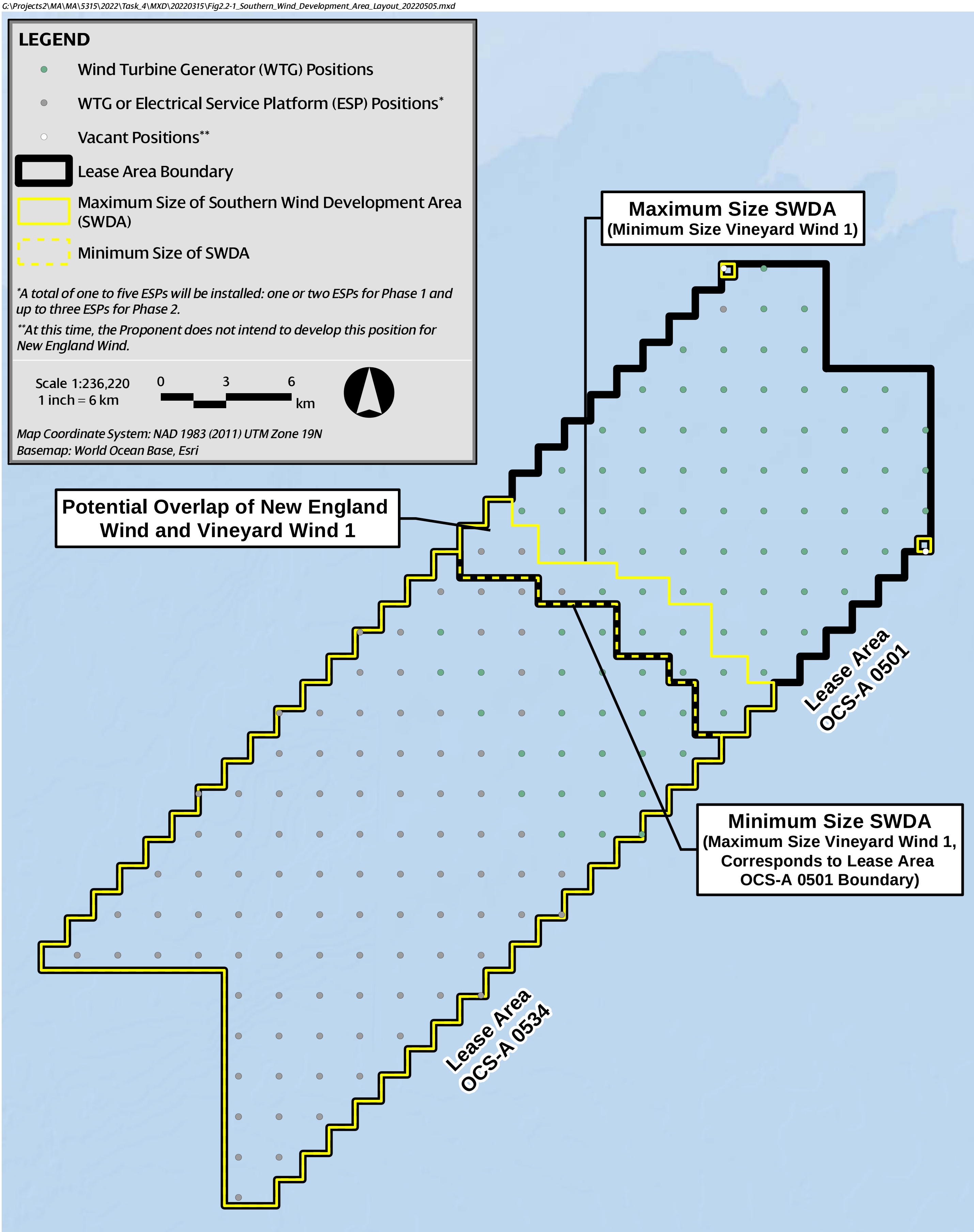

Figure 2.2-1

Southern Wind Development Area

Martha's Vineyard and approximately 38 km (24 mi) from Nantucket.[14] Water depths in the SWDA (excluding the two separate aliquots) generally range from approximately 43–62 m (141–203 ft). Water depths in the separate aliquots range from 38–40 m (125–131 ft).

The WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (1.85 km) spacing between positions.[15] This grid layout provides 1 NM wide corridors in the east-west and north-south directions as well as 0.7 NM (1.3 km) wide corridors in the northwest-southeast and northeast-southwest directions.

Coordinates for the WTG/ESP positions within the SWDA are provided in Appendix I-A. Appendix I-A indicates which WTG/ESP positions are located in the portion of Lease Area OCS-A 0501 that may be developed for New England Wind or Vineyard Wind 1 as well as which positions may be used for Phase 1 and/or Phase 2. Further discussion of the WTG/ESP layout is provided in Section 2.2.1 below.

The SWDA is optimal for offshore wind development. It has high wind speeds, excellent seafloor conditions, moderate water depths, and reasonable proximity to multiple grid connection locations in an area of high electrical load and a need for new generation capacity.

2.2.1 WTG and ESP 1 x 1 NM Layout

Offshore renewable wind energy facilities are typically designed to maximize the amount of energy that can be generated within a given area. In general, the most optimal WTG layout for wind energy production is a non-grid WTG layout with closer turbine spacing and a higher density of WTGs around the edges of the wind farm; such a design maximizes the number of WTGs per area while minimizing wake effects that impact the efficiency of downwind turbines.

However, as permitting of the first offshore wind farms within the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) progressed, other users of the OCS expressed the need for alternative, more uniform turbine layouts to accommodate vessel transits, fishing, and other uses of the MA WEA and RI/MA WEA. Various wind turbine layouts and transit plans were proposed in 2018 through numerous forums in New England, including proposals from the Massachusetts Coastal Zone Management Fisheries Working Group and the Responsible Offshore Development Alliance.

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[14] Within the SWDA, the closest WTG is approximately 34 km (21 mi) from Martha's Vineyard and 40 km (25 mi) from Nantucket.

[15] Where necessary, WTGs and ESPs may be micro-sited by a maximum of 152 m (500 ft) to avoid unfavorable seabed conditions, maintain facilities within lease area boundaries, and/or for other unexpected circumstances.

Recognizing that a consensus among all stakeholders could not be reached, the United States Coast Guard (USCG) initiated the Massachusetts and Rhode Island Port Access Route Study (MARIPARS) on March 26, 2019 to evaluate the need for vessel routing measures, including regional transit lanes, within the MA WEA and RI/MA WEA (USCG-2019-0131). The study solicited several rounds of public input from maritime community representatives, fishing industry representatives, developers, environmental groups, and other interested stakeholders.

In response, on November 1, 2019, the New England offshore wind leaseholders submitted a joint letter to USCG that proposed a collaborative regional layout for wind turbines across the entire RI/MA WEA and MA WEA. As stated in the letter:

> Under this proposal each turbine would be spaced 1 nautical mile (nm) apart in fixed east-to-west rows and north-to-south columns to create the 1 nm by 1 nm grid arrangement preferred by many stakeholders, including fishermen operating in the region. This 1x1 nm layout has also been confirmed through expert analysis to allow for safe navigation without the need for additional designated transit lanes. This proposed layout will provide a uniform, wide spacing among structures to facilitate search and rescue operations.

On May 27, 2020, USCG published the final MARIPARS, which found that, "After considering all options and the vessel traffic patterns within the MA/RI WEA, a standard and uniform grid pattern with at least three lines of orientation throughout the MA/RI WEA would allow for safe navigation and continuity of USCG missions through seven adjacent wind farm lease areas over more than 1400 square miles of ocean."[16] More specifically, USCG recommended:

- "Lanes for vessel transit should be oriented in a northwest to southeast direction, 0.6 NM to 0.8 NM wide. This width will allow vessels the ability to maneuver in accordance with the COLREGS while transiting through the MA/RI WEA.
- Lanes for commercial fishing vessels actively engaged in fishing should be oriented in an east to west direction, 1 NM wide.
- Lanes for USCG SAR operations should be oriented in a north to south and east to west direction, 1 NM wide. This will ensure two lines of orientation for USCG helicopters to conduct SAR operations."

The USCG concluded that, "The adoption of a standard and uniform grid pattern through BOEM's approval process will likely eliminate the need for the USCG to pursue formal or informal routing measures within the MA/RI WEA at this time." The 1 x 1 NM WTG/ESP layout was also approved by BOEM through its Record of Decision on the Vineyard Wind 1 project.

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16 The "MA/RI WEA" as used in the USCG's (2020) MARIPARS includes all adjacent lease areas on the Outer Continental Shelf (OCS) south of Martha's Vineyard, Massachusetts, and east of Rhode Island, which are referred to in the COP as the "MA WEA and RI/MA WEA."

Thus, New England Wind will adopt the 1 x 1 NM WTG/ESP layout in accordance with the USCG's recommendations contained in the May 2020 MARIPARS.[17] See Section 7.8 for further discussion of New England Wind's WTG/ESP layout in relation to navigational safety. It is worth noting that the adopted grid layout limits the total energy production potential of New England Wind and the associated benefits of clean, renewable energy.

2.3 Offshore Export Cable Corridor

Four or five offshore export cables will transmit electricity generated by the New England Wind WTGs from the ESPs to shore. Phase 1 will include two 220–275 kV high voltage alternating current (HVAC) offshore export cables. Phase 2 will include two or three 220–345 kV HVAC offshore export cables.

The Proponent intends to install the offshore export cables for both Phases within a shared Offshore Export Cable Corridor (OECC).[18] The New England Wind OECC will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel toward landfall sites in the Town of Barnstable (see Figure 2.3-1). At approximately 2–3 km (1–2 mi) from shore, the OECC for each Phase will diverge to reach separate landfall sites in Barnstable. The OECC specific to each Phase is further described in Sections 3.1.3 and 4.1.3.

While the Proponent plans to install all New England Wind offshore export cables within the OECC shown on Figure 2.3-1, the Proponent has identified two variations of the Phase 2 OECC. These variations are necessary to provide the Proponent with commercial flexibility should technical, logistical, grid interconnection, or other unforeseen issues arise during the Construction and Operations Plan (COP) review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC. These variations of the Phase 2 OECC are described in Section 4.1.3.

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[17] This 1 x 1 NM WTG/ESP layout is expected to be adopted by offshore wind developers regionally throughout the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) in response to stakeholder feedback.

[18] Experience in the offshore wind industry in Europe as well as offshore cable installations in the US has demonstrated that use of an installation corridor can provide flexibility in the engineering and installation stages to maximize the likelihood of successful cable burial while also avoiding and minimizing environmental impacts. The OECC is sufficiently defined for environmental and stakeholder review but allows for some flexibility to adjust to new information and natural variability in the dynamic marine environment.

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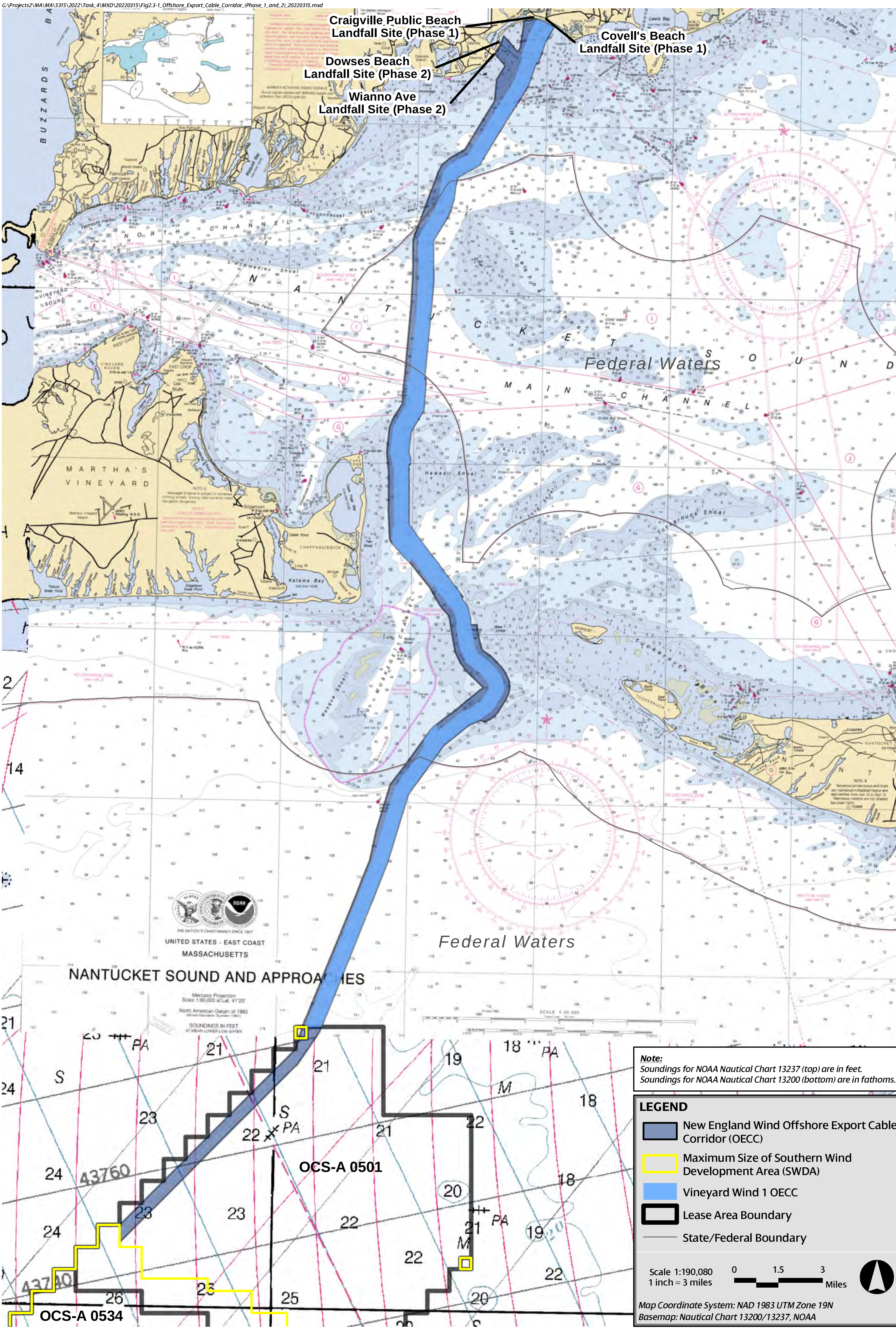

New England Wind

Figure 2.3-1

New England Wind Offshore Export Cable Corridor (Phases 1 and 2)

2.3.1 Feasibility of Using the OECC for Both Vineyard Wind 1 and New England Wind

Based upon careful consideration of multiple technical, environmental, and commercial factors, the Proponent identified the OECC for New England Wind that is largely the same OECC included in the approved Vineyard Wind 1 COP, but it has been widened by approximately 300 m (984 ft) to the west along the entire corridor and by approximately 300 m (984 ft) to the east in portions of Muskeget Channel, for a total width of approximately 950–1,700 m (3,100–5,500 ft). The OECC proposed in the Vineyard Wind 1 COP included two options through Muskeget Channel (an eastern option and a western option, as described in Appendix I-G). The Proponent has selected the eastern option through Muskeget Channel for the New England Wind OECC, but is reserving the fallback option to install one or two Phase 2 cables within the western option, referred to as the Phase 2 OECC Western Muskeget Variant, as described in Section 4.1.3.2.

New England Wind is using a shared OECC with Vineyard Wind 1 for four key reasons. First, the OECC provides for an efficient, technically feasible connection of the SWDA to the grid interconnection point in West Barnstable. There are limited substations within reasonable proximity to Lease Area OCS-A 0534 that can accommodate power from Phase 1 and/or Phase 2, so Eversource's 345 kV West Barnstable Substation has been selected as the grid interconnection point for each Phase of New England Wind.[19] Accordingly, the offshore export cables must bring power from the SWDA to landfall sites within reasonable proximity to the West Barnstable Substation, and the Proponent has identified that the landfall sites will be located in Barnstable for both Phases. Further, because the SWDA is bordered to the northwest and southeast by other developers' lease areas,[20] the only suitable route to shore is from the northeastern border of the SWDA. Given these considerations, there are limited options available to route cables from the northeastern boundary of the SWDA to landfall sites in Barnstable. As described in Appendix I-G, multiple route options were evaluated when siting the OECC for Vineyard Wind 1 and it was determined that the current OECC allows for less impacts than other alternatives evaluated, less electrical line losses, and lower installation and operational costs. Accordingly, using substantially the same OECC for New England Wind as Vineyard Wind 1 provides a viable route from the SWDA to the grid interconnection point that minimizes environmental, operational, and commercial impacts relative to longer alternative routes.

Second, the geological conditions within the OECC are well understood and the site geology and conditions are suitable for cable installation. Through the OECC survey work completed as part of Vineyard Wind 1, a large amount of survey data was collected. By the end of 2019, more than 4,272 km (2,307 NM) of geophysical trackline data, 123 vibracores, 83 cone penetrometer tests (CPTs), 82 benthic grab samples with still photographs, and 50 underwater video transects were

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[19] As described in Section 4.1.3.3, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise.

[20] The SWDA is bordered to the northeast by Vineyard Wind 1, which is a joint venture between Avangrid Renewables and Copenhagen Infrastructure Partners.

gathered to support the characterization of the OECC.[21] Additionally, reconnaissance survey work for Vineyard Wind 1 (see Appendix I-G), which included coverage of the western portion of Muskeget Channel and routes to the east of Horseshoe Shoal in Nantucket Sound, did not identify areas where conditions appeared more favorable for cable installation. To the contrary, such reconnaissance survey work identified features outside of the OECC such as shoals, large concentrations of boulders, deep channels, and high currents that would make cable installation and maintenance in an alternate location more challenging. These factors would increase health and safety risk during installation and maintenance, risk of not achieving sufficient burial depths, and risk of cable exposure. The Proponent has also assessed the OECC for installation feasibility, which includes ensuring that water depths are suitable for fully-loaded cable installation vessels, slopes are workable for typical cable installation tools, sufficient room is available for anchoring, etc. Based on these detailed geotechnical and installation feasibility analyses, the Proponent has determined that the identified cable corridor is the most suitable for cable installation and the needs of New England Wind.

Third, the use of a shared OECC has important commercial considerations while also helping to minimize environmental impacts. By utilizing a shared OECC, the Proponent is able to leverage the existing survey work already performed for Vineyard Wind 1, which means less survey vessel work and equipment usage, fewer man hours at sea and associated health and safety risks, fewer air emissions, and lower risk of potential impacts to marine species, as well as decreased survey costs, which are a significant portion of pre-construction costs. Lessons learned during the installation of Vineyard Wind 1's cables specific to the conditions within the OECC will undoubtedly inform and benefit the installation of New England Wind's offshore export cables. The use of the same OECC for Vineyard Wind 1 and New England Wind also limits the disturbed areas to a single corridor. The Proponent proposes a target burial depth below potential conflict with fishing gear. The Proponent will prioritize achieving sufficient cable burial depth; however, where sufficient burial depth cannot be achieved and cable protection is required, or should marine users elect to avoid these areas, co-locating the Vineyard Wind 1 and New England Wind cables within a shared OECC would limit the potential area of impact.

Fourth, the Vineyard Wind 1 OECC was thoroughly evaluated and approved by the Commonwealth of Massachusetts and BOEM. BOEM has also already reviewed all existing geophysical and geotechnical data for the Vineyard Wind 1 OECC.

To assess the feasibility of using the same OECC for Vineyard Wind 1 and New England Wind, the Proponent commissioned a preliminary route design study for the New England Wind cables, which is provided as Appendix III-P. This report includes a comprehensive assessment of the

[21] Additional survey data was collected for the expanded portions of the OECC in 2020; this data, in conjunction with the data already collected, will be used by the cable installation contractor (once selected) to further assess conditions present in the OECC, determine cable alignments within the OECC, and select cable installation tools that are appropriate for the site conditions.

geophysical and geotechnical conditions along the route, including the presence of seabed features and considerations such as sand waves, magnetic anomalies, coarse deposits, rocks or boulders, water depths, and seabed slopes. Recommendations for cable installation tools that are appropriate for the site conditions are also included.

It is expected that the Vineyard Wind 1 offshore export cables will be located in the central or eastern portion of the OECC. To avoid cable crossings, the two Phase 1 cables are expected to be located to the west of the Vineyard Wind 1 cables and, subsequently, the two or three Phase 2 cables are expected to be installed to the west of the Phase 1 cables. The cables will typically be separated by a distance of 50–100 m (164–328 ft) to provide appropriate flexibility for routing and installation and to allow for maintenance or repairs, although this distance could be further adjusted pending ongoing routing evaluation. While the Phase 1 and Phase 2 cables are expected to be physically located west of the Vineyard Wind 1 cables, temporary construction impacts (e.g. use of anchors) during installation of the Phase 1 or Phase 2 cables may occur anywhere within the OECC.

Preliminary cable alignments have been developed for the New England Wind cables that assume the presence of the Vineyard Wind 1 cables in the eastern or central portions of the corridor. The preliminary cable alignments presented in Appendix III-P were developed taking all seabed features and site conditions into consideration. Ultimately, the preliminary route design study demonstrates that it is technically feasible to place the additional New England Wind cables within the OECC. However, the preliminary cable alignments are expected to be refined following detailed engineering. As described above and in Section 4.1.3, the Proponent has identified two variations of the Phase 2 OECC in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC.

2.4 Onshore Development Areas

Each Phase of New England Wind will have separate onshore transmission system(s), but both Phases will connect to the ISO New England (ISO-NE) electric grid at the same grid interconnection point: Eversource's 345 kV West Barnstable Substation.[22]

Phase 1 will include one landfall site, one Onshore Export Cable Route, one onshore substation site, and one Grid Interconnection Route. The potential landfall sites, Onshore Export Cable Routes, onshore substation site, and Grid Interconnection Routes within the Phase 1 Onshore Development Area are illustrated in Figure 2.4-1 and described in Section 3.2.2.

[22] As described in Sections 4.1.3 and 4.1.4, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise. Under this scenario, Phase 2 could include one onshore transmission system in Barnstable (using either the Dowses Beach Landfall Site or Wianno Avenue Landfall Site) and/or an onshore transmission system(s) in proximity to the second grid interconnection point.

Phase 2 will include one or two landfall sites, one or two Onshore Export Cable Routes, one or two onshore substation sites, and one or two Grid Interconnection Routes. The potential landfall sites, Onshore Export Cable Routes, and Grid Interconnection Routes within the Phase 2 Onshore Development Area are illustrated on Figure 2.4-1 and described in Section 4.2.2. The Phase 2 onshore substation site(s) will be located generally along the Phase 2 onshore routes identified in Figure 2.4-1.

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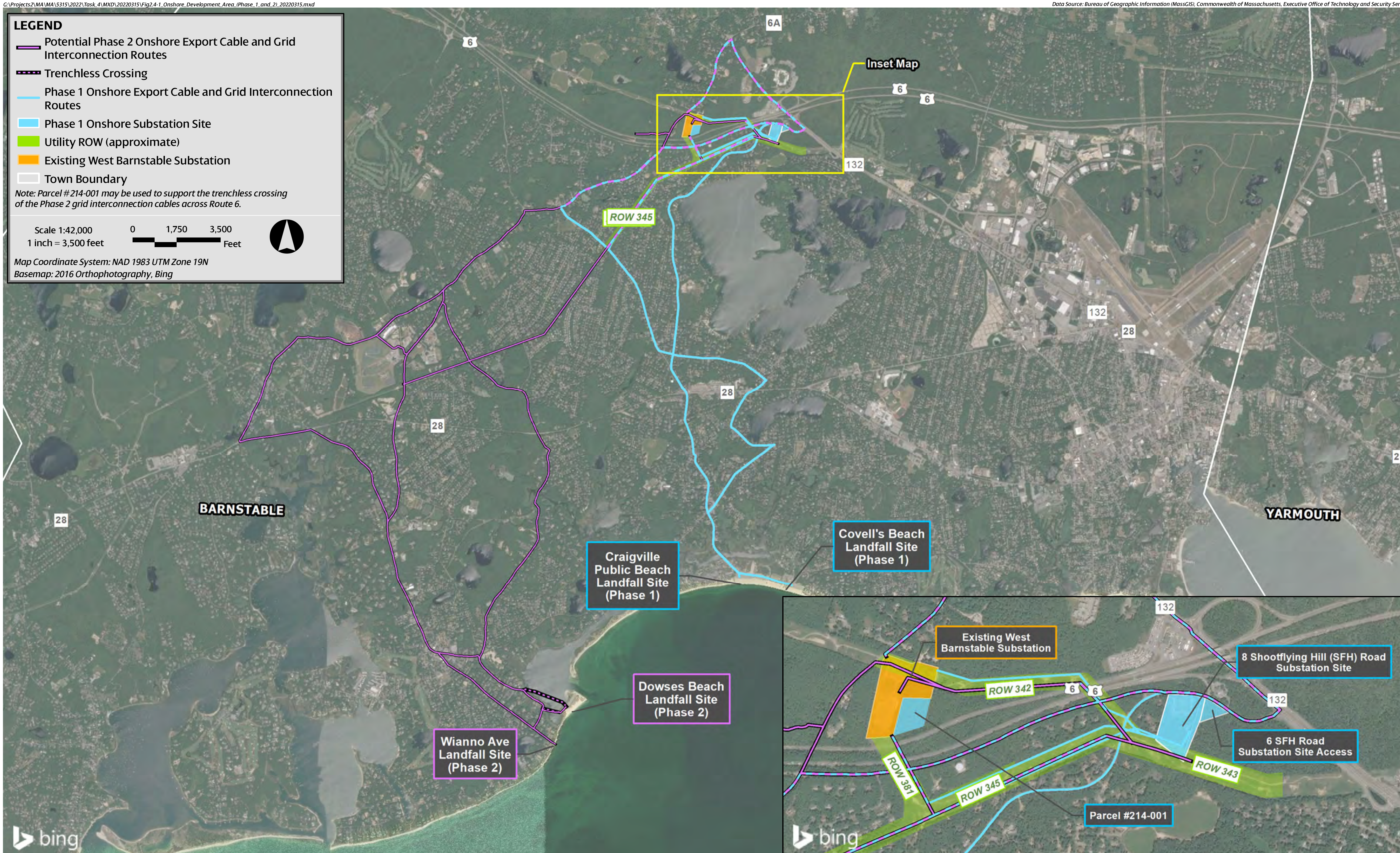
Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services



New England Wind

AVANGRID RENEWABLES

Figure 2.4-1

Onshore Development Areas for Phases 1 and 2

Section 3.0

New England Wind Phase 1

3.0 NEW ENGLAND WIND PHASE 1

3.1 Overview of Phase 1

3.1.1 Phase 1 Construction and Operation Concept

3.1.1.1 Objective

The objective for Phase 1 is to design, permit, construct, operate, and decommission offshore renewable wind energy facilities in the Southern Wind Development Area (SWDA) that will deliver power to one or more Northeastern states and/or to other offtake users, including but not limited to 804 MW of power to the ISO New England (ISO-NE) electric grid to meet the Proponent's obligations under long-term contracts with Connecticut electric distribution companies (see Section 1.2). Phase 1 is also referred to as Park City Wind.

The wind turbine generators (WTGs) will be among the most efficient renewable energy generators commercially available for offshore use at the time of construction. Power from Phase 1 will make a substantial contribution to the region's electrical reliability and will enable Connecticut to meet the state's renewable energy requirements, including Connecticut Public Act No. 18-82, "An Act Concerning Climate Change Planning and Resiliency," which requires the state to reduce greenhouse gas emissions from 2001 levels 45% by 2020 and 80% by 2050. Phase 1 is designed to maximize both the short-term and long-term job creation and economic development benefits for Connecticut while minimizing costs to ratepayers, potential impacts to the environment, and effects on other marine industries (see Section 4.1 of COP Volume III).

3.1.1.2 Phase 1 Project Design Envelope and Proposed Activities

The key elements of Phase 1, as bounded by the Envelope (see Table 3.1-1), are as follows:

- **Layout:** The Phase 1 WTGs and electrical service platform(s) (ESP[s]) will be oriented in an east-west, north-south grid pattern with one nautical mile (NM) (1.85 kilometer [km]) spacing between WTG/ESP positions.

- **Wind Turbine Generators:** Phase 1 will include 41 to 62 WTGs..

- **Electrical Service Platform(s):** Phase 1 will include one or two ESP(s), which are offshore substations that serve as common interconnection points for WTGs. The ESP(s) will include step-up transformers and other electrical gear to increase the voltage of power generated by the WTGs.

- **Monopile and Jacket Foundations:** The WTGs and ESP(s) will be supported by monopile and/or jacket foundations. A monopile is a long, hollow cylindrical steel pile that is driven into the seabed to support a WTG or ESP. Typically, a monopile is topped by a transition piece (TP) although an extended monopile (a monopile with no TP) may be used. A jacket foundation is a steel structure that includes several legs connected with welded steel tubular cross bracing. The jacket legs are secured to the seafloor using piles at the base of each leg.

- **Scour Protection:** WTG and ESP foundations may have scour protection. The scour protection is expected to be one or more layers of rock laid around each foundation.

- **Inter-Array and Inter-Link Cables:** 66 to 132 kilovolt (kV) inter-array cables will connect "strings" of WTGs to an ESP. To provide additional reliability, the ESPs may be connected with a 66 to 275 kV inter-link cable. The inter-array and inter-link cables will be buried beneath the seafloor. The maximum anticipated total length of the Phase 1 inter-array cables is approximately 225 km (121 NM) and the maximum anticipated total length of the inter-link cable is approximately 20 km (11 NM).

- **Offshore Export Cables:** Two 220–275 kV offshore export cables will transmit power from the offshore ESP(s) to the shore-side landfall site. The Phase 1 offshore export cables will be installed beneath the seafloor within the Offshore Export Cable Corridor (OECC) from the SWDA to either the Craigville Public Beach Landfall Site or the Covell's Beach Landfall Site. The maximum total length for the two Phase 1 offshore export cables is approximately 202 km (109 NM).

- **Cable Protection (if required):** Where it is difficult to achieve a sufficient burial depth or where cables must cross existing infrastructure, the inter-array, inter-link, and offshore export cables may be protected by rocks, gabion rock bags, prefabricated flexible concrete coverings (referred to as concrete mattresses), or half-shell pipes (or similar products).

- **Onshore Export Cables:** Underground onshore export cables will transmit power from one of two potential Phase 1 landfall sites to a new Phase 1 onshore substation. The 220 to 275 kV onshore export cables will be installed in an underground duct bank along one of two potential Onshore Export Cable Routes from Craigville Public Beach or Covell's Beach to the onshore substation.

- **Onshore Substations and Grid Interconnection Point:** Phase 1 will include a new onshore substation in the Town of Barnstable. The onshore substation will house transformers, switchgear, and other necessary equipment. Using 345 kV underground onshore cables installed along Grid Interconnection Routes, the onshore substation will connect to the electric grid at Eversource's existing 345 kV West Barnstable Substation.

- **Installation:** The Envelope also describes potential construction and installation approaches. As a general matter, foundation, ESP, and WTG installation will be performed using jack-up vessels, anchored vessels, or dynamic positioning (DP) vessels along with necessary support vessels and barges. Cable laying is expected to be accomplished primarily by jet plowing, jet trenching, or mechanical plowing. Vessel types under consideration for cable installation include DP, anchored, self-propelled, or barge.

The design of Phase 1 may be further refined within the Envelope during the permitting process. The Envelope for Phase 1 of New England Wind is summarized in Table 3.1-1 below. The locations of the Phase 1 offshore facilities are illustrated in Figure 3.1-1. The Phase 1 onshore facilities are illustrated in Figure 3.1-2.

Table 3.1-1 Phase 1 of New England Wind Design Envelope Summary

Layout and Size of Phase 1	WTGs	WTG Foundations
• 41–62 wind turbine generators (WTGs) installed • One or two electrical service platforms (ESPs) installed • Windfarm layout in E-W & N-S grid pattern with 1 NM (1.85 km) spacing between WTG/ESP positions • Area of Phase 1 SWDA: 150–231 km^2 (37,066–57,081 acres)	• 41–62 WTGs • Maximum rotor diameter of 285 m (935 ft) • Maximum tip height of 357 m (1,171 ft) • Minimum tip clearance of 27 m (89 ft) • Installation with a jack-up vessel, anchored vessel, or dynamic positioning (DP) vessel and components likely supplied by feeder vessels	• Each WTG installed on a monopile or piled jacket foundation • Scour protection may be used around all foundations • Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets • Installation with a jack-up vessel, anchored vessel, or DP vessel and components potentially supplied by feeder vessels
ESPs (Topside and Foundation)	**Inter-Array & Inter-Link Cables**	**Offshore Export Cables**
• One or two ESP(s) • Each ESP installed on a monopile or jacket foundation (ESPs installed on monopiles may be co-located) • Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets • Scour protection may be installed around the foundations • Installation with a jack-up vessel, anchored vessel, or DP vessel	• 66–132 kV inter-array cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-array cable length of ~225 km (~121 NM) • Up to one 66–275 kV inter-link cable buried at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-link cable length of ~20 km (~11 NM) • Example layout identified, not finalized • Pre-lay grapnel run and pre-lay survey • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial	• Two 220–275 kV offshore export cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total offshore export cable length of ~202 km (~109 NM) • Cables installed in one Offshore Export Cable Corridor • Pre-lay grapnel run, pre-lay survey, and possibly boulder clearance • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow, possibly with dredging in some locations to achieve burial depth • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial

Note: Elevations are relative to Mean Lower Low Water (MLLW).

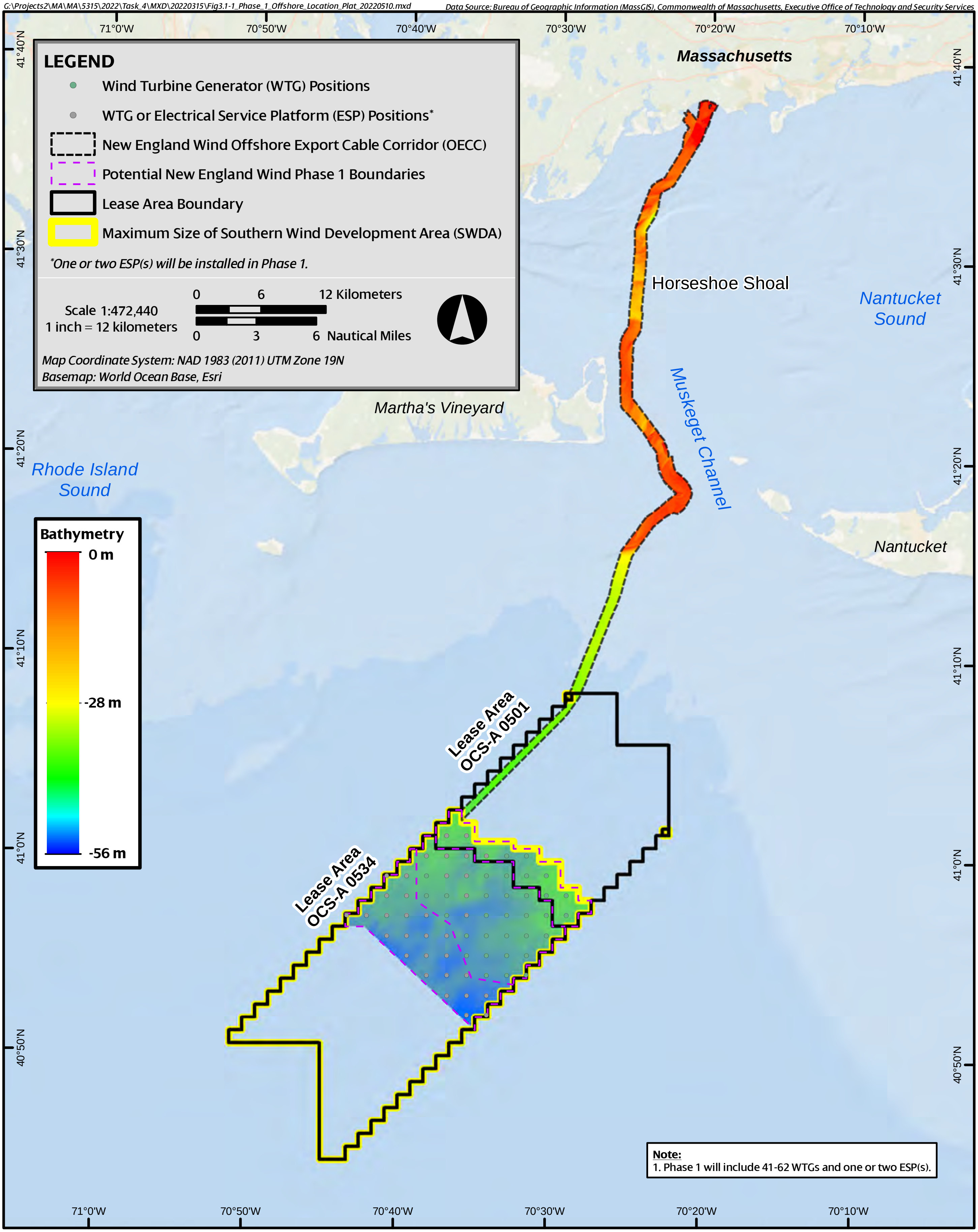


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Figure 3.1-1
Phase 1 Offshore Location Plat

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Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

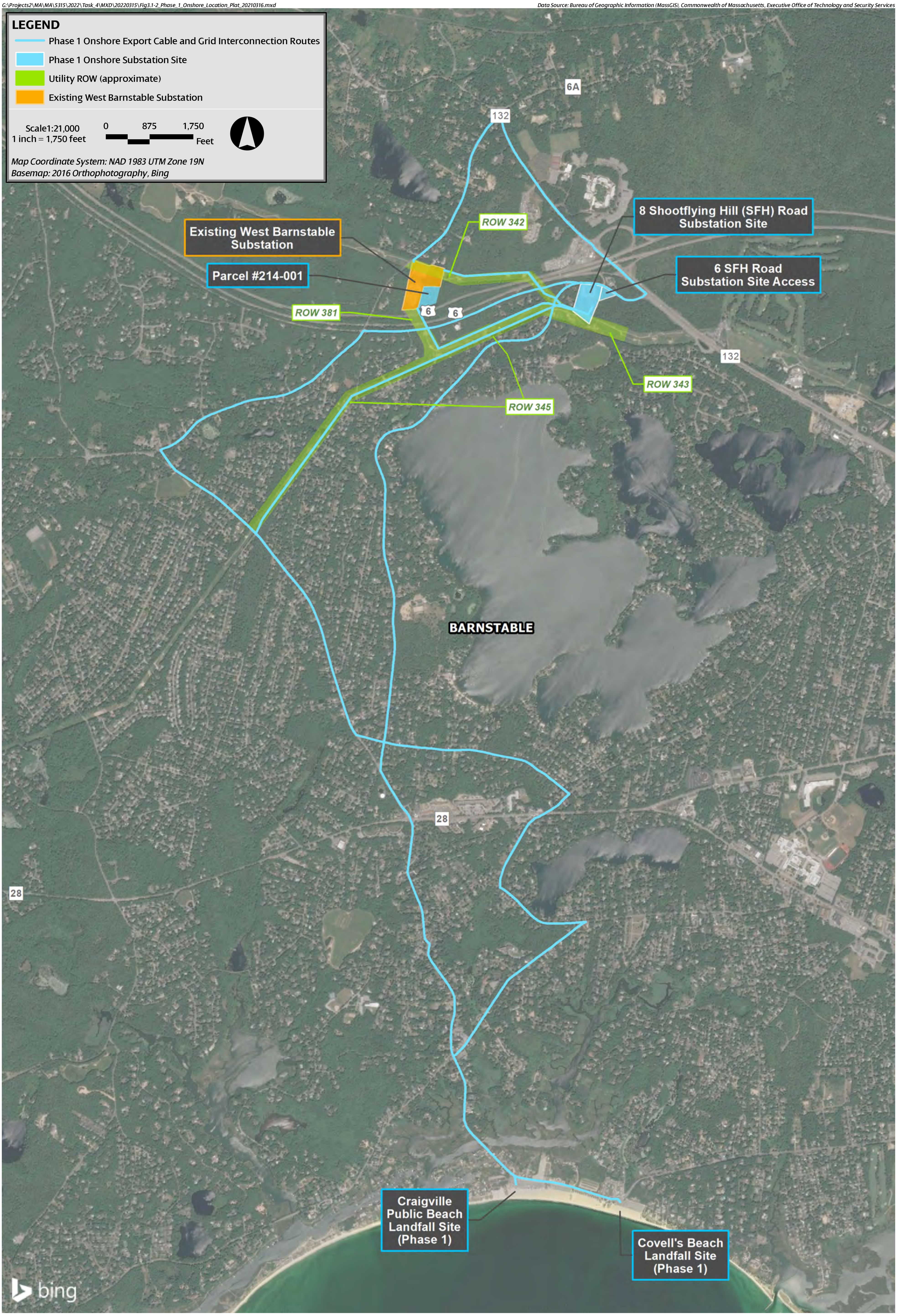

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Figure 3.1-2

Phase 1 Onshore Location Plat

3.1.1.3 Tentative Draft Schedule for Phase 1

Federal and Massachusetts environmental reviews, and subsequent federal, state, regional and local permitting are expected to be a principal focus of New England Wind Phase 1 activities during 2020–2023. Assuming the necessary permits are issued and financial close is achieved, onshore construction of Phase 1 would likely begin in late 2023 and offshore construction would likely begin in 2025. Under that schedule, commercial operations are expected to commence in 2026. A high-level representation of the Phase 1 construction schedule is provided as Figure 3.1-3.

Phase 1 would operate for up to 30 years. A more detailed discussion of Phase 1 operations and maintenance (O&M) is provided in Section 3.3.2. Once the Phase 1 operational term ends, the Phase 1 facilities will be decommissioned. Decommissioning of Phase 1 is described in Section 3.3.3.

3.1.2 Phase 1 Portion of the SWDA

The Phase 1 offshore facilities in the Southern Wind Development Area (SWDA) will consist of 41 to 62 WTGs, one or two ESP(s), their foundations, and the associated offshore cables (see Table 3.1-2). The WTGs/ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (1.85 km) spacing between WTG/ESP positions.[23]

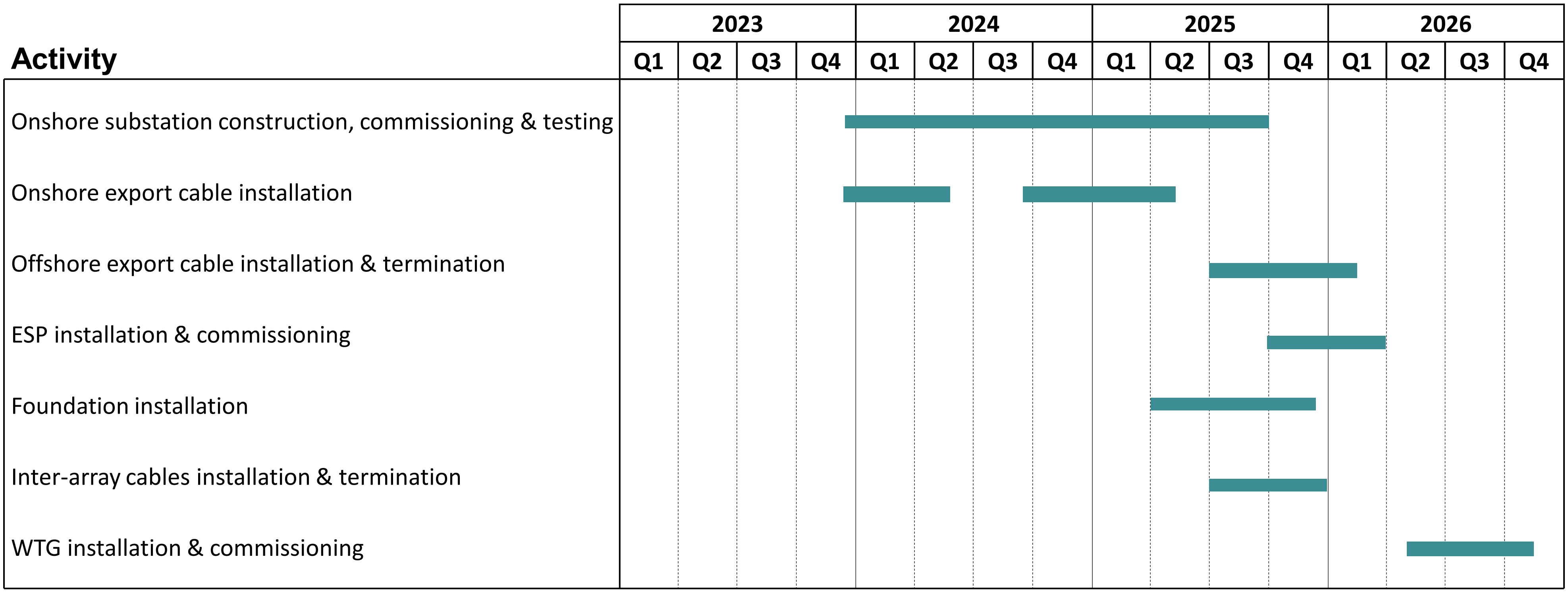
Table 3.1-2 Phase 1 WTG and ESP Positions

	Minimum	Maximum
WTGs Installed	41	62
ESPs Installed	1	2

The portion of the SWDA that is developed for Phase 1 will depend on:

- The final geographic size of Vineyard Wind 1 will define the northeastern border of Phase 1. Lease Area OCS-A 0501 contains 10 "spare" or extra WTG positions for Vineyard Wind 1. If some or all of those spare positions are not developed for Vineyard Wind 1, they will be assigned from Vineyard Wind 1 LLC to Lease Area OCS-A 0534 and developed as part of Phase 1. Therefore, the potential footprint of Phase 1 includes a portion of Lease Area OCS-A 0501 (see Figure 3.1-4). If Vineyard Wind 1 uses its maximum number of spare positions, Phase 1 will be located farther southwest than if Vineyard Wind 1 were to use fewer spare positions.

[23] Where necessary, WTGs and ESP(s) may be micro-sited by a maximum of 152 m (500 ft) to avoid unfavorable seabed conditions, maintain facilities within lease area boundaries, and/or for other unexpected circumstances.



Note: Commercial operations are expected to commence in 2026.

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Figure 3.1-3

Draft Phase 1 High-Level Construction Schedule

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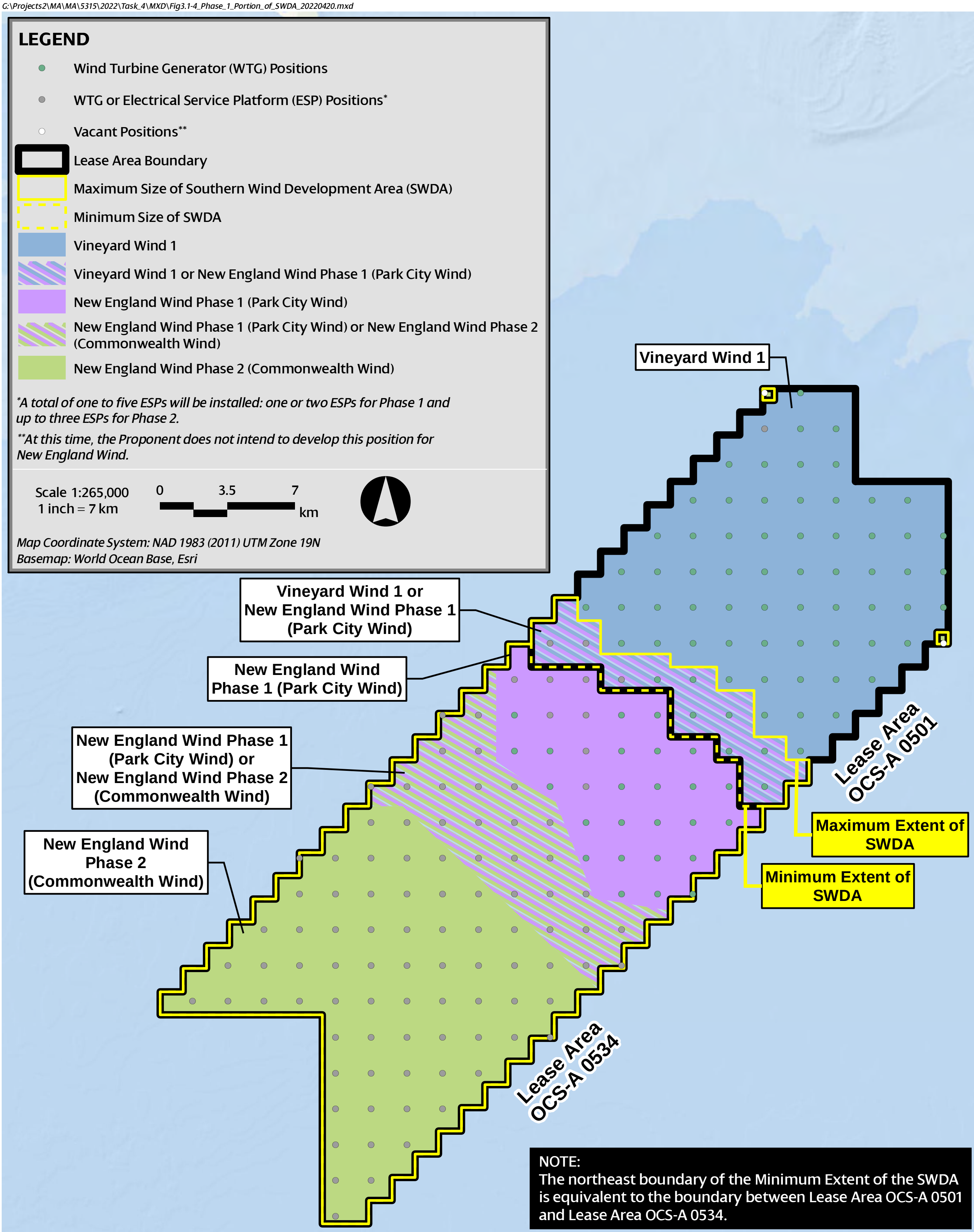

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Figure 3.1-4
Phase 1 Portion of SWDA

- Phase 1 could include 41 to 62 WTGs depending on WTGs' electrical capacity. The capacity of WTGs selected for Phase 1 will depend on the feasibility and commercial availability of WTGs to meet the Phase 1 construction schedule. WTGs with higher generating capacities would result in a smaller footprint, while lower generating capacities would result in a larger footprint. To account for the range in the number of WTGs that may be developed for Phase 1, the potential footprint of Phase 1 overlaps with the potential footprint of Phase 2 (see Figure 3.1-4).

- Engineering and environmental constraints could eliminate positions thereby extending the Phase 1 footprint farther southwest.

As a result, the Phase 1 footprint within the SWDA could range in size between 150–231 square kilometers (km^2) (37,066–57,081 acres). Figure 3.1-4 illustrates the portions of the SWDA that may be developed as part of Phase 1. Figure 3.1-5 shows a representative Phase 1 layout if Park City Wind were to use 14 MW WTGs and Vineyard Wind 1 only used three of its spare positions.[24]

Water depths in the portion of the SWDA that may be developed for Phase 1 range from 43 to 55 meters (m) (141 to 180 feet [ft]).

3.1.3 Phase 1 OECC

As described in Section 2.3, the Phase 1 offshore export cables will be installed within the Offshore Export Cable Corridor (OECC). The OECC will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel towards the southern shore of Cape Cod. The OECC for Phase 1 will then continue toward the Craigville Public Beach Landfall Site or Covell's Beach Landfall Site (see Figure 3.1-6).

From either Phase 1 landfall site[25] to the SWDA boundary (excluding the two separate aliquots that are closer to shore), the OECC is approximately 78 km (42 NM). To allow additional cable length for turns and micro-siting of the cable within the corridor, the maximum length of each cable within the OECC is ~83 km (~45 NM).[26] Within the SWDA, an additional length of offshore export cable (up to ~18 km [~10 NM] per cable) will be needed to reach the Phase 1 ESP(s). In total, the maximum length of each Phase 1 offshore export cable between the landfall site and the ESP(s) is approximately 101 km (54 NM).

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24 The representative Phase 1 layout shown on Figure 3.1-5 assumes that Phase 1 includes 58 WTGs, one ESP, and two spare positions for Phase 1. This is intended to be illustrative and is not necessarily the layout that would be utilized if Park City Wind were to select 14 MW WTGs.

25 The length of the OECC is measured from the offshore edge of the corridor at the landfall site.

26 The offshore export cable length includes a 15% allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5% allowance for micro-siting within the OECC outside the lease areas.

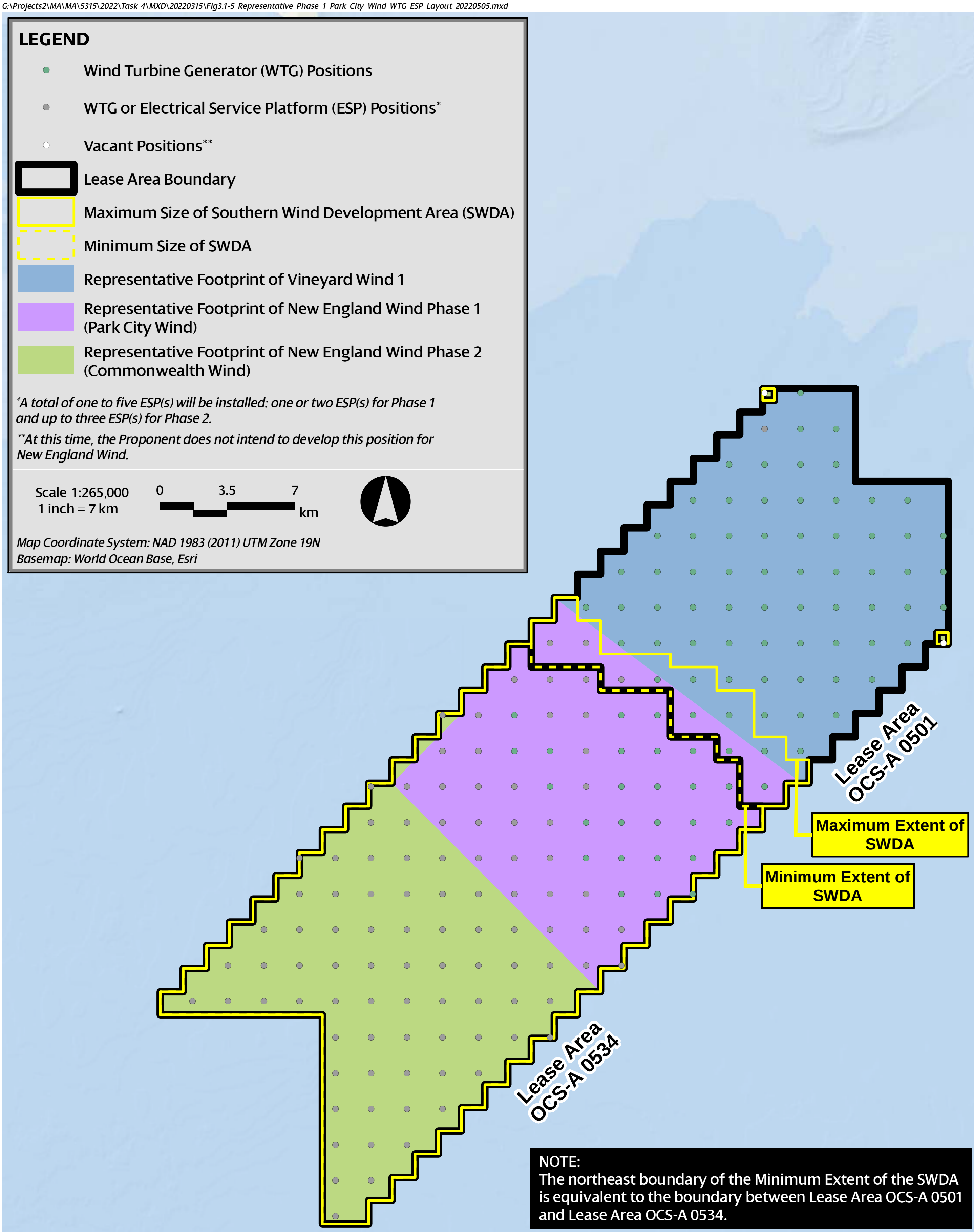

Figure 3.1-5

Representative Phase 1 (Park City Wind) WTG/ESP Layout

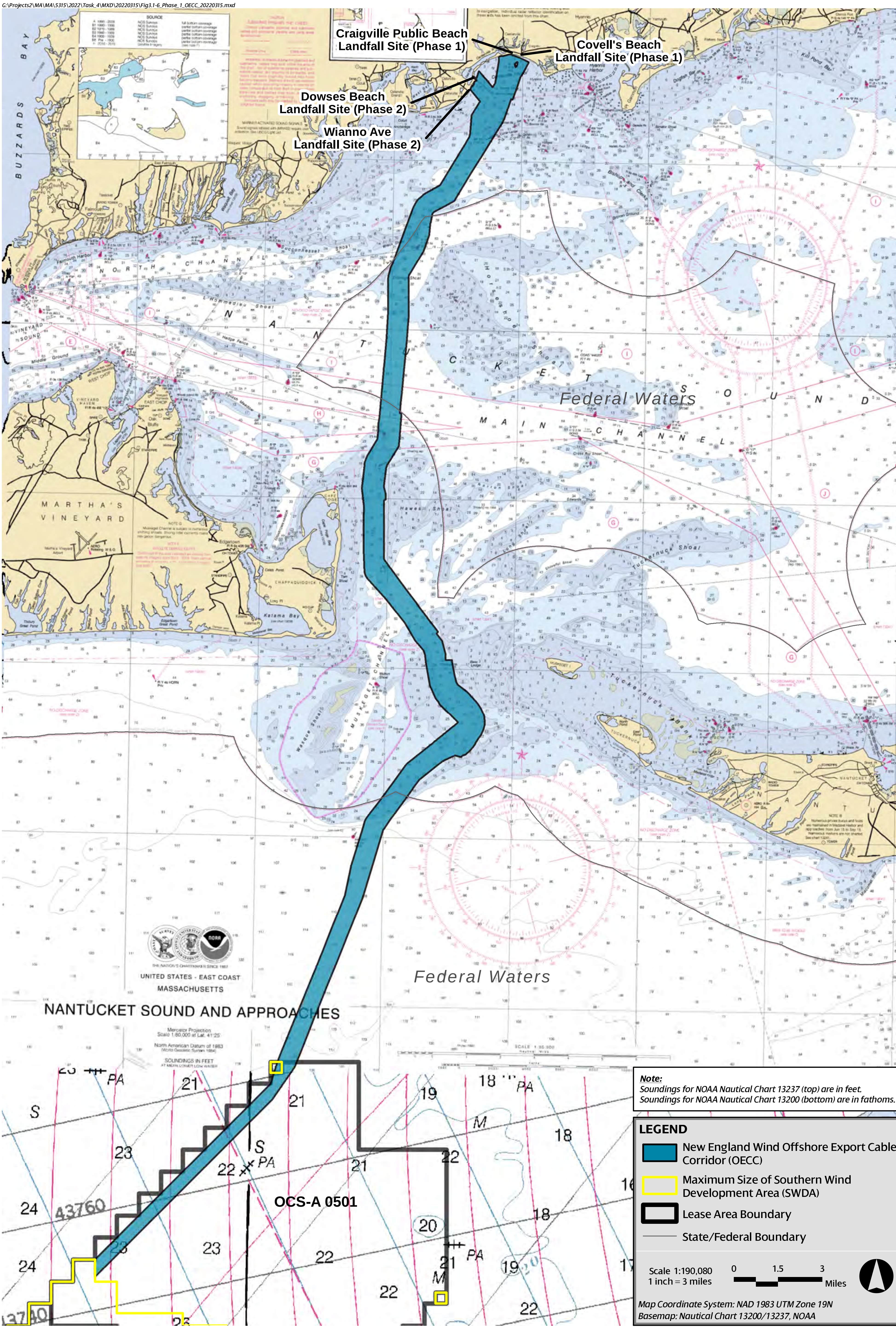

Figure 3.1-6
Phase 1 Offshore Export Cable Corridor

Outside the SWDA, the Phase 1 cables will be installed within a portion of the approximately 950–1,700 m (3,100–5,500 ft) wide OECC.[27] As noted in Section 2.3, the Phase 1 offshore export cables are expected to be located west of the Vineyard Wind 1 offshore export cables in order to avoid crossing the Vineyard Wind 1 cables, which are anticipated to be installed within the central or eastern portion of the OECC prior to the installation of the Phase 1 cables. To provide appropriate flexibility for routing and installation and to allow room for maintenance or repairs, the Phase 1 cables will typically be separated from each other and the Vineyard Wind 1 cables by a distance of 50–100 m (164–328 ft), although this distance could be further adjusted pending ongoing routing evaluation.

3.1.4 Phase 1 Onshore Development Area

The Phase 1 offshore export cables will transition to onshore export cables at one of two potential landfall sites in the Town of Barnstable. The onshore export cables will then follow one of two potential Onshore Export Cable Routes (with variants) from the selected landfall site to the onshore substation. One of two potential Grid Interconnection Routes (with variants) will connect the Phase 1 onshore substation to the grid interconnection point at the West Barnstable Substation. The Phase 1 onshore facilities are shown on Figure 3.1-2 and described in greater detail in Section 3.2.2.

3.2 Phase 1 Structures and Facilities – General Structural Design and Fabrication

3.2.1 Phase 1 Offshore Facilities

The Phase 1 offshore facilities will include 41—62 wind turbine generators (WTGs) and their foundations, one or two electrical service platforms (ESPs) and their foundations, inter-array cables, and offshore export cables. Phase 1 may also include scour protection for the foundations and an inter-link cable that connects the ESPs. The WTGs, ESP(s), inter-array cables, inter-link cable, and portions of the offshore export cables are in federal waters. The remaining portions of the offshore export cables are in Massachusetts waters.

3.2.1.1 Wind Turbine Generators

Phase 1 will consist of 41–62 WTGs that are specially designed for offshore use. The WTGs consist of two main components: the Rotor Nacelle Assembly (RNA) and the tower. The RNA consists of a three-bladed rotor connected at the hub and a nacelle. The RNA is mounted on the tower. The tower is typically constructed in two or more sections and is mounted on a foundation via a bolted and/or grouted connection (see Section 3.2.1.2 for further description of WTG foundations). Both the nacelle and the tower are steel structures coated to protect against corrosion in harsh marine environments.

[27] Where the OECC travels through Lease Area OCS-A 0501, the width of the corridor may be narrower than 950 m (3,100 ft) to avoid possible interference with Vineyard Wind 1's offshore facilities.

The nacelle contains a driveshaft and gearbox or direct-drive system (depending on WTG type), the electrical generator, motors to yaw and pitch the WTG, and workspaces for maintenance of the WTG. Wind sensors mounted on the top of the nacelle are used to control the yaw and pitch systems, which turn the RNA into the wind to maximize power production and out of the wind to maintain the WTG's safety in high winds. The blade pitch controllers adjust the angle of the blades to optimize power production whilst mitigating loads under the prevailing conditions. The brake, pitch, and yaw systems may be operated using electric or hydraulic control systems. The nacelle also contains a full array of instrumentation, cables, controls, fire protection systems, other safety equipment, ventilation and cooling, and ancillary equipment. Typically, a helihoist platform is located on top of the nacelle.

For service purposes, the WTGs will be equipped with auxiliary cranes in the nacelle and on the external working platform (which is mounted on the foundation and/or transition piece [TP]) capable of lifting spare parts to their proper location in accordance with operations and maintenance procedures. The WTGs will also include access ways for personnel inside the tower, including an elevator that will serve as the main access route. The elevator will be designed to carry personnel, tools, small equipment, and small spare parts. Ladders will serve as a secondary access route. All access routes will be designed to promote safety and will comply with all relevant standards and regulations. In addition, generators and/or batteries may be installed in the WTGs or on their foundations to provide standby/emergency power. Lightning protection will be installed on the WTGs to protect the WTGs' electrical systems.

The WTG parameters for Phase 1 are provided in the table below and illustrated in Figure 3.2-1.

Table 3.2-1 Phase 1 WTG Parameters

WTG Parameter	Dimension
Maximum Tip Height	357 m (1,171 ft) MLLW[1]
Maximum Top of The Nacelle Height[2]	221 m (725 ft) MLLW
Maximum Hub Height	214 m (702 ft) MLLW
Maximum Rotor Diameter	285 m (935 ft)
Minimum Tip Clearance	27 m (89 ft) MLLW
Maximum Blade Chord	9 m (30 ft)
Maximum Tower Diameter	10 m (33 ft)

Notes: WTG tip height, hub height, tip clearance, and rotor diameter dimensions may not align perfectly due to rounding and unit conversions.

1. Mean Lower Low Water (MLLW) is the average height of the lowest tide recorded at a tide station each day during the recording period. Elevations relative to Mean Higher High Water (MHHW) are approximately 1 m (3 ft) lower than those relative to MLLW.
2. Height includes Federal Aviation Administration (FAA) lights and other appurtenances.

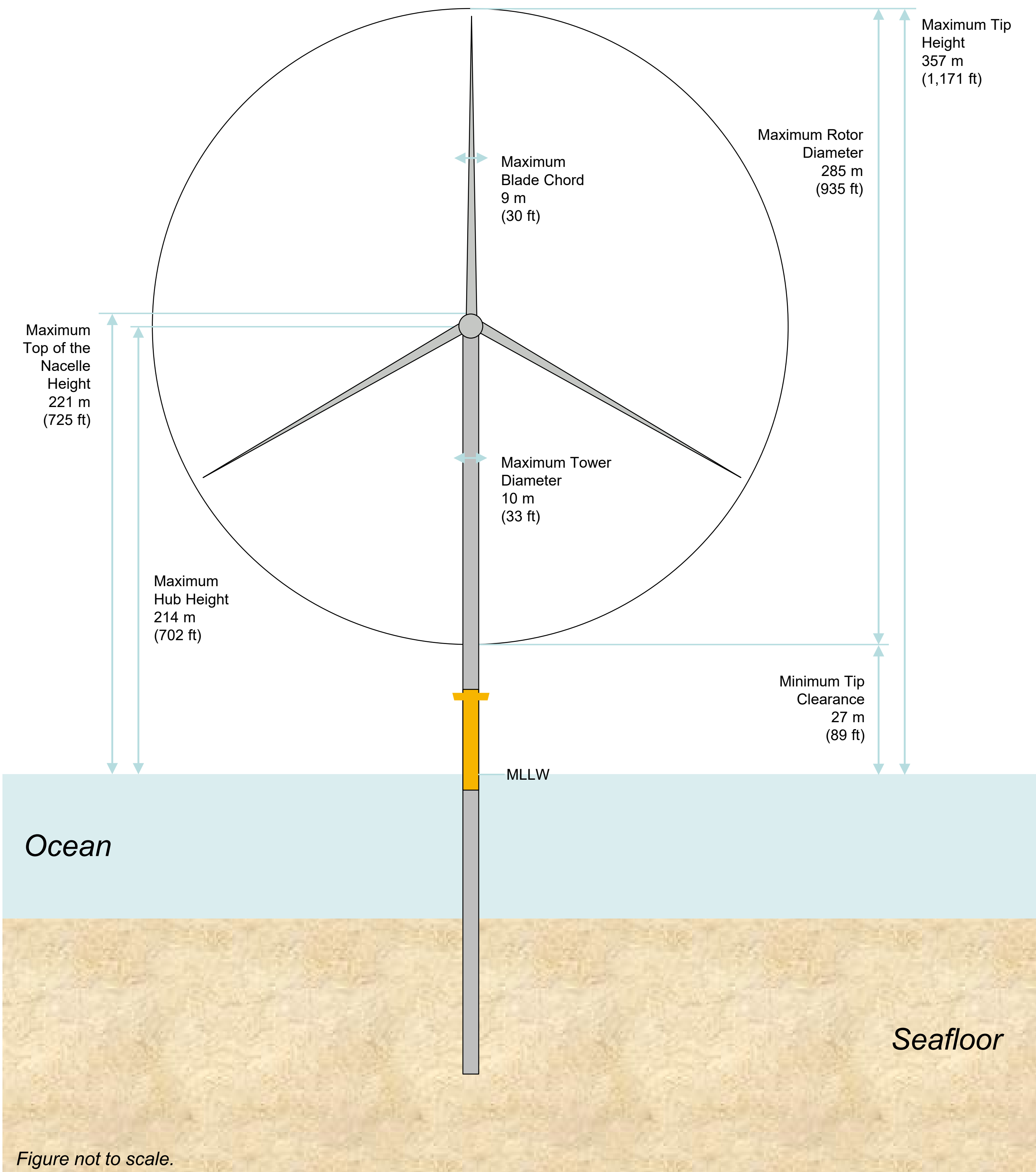

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Figure 3.2-1

Phase 1 Wind Turbine Generator

The WTG design will be verified for the specific site conditions during the Certified Verification Agent (CVA) review process (see Section 3.2.3.2), where the design will be able to withstand wind speeds and gusts anticipated at the SWDA (see Appendix I-E). The WTGs will be designed to automatically stop power production when wind speeds exceed a maximum value, after which the rotor will normally idle. The exact speed at which power production will cease depends on the manufacturer's specifications. The structures will be designed for the extreme environmental conditions (including wind speed and wave height) verified by the CVA. Design wave heights are expected to be in the range of 20 m (66 ft).

The WTGs will include an aviation obstruction lighting system in compliance with Federal Aviation Administration (FAA) and/or Bureau of Ocean Energy Management (BOEM) requirements. The aviation obstruction lighting system will consist of two synchronized FAA L-864 red flashing aviation obstruction lights placed on the nacelle of each WTG. If the WTGs' total tip height is 213.36 m (699 ft) or higher, there will be at least three additional low intensity L-810 flashing red lights on the tower at a point approximately midway between the top of the nacelle and sea level. If approved by BOEM and the FAA, 30 flashes per minute will be utilized for air navigation lighting. Other temporary lighting (e.g. helicopter hoist status lights) may be utilized for safety purposes when necessary.

The Proponent is working to reduce lighting to lessen the potential impacts of nighttime light on migratory birds and to address potential visual impacts. The Proponent expects to use an Aircraft Detection Lighting System (ADLS) that automatically activates all aviation obstruction lights (any FAA lights on both the nacelle and tower) when aircraft approach the Phase 1 WTGs, subject to BOEM approval. A report on how often the ADLS would likely be activated is included in Appendix III-N for informational purposes. If the use of ADLS is not approved, reduced lighting schemes will be reviewed and discussed with BOEM. In accordance with FAA Advisory Circular 70/7460-1M and BOEM's (2021) *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development*, the WTGs will be no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey in color; the Proponent anticipates that the WTGs will be painted off-white/light grey to reduce their visibility against the horizon. Aviation concerns are further discussed in Section 7.9 of COP Volume III.

To aid mariners navigating within and near the SWDA, each WTG will be maintained as a Private Aid to Navigation (PATON) in accordance with United States Coast Guard (USCG) guidance. Based on USCG's current *ME, NH, MA, RI, CT, NY, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance* contained in District 1 Local Notice to Mariner (LNM) 44/20, the Proponent will implement a uniform system of marine navigation lighting and marking that includes yellow flashing lights on every WTG foundation and alphanumeric identifiers (as close to 3 m [10 ft] high as possible) on each WTG tower and/or foundation. The lights and alphanumeric identifiers would be visible from all directions. The Proponent also expects to indicate the WTG's air draft restriction on the foundation and/or tower. Mariner Radio Activated Sound Signals (MRASS) and Automatic Identification System (AIS) transponders are included in the offshore facilities' design to enhance marine navigation safety. The number, location, and type of MRASS and AIS transponders will be determined in consultation with USCG. Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

3.2.1.2 WTG Foundations

The Phase 1 Envelope includes two concepts for the foundations supporting the WTGs:

- Monopiles (with or without TPs)
- Piled jackets

3.2.1.2.1 Monopiles (With or Without Transition Pieces)

A monopile is a single, hollow cylinder fabricated from steel that is secured into the seabed (see Figure 3.2-2). Monopiles are a proven concept used successfully at many offshore wind farms.

The base of the monopile will have j-shaped steel tubes (J-tubes) or an opening to allow the inter-array cables to enter and exit the foundation safely. The monopile foundations will be equipped with a corrosion protection system designed in accordance with relevant standards. The monopiles will likely require the use of an anode cage (a steel structure that has anodes attached to it) to ensure sufficient corrosion protection closer to the seabed. The monopiles will be surrounded by scour protection (see Section 3.2.1.4).

Typically, a separate TP will be installed between the monopile and WTG tower. The TP features a connecting flange enabling the WTG tower section to be mounted on top of the TP using grout, bolts, and/or a slip-joint (i.e. a conical connection between the monopile and TP held in place by gravity without grout or bolts); it also contains secondary structures such as boat landing(s), internal and external platforms, and various electrical equipment needed during installation and operation (e.g. cranes). In a variation of the concept, the monopile is extended to include the TP (this is referred to as an “extended monopile”). In this case, secondary structures are attached after installation of the pile.

3.2.1.2.2 Piled Jackets

A piled jacket foundation is a steel structure that includes three to four legs, which are connected by welded steel tubular cross bracing and secured to the seafloor using piles (see Figure 3.2-3). The piles may be driven through pile “sleeves” or guides mounted to the base of each leg. Alternatively, the piles may be pre-installed prior to the installation of the jacket structure. Piled jackets may include mudmats at the base of each leg to transfer and distribute the load of the jacket to the seafloor sediments and provide temporary support prior to pile driving.

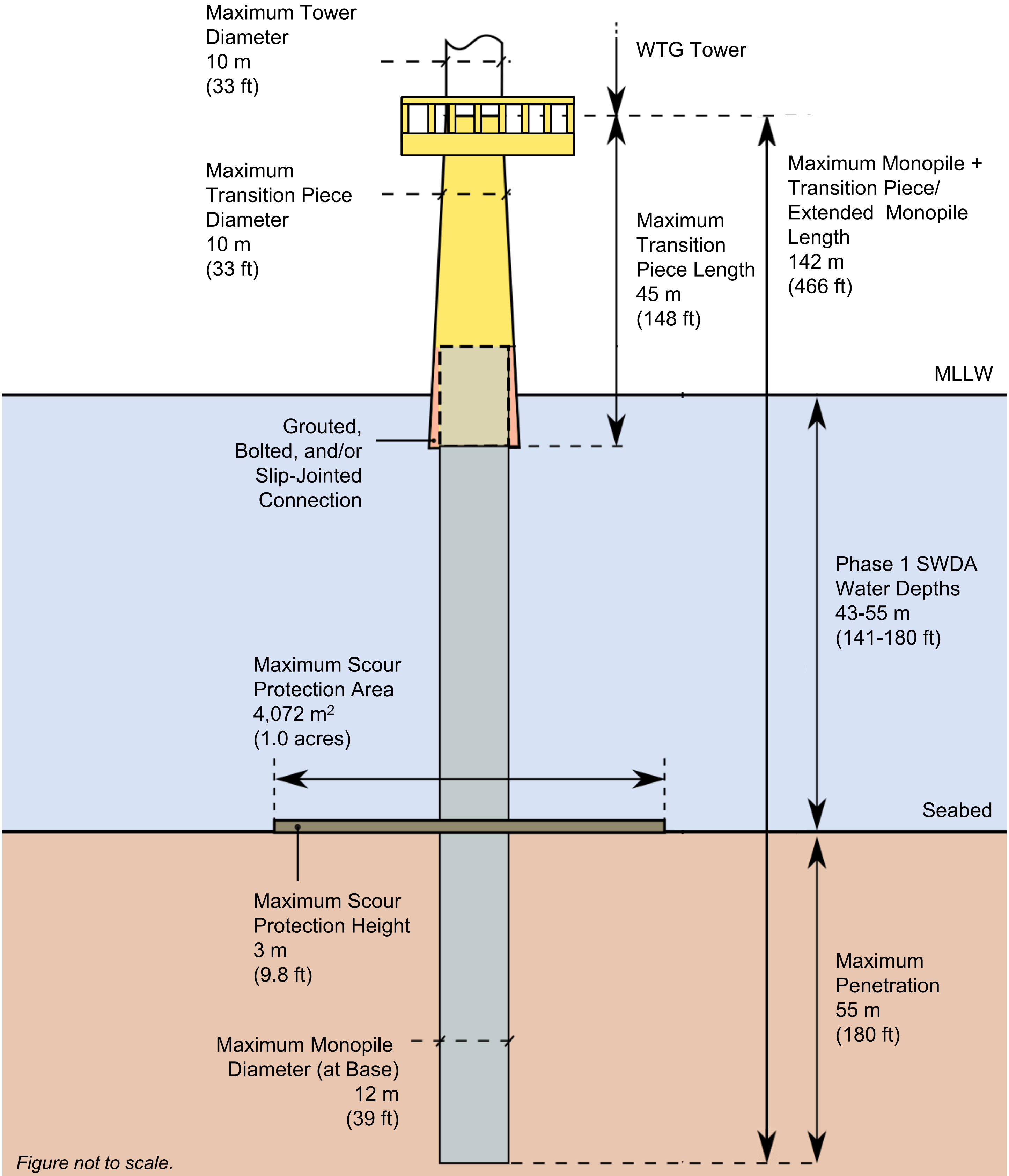


Figure 3.2-2
Phase 1 WTG Foundation - Monopile

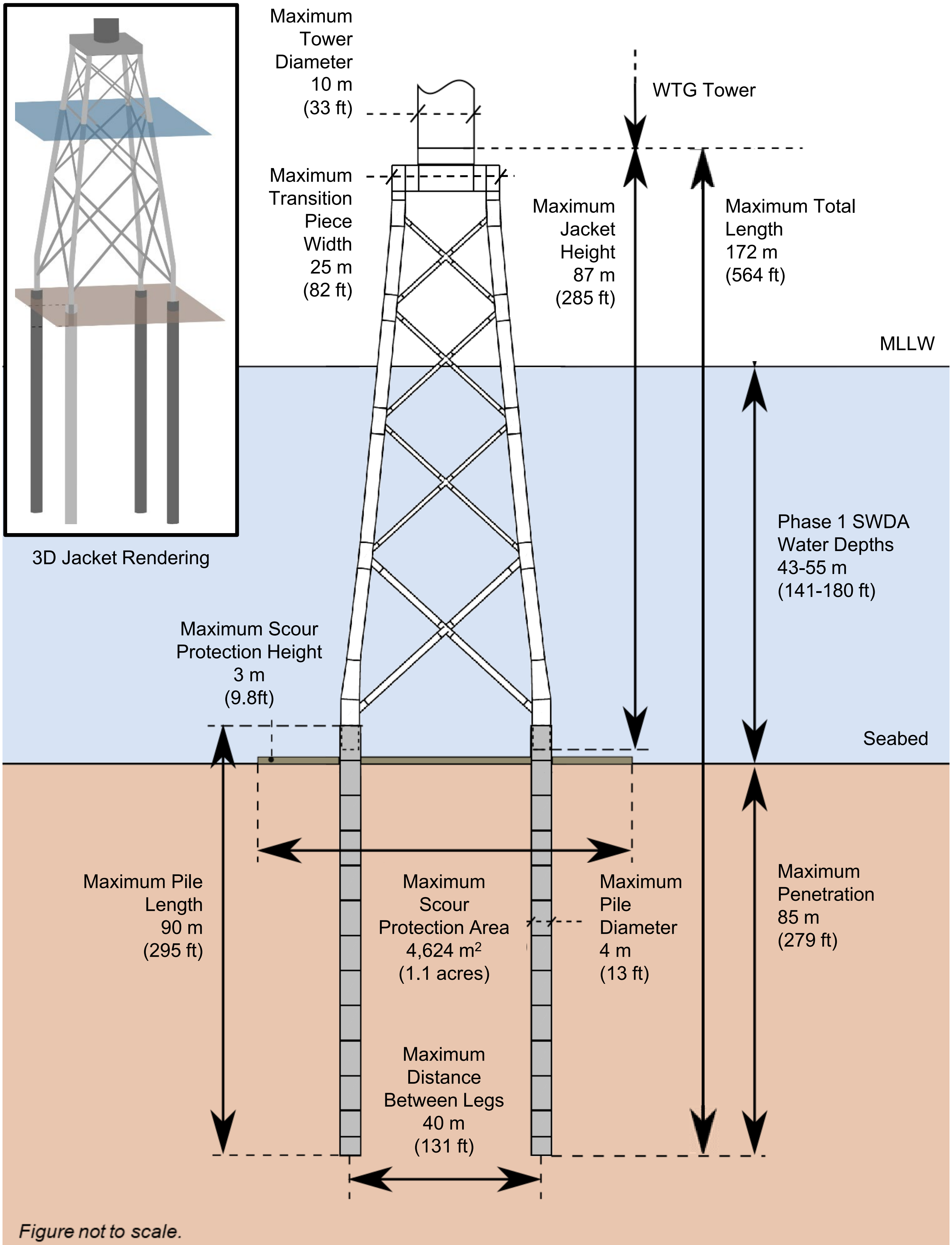


Figure 3.2-3

Phase 1 WTG Foundation – Piled Jacket

The jacket will include an integrated TP and contain secondary structures such as boat landing(s), cable tubes, a tower flange for mounting the WTG, internal and external platforms, and various types of electrical equipment needed during installation and operation. The jacket will also contain J-tubes (or a similar alternative) to allow the inter-array cables to enter and exit the foundation safely. Further, as described for the monopiles (see Section 3.2.1.2.1, above), the jacket will be equipped with a corrosion protection system (e.g. anode cage) designed in accordance with relevant standards. The jackets may or may not be surrounded by scour protection (see Section 3.2.1.4).

3.2.1.2.3 Phase 1 Maximum WTG Foundation Parameters

At this time, the Proponent expects to use all monopiles for the Phase 1 WTG foundations. However, the Phase 1 Envelope also considers jackets. A combination of WTG foundation types may be used, pending the outcome of a foundation feasibility analysis.

The WTG foundation parameters for Phase 1 are provided in the table below and illustrated in Figures 3.2-2 and 3.2-3. Representative photographs of various foundation concepts can be found in Figure 3.2-4.

Table 3.2-2 Phase 1 WTG Foundation Dimensions

Concept	Monopiles	Jackets
	With or Without TP	Piles (3-4 Piles)
Maximum Total Length (from interface with WTG to deepest point beneath the seafloor)	142 m (466 ft)	172 m (564 ft)
Maximum Pile Length	142 m (466 ft)[1]	90 m (295 ft)
Maximum Pile Diameter at Base	12 m (39 ft)	4 m (13 ft)
Maximum Penetration	55 m (180 ft)	85 m (279 ft)
Maximum TP Length for Monopiles/Height above Mudline for Jackets	45 m (148 ft)	87 m (285 ft)
Maximum TP Diameter/Width[2]	10 m (33 ft)	25 m (82 ft)
Maximum Distance Between Adjacent Legs	N/A	40 m (131 ft)

Notes: Dimensions may not sum perfectly due to rounding and unit conversions.

1. Indicates the maximum monopile length using an extended monopile concept.
2. Transition piece diameter/width does not include any secondary structures such as boat landing(s) and external platforms.

Figure 3.2-4

Representative Photographs of WTG Foundations

As described in Section 3.2.1.1 above, each WTG and its foundation will be maintained as a PATON. Based on USCG District 1 LNM 44/20, the Proponent will include yellow flashing lights on every WTG foundation and alphanumeric identifiers (as close to 3 m [10 ft] high as possible) on each WTG tower and/or foundation. The Proponent also anticipates that each foundation will be coated with high-visibility yellow paint (above sea level). Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

3.2.1.3 Electrical Service Platforms (Topsides and Foundations)

Phase 1 will include one or two ESP(s), which will serve as common interconnection points for the Phase 1 WTGs. The potential ESP locations are shown on Figure 3.1-4. Photographs of ESPs can be found in Figure 3.2-5.

Power generated by the WTGs will be transmitted to the ESP(s) via 66 to 132 kV submarine inter-array cables. These inter-array cables will connect to circuit breakers and transformers located within the ESP topside(s), which will increase the voltage level to that of the offshore export cables. From the ESP(s), the offshore export cables will transmit electricity to shore. Additional information about the offshore cable systems is included in Sections 3.2.1.5 and 3.2.1.6.

Each ESP will be installed on a monopile or piled jacket foundation. ESP monopile and jacket foundations are similar in concept to the WTG foundations described in Section 3.2.1.2, but have different maximum dimensions. The ESP foundation(s) may or may not be surrounded by scour protection (see Section 3.2.1.4). If two ESPs are used, they may be located at two separate positions or co-located at one of the potential ESP positions shown on Figure 3.1-4 (co-located ESPs would be smaller structures installed on monopile foundations). If the ESPs are co-located, each ESP's monopile foundation would be located within 76 m (250 ft) of one of the potential ESP locations (i.e. the monopiles would be separated by up to 152 m [500 ft]).

The ESP topside and foundation parameters for Phase 1 are provided in the tables below and illustrated in Figures 3.2-6 and 3.2-7.

Table 3.2-3 Phase 1 ESP Topside Maximum Dimensions

ESP Topside Parameter	Dimension
Maximum Width	60 m (197 ft)
Maximum Length	100 m (328 ft)
Maximum Height	38 m (125 ft)
Maximum Height of Topside above MLLW	70 m MLLW (230 ft MLLW)

Note: Dimensions include possible helipad but do not include antennae.

Figure 3.2-5

Representative Photographs of Electrical Service Platforms

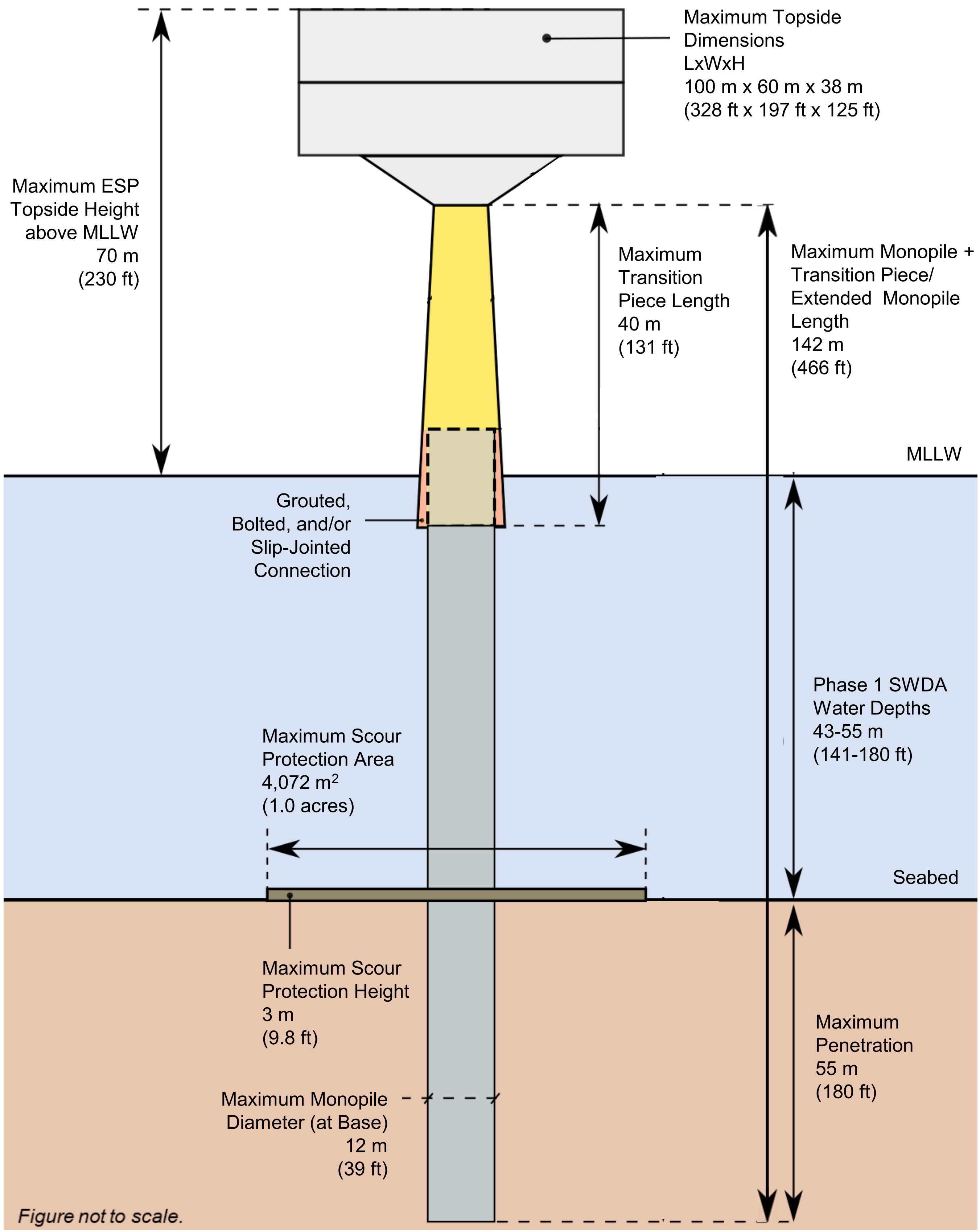


Figure 3.2-6

Phase 1 ESP Topside and Foundation - Monopile

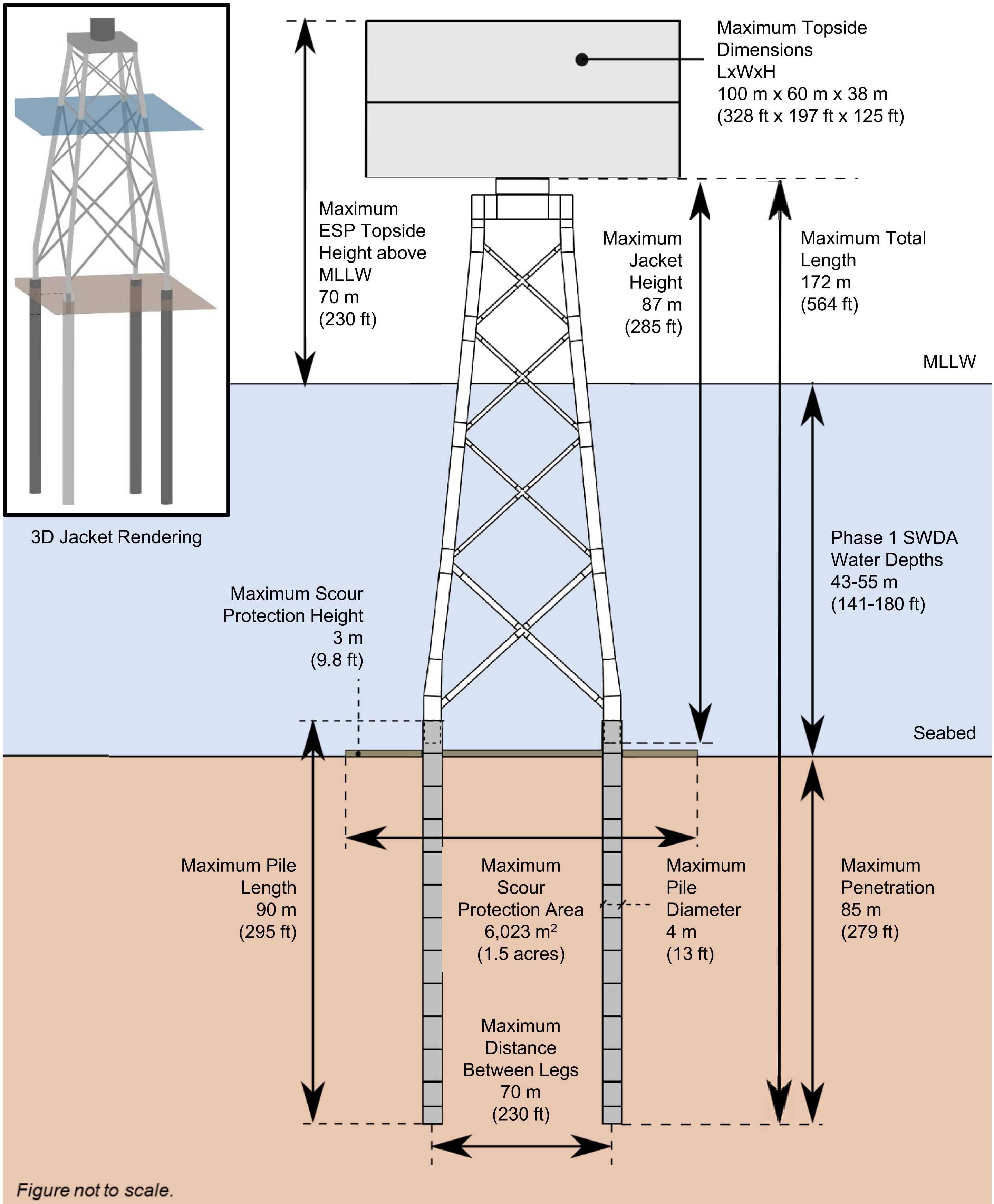


Figure 3.2-7

Phase 1 ESP Topside and Foundation - Piled Jacket

Table 3.2-4 Phase 1 ESP Foundation Maximum Dimensions

Foundation Concept	Monopiles	Piled Jackets
Number of Legs per Foundation	1	3–6
Number of Piles Driven per Foundation	1	3–12
Maximum Total Length (from interface with ESP to deepest point beneath the seafloor)	142 m (466 ft)[1]	172 m (564 ft)
Maximum Pile Length	142 m (466 ft)	90 m (295 ft)
Maximum Pile Diameter at Base	12 m (39 ft)	4 m (13 ft)
Maximum Penetration	55 m (180 ft)	85 m (279 ft)
Maximum TP Length for Monopiles/ Jacket Height Above Mudline	40 m (131 ft)	87 m (285 ft)
Maximum Distance Between Adjacent Legs	N/A	70 m (230 ft)

Notes: Dimensions may not sum perfectly due to rounding and unit conversions.

1. Indicates the maximum monopile length using an extended monopile concept.

Additional equipment on each ESP is subject to final design but is anticipated to include the following: switchgear for connection to the onshore substation, switchgear for connection with the WTGs, transformer oil spill tanks, shunt reactors, auxiliary systems, air-based cooling systems, fire pumps, an oil/water separator, fire detection and firefighting equipment, cranes, rescue and evacuation facilities and equipment (such as life rafts or boats, lifejackets), supervisory control and data acquisition (SCADA) equipment, and communications and navigation systems. A heating, ventilation, and air conditioning system may be installed in the ESP topside(s) to protect the equipment and personnel from extreme temperatures. In addition, one or more generators and/or batteries may also be installed on the ESP(s) to provide standby/emergency power. Lightning protection will also be installed to protect each ESP's electrical system. The ESP(s) may also include a helipad for maintenance work and are anticipated to include at least one boat landing.

If an ESP exceeds an overall height of 60.96 m (200 ft) above ground level/above mean sea level or exceeds any obstruction standard contained in 14 CFR Part 77, the ESP will include an aviation obstruction lighting system in compliance with FAA and/or BOEM requirements. If approved by BOEM and the FAA, 30 flashes per minute will be utilized for air navigation lighting. Subject to BOEM approval, aviation lights on the ESP(s) will also be activated by ADLS. Other temporary lighting (e.g. helipad lights) may be utilized for safety purposes when necessary.

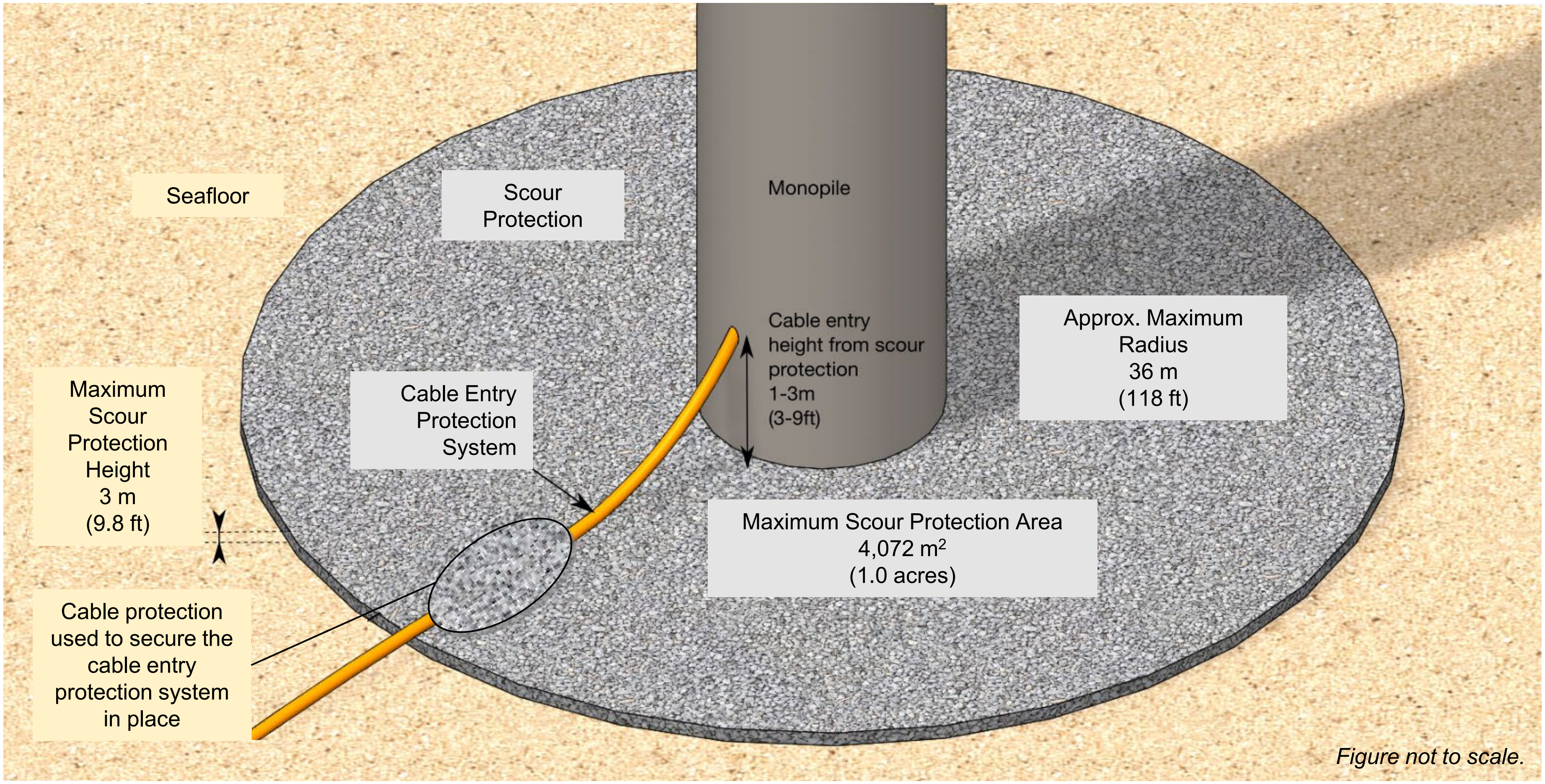
Like the WTGs, each ESP will be maintained as a PATON in accordance with USCG's PATON marking guidance for offshore wind facilities in First District-area waters (see Section 3.2.1.1). The Proponent currently expects each ESP to include yellow flashing lights, alphanumeric identifiers, and high-visibility yellow paint on each foundation. Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

3.2.1.4 Scour Protection

Scour protection may be installed around each WTG and ESP foundation to protect the foundations from scour development, which is the removal of the sediments near structures by hydrodynamic forces. Scour protection consists of rock material placed around the foundation that can withstand the increased seabed drag created by the presence of the foundation. Rock scour protection may be installed in one or two layers; if installed in two layers, the lower first layer (i.e. the filter layer) would consist of smaller rock size followed by an upper armor layer consisting of larger rock.

An evaluation of the potential for scour at the SWDA (included as Appendix III-Q) found that, due to low currents within the SWDA, there is low sediment mobility and transport; therefore, significant scour is not expected. The need for scour protection is specific to the final design of the foundation concept(s) selected and will be further assessed upon detailed engineering of the foundations. Scour protection will be used for the larger diameter monopiles, but may or may not be needed for the smaller diameter piles used for jacket foundations.

Table 3.2-5 and 3.2-6 below contain the maximum scour protection dimensions associated with each Phase 1 WTG and ESP foundation concept, respectively. The Proponent may install scour protection of any shape and size up to the maximum heights and areas provided below (including no scour protection for jacket foundations). An example of scour protection for the monopile foundation concept is illustrated in Figure 3.2-8.



Note: Conceptual drawing provided for Phase 1 monopile foundations only; scour protection dimensions for jacket foundations are provided in Tables 3.2-5 and 3.2-6 and may not be circular.

Figure 3.2-8

Typical Scour Protection for Phase 1 Monopile Foundations

Table 3.2-5 Phase 1 WTG Scour Protection Dimensions

Concept	WTG Foundations	
	Monopile	**Piled Jacket (3-4 Piles)**
Maximum Scour Protection Height	3 m (9.8 ft)	3 m (9.8 ft)
Approximate Maximum Dimensions[1]	Radius of 36 m (118 ft)	Square/rectangle with sides of 68 m (223 ft)
Maximum Area of Scour Protection per Foundation[2]	4,072 m^2 (1.0 acres)	4,624 m^2 (1.1 acres)

Notes: Dimensions may not sum/multiply perfectly due to rounding and unit conversions.

1. The approximate dimensions of scour protection are provided for informational purposes; however, the scour protection may not be the shape described (e.g. scour protection for a jacket may be a rounded triangle or donut-shaped). Regardless of the shape, the area of scour protection will fall within the maximum area of scour protection provided above.
2. The area of scour protection includes the physical footprint of the foundation.

Table 3.2-6 Phase 1 ESP Scour Protection Dimensions

Concept	ESP Foundations	
	Monopile	**Piled Jacket (3-12 Piles)**
Maximum Scour Protection Height	3 m (9.8 ft)	3 m (9.8 ft)
Approximate Maximum Dimensions[1]	Radius of 36 m (118 ft)	Rectangle with sides of 97 m x 62 m (318 ft x 203 ft)
Maximum Area of Scour Protection per Foundation[2]	4,072 m^2 (1.0 acres)	6,023 m^2 (1.5 acres)

Notes: Dimensions may not sum/multiply perfectly due to rounding and unit conversions.

1. The approximate dimensions of scour protection are provided for informational purposes; however, the scour protection may not be the shape described (e.g. scour protection for a jacket may be a rounded triangle or donut-shaped). Regardless of the shape, the area of scour protection will fall within the maximum area of scour protection provided above.
2. The area of scour protection includes the physical footprint of the foundation.

3.2.1.5 Offshore Export Cables

3.2.1.5.1 Offshore Export Cable Design

Two 220–275 kV offshore export cables will transmit electricity from the Phase 1 ESP(s) to the selected landfall site. Each offshore export cable is expected to be comprised of a three-core high voltage alternating current (HVAC) cable for power transmission and one or more fiber optic cables[28] for communication, temperature measurement, and protection of the high-voltage

[28] Fiber optic cables are typically integrated into the offshore export cable, but may be bundled externally to the export cable. In either scenario, the fiber optic and export cables would be installed simultaneously.

system (see Figure 3.2-9). The three cores of the cable will consist of copper or aluminum conductors. Typically, each core will be encapsulated by steel armoring, cross-linked polyethylene (XLPE) insulation, and waterproof sheathing; however, designs vary between cable suppliers and cable technology continues to evolve. Each cable will have an outer diameter of approximately 0.3 m (1 ft).

The cable design may include a Distributed Temperature System (DTS), so that the temperature of the cable is monitored at all times; significant changes in temperature recorded by this system may also be used to indirectly indicate cable exposure. The offshore export cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) (see Section 3.3.1.3.6 for a description of cable installation techniques).

As described in Section 3.1.3, the Phase 1 offshore export cables will be installed within the OECC from the landfall site to the northwestern corner of the SWDA (see Figure 3.1-6). Between the northwestern corner of the SWDA and the Phase 1 ESP(s), the offshore export cables may be installed in any area of the SWDA. All areas where the offshore export cables may be located will have been surveyed in accordance with BOEM regulations and guidance. Accounting for additional cable length needed for turns and micro-siting, the maximum length of each offshore export cable within the OECC is ~83 km (~45 NM) and the maximum length per cable within the SWDA is ~18 km (~10 NM).[29] Altogether, the maximum length of each Phase 1 offshore export cable from the landfall site to the ESP is approximately 101 km (54 NM), giving a total maximum length of ~202 km (~109 NM) for Phase 1.

3.2.1.5.2 Offshore Export Cable Separation and Alignment

Cable Separation

The Phase 1 offshore export cables will be installed within the same OECC as Vineyard Wind 1's offshore export cables and any subsequent Phase 2 cables, resulting in three sets of cables within the OECC. The cables will typically be separated by a distance of 50–100 m (164–328 ft) to provide appropriate flexibility for routing and installation and to allow room for maintenance or repairs. This separation distance could be further adjusted, pending ongoing routing evaluation, to account for local conditions, such as deeper waters, micro-siting for sensitive habitat areas, or other environmental or technical reasons.

[29] The offshore export cable length includes a 15% allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5% allowance for micro-siting within the OECC outside the lease areas.

Design:

1. Conductor (Al or Cu)
2. Inner semi-conducting layer
3. XLPE insulation
4. Outer semi-conducting layer
5. Swellable tape
6. Lead sheath
7. PE oversheath
8. Fibre optic cable
9. Filler profiles
10. Bedding (PP)
11. Armouring
12. Outer sheath (PP)

Figure 3.2-9

Typical Phase 1 Offshore Cable Cutaway

Offshore Export Cable Alignment Engineering

The Proponent has conducted preliminary route engineering to develop the first iteration of the Phase 1 and Phase 2 offshore export cable alignments within the SWDA and OECC (see Appendix III-P). These preliminary cable alignments are supported by a risk assessment that determines the minimum level of burial required to protect the cables and an assessment of the method of burial that is most suitable for specific site conditions. The preliminary alignments consider numerous seabed features and environmental constraints, including areas of coarse deposits, boulders, sand waves, seabed slopes, water depths, magnetic anomalies, and the location of other existing or planned cables.

The preliminary routing of the cables has avoided sensitive habitats including eelgrass, hard bottom, and complex bottom (i.e. sand waves) where feasible, but avoidance of all sensitive habitats is not always possible. Route engineers must develop routes for cables within the OECC that are technically viable and provide workable slopes, suitable water depths for available cable installation vessels, feasible turning radii for the cables, avoid high concentrations of boulders or very stiff sediments where cable burial would be challenging, maintain a sufficient distance between the planned Vineyard Wind 1 cables and Phase 2 cables, and avoid crossing the planned Vineyard Wind 1 cables. It is expected that the identified eelgrass resources near Spindle Rock in proximity to the landfall sites will be avoided (see Figure 6.4-1 of COP Volume III). It is also expected that isolated areas of hard bottom may be avoided, such as at Spindle Rock; however, in areas such as Muskeget Channel where hard bottom extends across the entire corridor, it will not be possible to avoid hard bottom.

Following the preliminary route engineering (as presented in Appendix III-P), the detailed route engineering will be completed by the contractor retained by the Proponent to supply and install the submarine cables. When conducting the detailed route engineering, the contractor will review and refine the alignments of the Phase 1 offshore export cables within the OECC based on the as-built alignments of the Vineyard Wind 1 cables and to optimize the installation activities and burial depth for its specific cable installation tool. Accordingly, the preliminary alignments may shift somewhat as the route is optimized. The contractor's design process will be overseen by the Proponent, and any deviations from the preliminary route design will be subject to the Proponent’s approval.

3.2.1.5.3 Cable Entry Protection System

The ends of the offshore export cables will likely be protected using protection conduits put in place at the approach to the ESP foundation(s) (see Figure 3.2-8). This cable entry protection system consists of different components of composite material and/or cast-iron half-shells with suitable corrosion protection, which protect the cables from fatigue and mechanical loads as they transition above the seabed and enter the foundation. Although a large majority of the cable entry protection system will likely lie on top of the scour protection (if used), it will likely extend a short distance beyond the edge of the scour protection. Additional cable protection may be placed on top of the cable entry protection system (within the footprint of the scour protection) to secure the cable entry protection system in place and limit movement of the cable, which can damage the cable. Cable protection is described in Section 3.2.1.5.4 below.

3.2.1.5.4 Cable Protection

While the target burial depth of the offshore export cables will be at least 1.5 m (5 ft) along their entire length, cable protection will not automatically be applied if the target burial depth cannot be achieved. The Proponent plans to use cable protection if a minimum burial depth of 1.5 m (5 ft) is not achieved within areas of higher risk of damage from anchor strikes. These areas of higher risk are based on existing vessel traffic patterns and comprise the majority of the OECC. To minimize the use of cable protection, where the risk of anchor strike is negligible, the Proponent plans to use cable protection if a minimum burial depth of 1.0 m (3.3 ft) is not achieved. Section 9.0 of Appendix III-P describes the decision framework for when to apply cable protection if sufficient burial depths are not achieved in lower and higher risk areas along the OECC. Cable protection may also be used if the cables need to cross other infrastructure (e.g. existing cables, pipes, etc.), to secure the cable entry protection system in place, or where a cable joint requires protection.

Potential cable protection methods include:

- **Rock placement:** Rocks laid on top of the cable to provide protection. Rock will be installed in a controlled and accurate manner on the sea floor likely using a DP fall-pipe vessel (see Section 3.3.1.3.10). Rocks used for cable protection will be sized for site-specific conditions; where feasible, Phase 1 will use rocks sized 6.4 centimeters (cm) (2.5 inches [in]) in diameter or larger.[30]

- **Gabion rock bags:** Rock bags consisting of rock encased in a net material (e.g. a polyester net) that can be accurately deployed on top of the cable and recovered from a vessel for temporary or permanent cable protection. The bag is equipped with a single lifting point to enable its accurate and efficient deployment and recovery. The net material would be designed to have an ~50-year lifespan.

- **Concrete mattresses:** Prefabricated flexible concrete coverings consisting of high-strength concrete profiled blocks cast around a mesh (e.g. ultra-violet stabilized polypropylene rope) that holds the blocks together. The mattress construction provides flexibility allowing it to settle over the contours of the cable or pipeline. The mesh would be designed to have a decades-long lifespan. The mattress may also include aerated polyethylene fronds, which will float (resembling seaweed) and encourage sediments to be deposited on the mattress.

[30] Some rocks may be fragmented into smaller pieces during handling, transport, and installation.

- **Half-shell pipes or similar (only for cable crossings or where the cable is laid on the seafloor):** Similar to the cable entry protection system described in Section 3.2.1.5.3 above, these products are made from composite materials and/or cast iron with suitable corrosion protection and are fixed around the cable to provide mechanical protection. Half-shell pipes (or similar solutions) are not used for remedial cable protection but could be used at cable crossings or where cable must be laid on the surface of the seabed. The half-shell pipes do not ensure full protection from damage due to fishing trawls or anchor drags (although they will offer some protection, they will not prevent damage).

The Proponent conservatively estimates that approximately 6% of the offshore export cables within the OECC could require one of these alternative cable protection methods.[31] The estimated length and area of offshore cables potentially requiring protection is presented in Section 3.3.1.13. Cable protection will be up to 9 m (30 ft) wide.

The Proponent intends to avoid or minimize the need for cable protection to the greatest extent feasible through careful site assessment and thoughtful selection of the most appropriate cable installation tool to achieve sufficient burial; therefore, the estimates of cable protection are expected to be conservative. A detailed Burial Assessment Study will be developed for the Phase 1 offshore export cables during the contractor's engineering and design phase and made available for the CVA process.

3.2.1.6 Inter-Array and Inter-Link Cables

As already noted, 66–132 kV inter-array cables will connect "strings" of multiple WTGs to the ESP(s). The WTGs can be connected together in a variety of inter-array cable configurations, including linear strings, with or without redundancy links (i.e. redundant inter-array cables at end of strings to enhance reliability), and branched strings. The farthest WTG on each string will have one outgoing connection and each subsequent WTG will have both incoming and outgoing inter-array cables.

The cable type is conceptually similar to the three-core alternating current cable used for the offshore export cables (see Section 3.2.1.5.1). However, the design may differ due to the lower voltages and different performance specification requirements of the inter-array cables. For example, the inter-array cables may not include a water-impervious lead sheath and may have different armoring, including high-density polyethylene (HDPE) or other materials. Each section of the inter-array cable string must transmit an increasing amount of power in the direction from the outermost WTG to the ESP. Therefore, multiple cross-sections with different capacities are envisaged for the inter-array cables. The outer diameter of the inter-array cables is anticipated to be up to 225 millimeters (8.9 in). These inter-array cables will be buried beneath the seafloor

[31] The Proponent conservatively estimates that approximately 2% of the offshore export cables within the SWDA could require cable protection.

at a target depth of 1.5–2.5 m (5–8 ft) (see Section 3.3.1.6 for a description of inter-array cable installation). The maximum anticipated length of the Phase 1 inter-array cables is approximately 225 km (121 NM).

In addition to the inter-array cables, if two ESPs are used, the ESPs may be connected by a 66 to 275 kV inter-link cable. The inter-link cable will be similar to either the offshore export cables or the inter-array cables. All inter-link cable designs would provide redundancy, thus improving reliability. The inter-link cable will be up to ~20 km (~11 NM) in length and will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft).

The development of the inter-array and inter-link cable layout is highly dependent upon the final number of WTGs included in Phase 1 and the selected location and number of ESPs. The design and optimization of the inter-array and inter-link cable system will occur during the final design of Phase 1 and will consider cable design and capacity, ground conditions, operating conditions, installation conditions, and potential cultural resources. This means that the Proponent is permitting an Envelope for the inter-array and inter-link cables that includes any potential layout within the SWDA. All areas where inter-array and inter-link cables may be located will have been surveyed in accordance with BOEM regulations and guidance. A representative inter-array cable layout for Phase 1 is provided as Figure 3.2-10 for illustrative purposes.[32]

Like the offshore export cables, all inter-array cables and inter-link cables will likely be protected with cable entry protection systems at the approach to the WTG and ESP foundations (explained above in Section 3.2.1.5.3). The cable entry protection system may extend a short distance beyond the scour protection.

Based on initial survey data for the SWDA, the Proponent expects that cable protection is less likely to be needed for the inter-array cables and inter-link cables than the offshore export cables due to consistent geology and limited coarse materials. As described in Section 3.3.1.6, the inter-array and inter-link cables are expected to be installed using jetting techniques. Jetting techniques are very suitable for the site conditions of relatively homogeneous consolidated sands, providing a high degree of confidence that sufficient burial will be achieved. Additionally, if sufficient burial is not achieved on the first pass, it is expected that one or more additional attempts with an installation tool may be made to achieve sufficient burial, which increases the likelihood that cable burial will be achieved. Where feasible, the inter-array and inter-link cable layout will be designed to avoid areas with increased risk of not achieving the target burial depth. In addition, the inter-array and inter-link cable layout will also be designed to avoid cable crossings; thus, no cable protection for cable crossings is expected.

[32] Figure 3.2-10 is illustrative of an inter-array cable layout that would occur when there is only one Phase 1 ESP. Thus, no inter-link cable is illustrated. The inter-link cable may be located between any two potential Phase 1 ESP locations.

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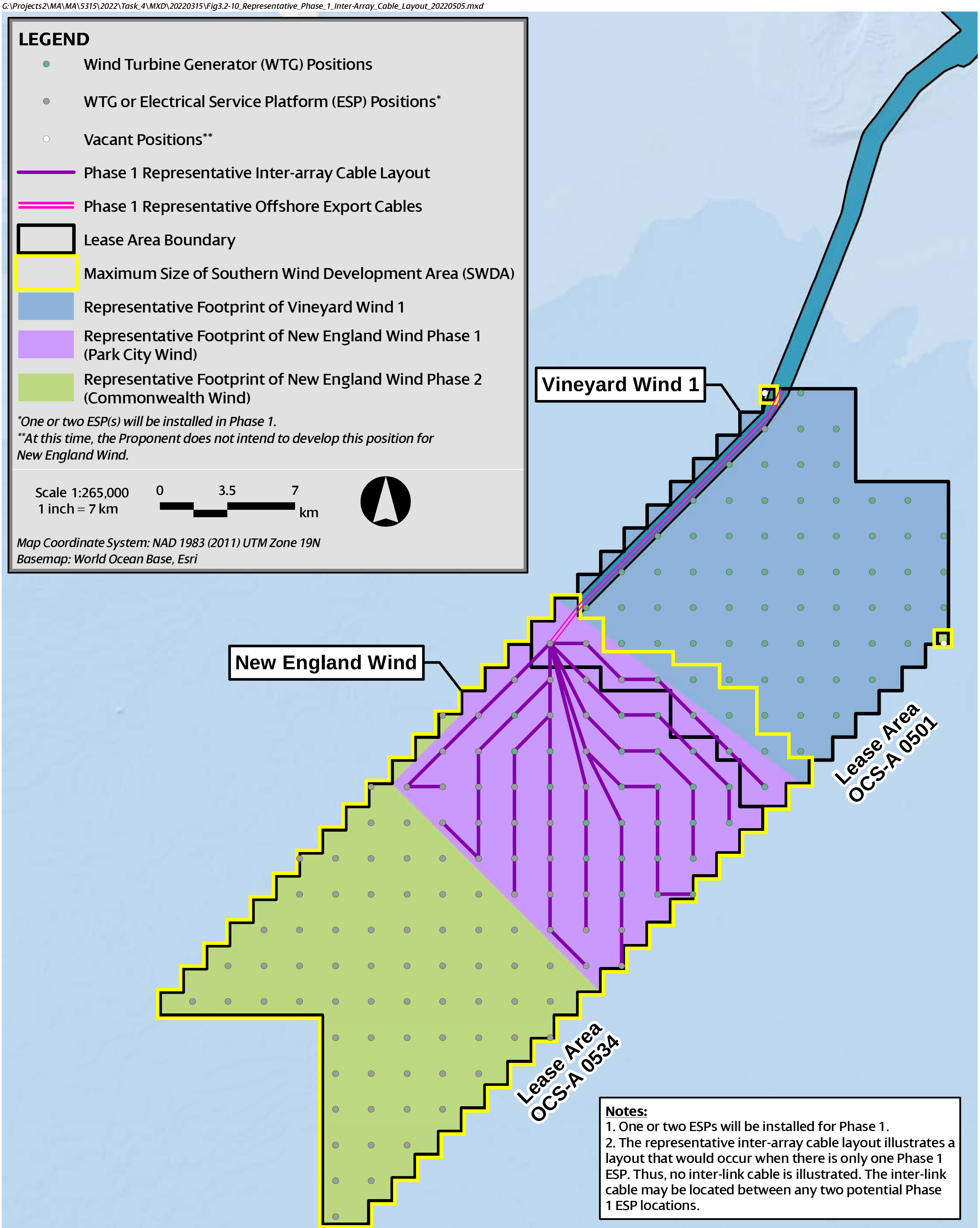

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Figure 3.2-10
Representative Phase 1 Inter-Array Cable Layout

Although not anticipated, the Proponent conservatively estimates that up to 2% of the total length of the inter-array and inter-link cables could require cable protection, with the majority of the cable protection likely located adjacent to the foundation's scour protection.[33] See Section 3.2.1.5.4 for a description of cable protection methods. Once additional survey data is collected for the SWDA and a cable layout is identified, the Proponent will likely perform a more detailed assessment of the need for cable protection over the inter-array and inter-link cables.

3.2.2 Phase 1 Onshore Facilities

The Phase 1 onshore facilities will ultimately include one of two potential landfall sites, one of two potential Onshore Export Cable Routes (with variants), one new onshore substation, and one of two potential Grid Interconnection Routes (with variants).

3.2.2.1 Landfall Sites

The Phase 1 offshore export cables will transition onshore via horizontal directional drilling (HDD) at one of two potential Phase 1 landfall sites in the Town of Barnstable:

- **Craigville Public Beach Landfall Site:** The Craigville Public Beach Landfall Site is located within a 0.014 km^2 (3.5 acre) paved parking area associated with a public beach that is owned and managed by the Town of Barnstable. The landfall site is situated in the central part of the Centerville Harbor bight in an area where the shoreline is relatively stable. Adjoining land uses include homes along the north side of Craigville Beach Road, a private beach club (Craigville Beach Club) and associated parking to the west, a private bathhouse and parking to the east (owned by the nearby Christian Campground), and some open space. The area is most heavily used during the summer season. The Craigville Public Beach Landfall Site has adequate space for an HDD staging area and favorable route options to the onshore substation site.

- **Covell's Beach Landfall Site:** Alternatively, the Phase 1 landfall site may be located at Covell's Beach (the landfall site used for Vineyard Wind 1), which is approximately 0.6 km (0.4 mi) east of Craigville Public Beach. The Covell's Beach Landfall Site is located at a paved parking area associated with Covell's Beach, a residents-only public beach that is owned and managed by the Town of Barnstable. This landfall site is advantageously located within the Centerville Harbor bight, has adequate space for a construction staging area, and provides favorable egress to the Onshore Export Cable Routes. However, the Covell's Beach Landfall Site is being used for Vineyard Wind 1, which may create engineering constraints and construction feasibility challenges. For this reason, the Proponent only expects to use the Covell's Beach Landfall Site for Phase 1 if unforeseen challenges arise that make it infeasible to use the Craigville Public Beach Landfall Site.

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[33] The estimate of cable protection includes any length of the cable entry protection system beyond the scour protection.

Ultimately, a single landfall site will be used for Phase 1. Both potential landfall sites described above are considered good candidates for cable landing given their favorable egress and inland routing to Eversource's existing 345 kV West Barnstable Substation via public roads and existing utility rights-of-way (ROWs).

Once the offshore export cables make landfall, they will transition to the onshore export cables within two parallel below-grade concrete transition vaults (one for each offshore cable). Each vault will have exterior dimensions of approximately 6 m (20 ft) wide by 18 m (60 ft) long by 1 m (3.5 ft) tall. Inside each vault, each offshore export cable will be separated and spliced into three separate single-core onshore export cables, giving a total of six onshore export cables for Phase 1. Immediately adjacent to the transition vaults, there may be smaller fiber optic cable vaults and/or link boxes.

After the onshore export cables and fiber optic cables leave the transition vaults and fiber optic cable vaults, they will be housed inside a concrete duct bank, as described in Section 3.2.2.2.2. At the landfall site, the duct bank will be entirely underground except for at-grade manhole covers.

Construction methods for the landfall sites are discussed in Section 3.3.1.8.

3.2.2.2 Onshore Export Cables

The Phase 1 onshore export cables will follow one of two potential Onshore Export Cable Routes (with variants) from the Craigville Public Beach Landfall Site or Covell's Beach Landfall Site to the Phase 1 onshore substation site:

- Shootflying Hill (SFH) Road Onshore Export Cable Route
- Oak Street Onshore Export Cable Route

The Phase 1 Onshore Export Cable Routes are approximately 6.5 to 10.5 km (4.0 to 6.5 mi) in length. These routes are shown on Figure 3.2-11 and described in more detail below. The onshore export cables will be installed in an underground duct bank along the selected Onshore Export Cable Route. The onshore export cable and duct bank design is described in 3.2.2.2.2 below.

3.2.2.2.1 Onshore Export Cable Routes

Shootflying Hill Road Onshore Export Cable Route

The Shootflying Hill (SFH) Road Onshore Export Cable Route begins at the Craigville Public Beach Landfall Site and proceeds generally north on Craigville Beach Road to Main Street. The route then continues north on Old Stage Road, passing through the Centerville Historic District. After crossing Route 28, the route follows Shootflying Hill Road until it turns southeast onto ROW #343 to reach the onshore substation (see Figure 3.2-11). The route passes through a mix of moderate-density residential and commercial areas. The total length of the SFH Road Onshore Export Cable Route is 6.5 km (4.0 mi).

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Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

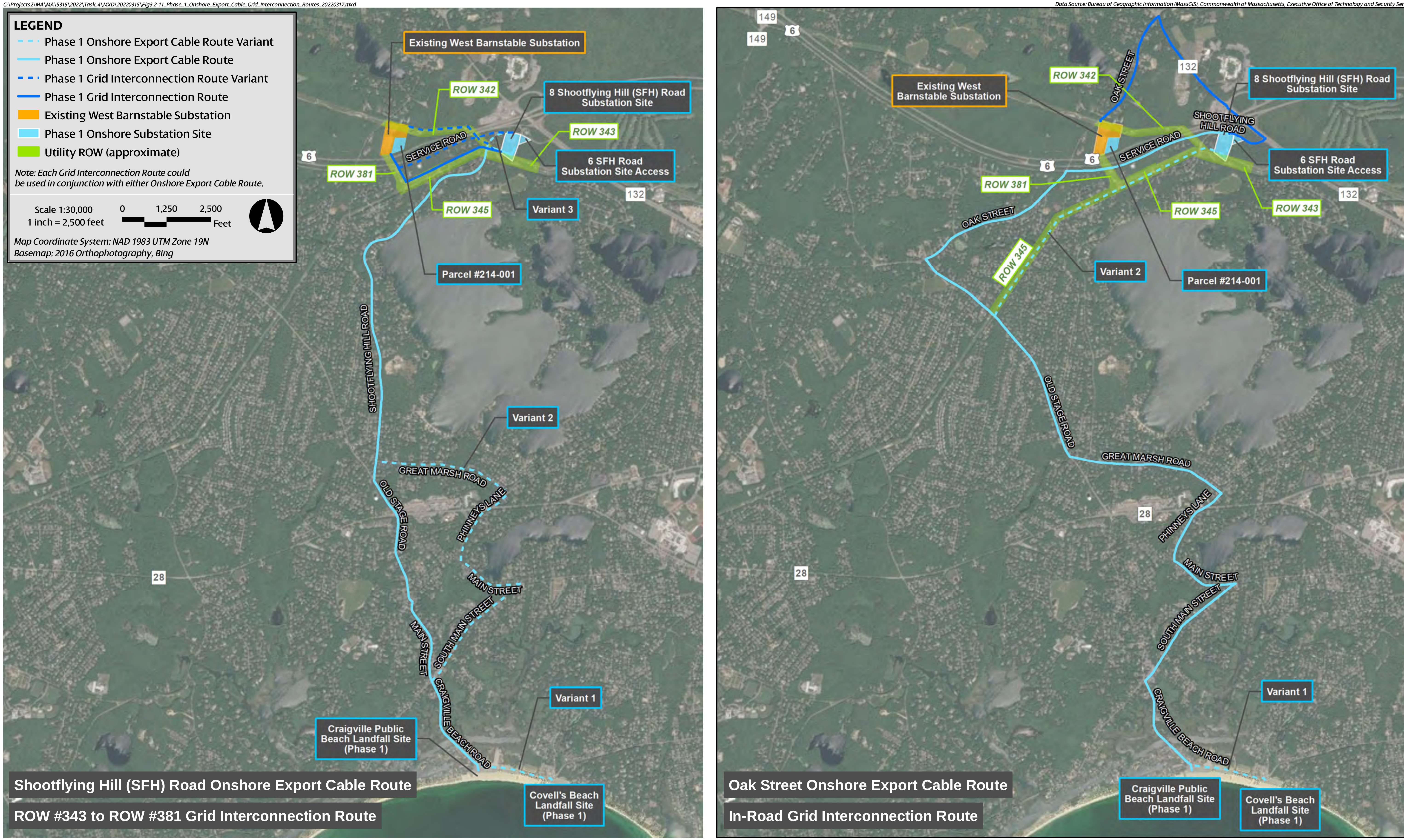

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Figure 3.2-11

Phase 1 Onshore Export Cable and Grid Interconnection Routes

There are three variants of the SFH Road Onshore Export Cable Route:

- Variant 1 (Covell's Beach Landfall Site) provides connection to the Covell's Beach Landfall Site in case unforeseen challenges arise that make it infeasible to use the Craigville Public Beach Landfall Site. The Covell's Beach Landfall Site variant has a total length of approximately 7.2 km (4.5 mi).

- Variant 2 (South Main Street) diverges from the SFH Road Onshore Export Cable Route at the intersection of Craigville Beach Road with South Main Street and follows South Main Street eastward to Main Street. The route then follows Mothers Park Road, Phinneys Lane, and Great Marsh Road, rejoining the SFH Road Onshore Export Cable Route north of Route 28 at Shootflying Hill Road. Use of Variant 2 avoids the Centerville Historic District, but adds approximately 2.0 km (1.2 mi) of route length, giving a total length of 8.4 km (5.2 mi). Although installation of the onshore export cables through the Historic District is technically feasible, this variant would only be utilized if the more direct route through the Historic District proves problematic.

- Variant 3 (Northern Substation Access) is essentially the same length as the SFH Road Onshore Export Cable Route, but provides an alternative for accessing the onshore substation site directly from the north from Shootflying Hill Road rather than from the south off of ROW #343. Variant 3 is 6.5 km (4.1 mi) in length and would be used if it is not possible to use existing utility ROWs.

The Craigville Beach Road segment of the SFH Road Onshore Export Cable Route (and its variants) includes an existing two-lane bridge over the Centerville River. Methodologies for crossing the Centerville River are discussed in greater detail in Section 3.3.1.10.2. Except for possibly the Centerville River crossing and the last 0.3 km (0.2 mi) along ROW #343 (if used), the entire route is almost entirely within public roadway layouts.

Oak Street Onshore Export Cable Route

The Oak Street Onshore Export Cable Route begins at the Craigville Public Beach Landfall Site and proceeds northerly on Craigville Beach Road. At the intersection between Craigville Beach Road and South Main Street, the route follows South Main Street eastward to Main Street. The route then follows Mothers Park Road, Phinneys Lane, and Great Marsh Road (similar to Variant 1 of the SFH Road Onshore Export Cable Route). From Great Marsh Road, the route turns northward onto Old Stage Road toward Oak Street, where it turns northeast and continues to Service Road. The route then follows Service Road to Shootflying Hill Road, which it follows to the onshore substation site. The total length of the Oak Street Onshore Export Cable Route is 9.8 km (6.1 mi).

The Proponent is also considering two variants of the Oak Street Onshore Export Cable Route (see Figure 3.2-11):

- Variant 1 (Covell's Beach Landfall Site) provides connection to the Covell's Beach Landfall Site in case unforeseen challenges arise that make it infeasible to use the Craigville Public Beach Landfall Site. The Covell's Beach Landfall Site variant has a total length of 10.5 km (6.5 mi).

- Variant 2 (ROW #345) shortens the route by approximately 1.1 km (0.7 mi) by utilizing approximately 2.7 km (1.6 mi) of utility ROW (along ROW #345 and ROW #343) between Old Stage Road and the onshore substation site. Variant 2 has a total length of 8.8 km (5.4 mi). While a shorter route with fewer construction-period traffic impacts and fewer potential conflicts with existing subsurface utilities, this variant would likely require tree clearing on private land within the utility ROW where the ROW has not been maintained to its full width. In addition, this variant would likely require a trenchless crossing within the utility ROW to avoid impacts to a wetland, increasing costs and the complexity of construction (see Figure 6.1-1 of COP Volume III). Finally, the variant would pass through more area mapped as public water supplies.

Unless Variant 2 is used, the Oak Street Onshore Export Cable Route and its variants are located entirely within public roadway layouts except for possibly the Centerville River crossing.

3.2.2.2.2 Onshore Export Cable and Duct Bank Design

Each onshore export cable is expected to be comprised of a single core consisting of a copper or aluminum conductor covered by solid XLPE insulation. Each onshore export cable will contain a metallic sheath and a non-metallic outer jacket that will wrap around the XLPE solid insulation. These last layers primarily function to avoid direct contact between the conductor and the ground as well as control and minimize the thermal and electrical losses. The cables will not contain any fluids. The diameter of each onshore cable could be up to approximately 15 cm (6 in). A manufacturer's cutaway of the onshore cable is provided as Figure 3.2-12; three of these cables will make up a single alternating current circuit.

The onshore export cables will be installed entirely underground within a duct bank along one of the Onshore Export Cable Routes, except for at-grade manhole covers and possibly at the Centerville River crossing. For both Phase 1 route options, the duct bank will primarily be installed within public roadway layouts (either beneath the road or within 3 m [10 ft] of pavement), although portions of the duct bank may be located within existing utility ROWs.

The duct bank will be an array of HDPE or polyvinyl chloride (PVC) conduits encased in concrete. Each onshore export cable and fiber optic cable is installed within its own conduit. Spare conduits and grounding will be also accommodated within the duct bank. For the majority of the onshore route, these conduits will be arrayed four conduits wide by two conduits deep, with the

Design:

1. Conductor (Al or Cu)
2. Inner semi-conducting layer
3. XLPE insulation
4. Outer semi-conducting layer
5. Wire screen (Al or Cu)
6. Lead sheath
7. PE oversheath

total duct bank measuring approximately 1.5 m (5 ft) wide and 0.8 m (2.5 ft) deep. A more upright design arrayed two conduits wide and four conduits deep is also possible, which would measure approximately 0.8 m (2.5 ft) wide and 1.5 m (5 ft) deep. Depending on the configuration of existing subsurface utilities, this duct bank arrangement could be modified along short stretches to enable deeper burial depth to respect utility separation requirements. The proposed duct bank will be formed using cast-in-place concrete installed in open trenches.

Once the duct bank is in place, the cables (one cable per sleeve) will be pulled into place via underground splice vaults and associated manholes, which are placed in staggered pairs approximately every 457–914 m (1,500–3,000 ft) or more along the Onshore Export Cable Route. The splice vaults are typically two-piece (top and bottom) pre-formed concrete chambers with openings at both ends to connect with the duct bank conduits and admit the cables. Each splice vault is typically 2.4 m (8 ft) wide by 10 m (34 ft) long and up to 2.7 m (9 ft) deep (interior dimensions). See Section 3.3.1.10 for a discussion of onshore export cable installation.

Both Phase 1 Onshore Export Cable Routes must cross the Centerville River where there is an existing two-lane bridge on Craigville Beach Road. Based on engineering considerations and consultations with the Town of Barnstable and the Massachusetts Department of Transportation (MassDOT), the current preferred option is microtunnel, followed by two other trenchless crossing options (HDD and direct pipe), and finally a parallel utility bridge option. The Centerville River crossing is discussed in greater detail in Section 3.3.1.10.2.

3.2.2.3 Onshore Substation

Phase 1 will require the construction of a new onshore substation where the onshore export cable voltage will step up from 220–275 to 345 kV in preparation for interconnection at the existing West Barnstable Substation.

The Phase 1 onshore substation will be constructed on a 0.027 km^2 (6.7 acre) privately-owned parcel located at 8 Shootflying Hill Road. The Proponent has secured an option to purchase the site and thus has site control. The 8 Shootflying Hill Road onshore substation site is southwest of the Route 6-Route 132 highway interchange, located approximately 1.3 km (0.8 mi) east of the West Barnstable Substation. The onshore substation site has frontage on Shootflying Hill Road and direct access to ROW #343. The northern part of the site currently contains a motel building and associated paved access and parking, while the southern part consists of wooded land. The motel and its paved areas will be removed prior to the start of substation construction. The onshore substation site is in a residentially zoned area and is bordered to the west by residential parcels, to the north by Shootflying Hill Road, to the east by land owned by the Chamber of Commerce and MassDOT, and to the south by ROW #343. The buried duct bank will enter the onshore substation site from either ROW #343 or Shootflying Hill Road, depending on the variant ultimately implemented (see Section 3.2.2.2.1).

The Phase 1 onshore substation will house two 220–275/345 kV “step-up” transformers, switchgear, and other necessary equipment. The onshore substation is expected to use a gas-insulated substation (GIS) design. A GIS is enclosed within a structure that uses sulfur hexafluoride (SF_6) gas to insulate the substation equipment. Use of SF_6 gas to insulate the substation’s electrical equipment rather than ambient air enables a more compact substation layout. The SF_6 gas will be used in new circuit breakers, which are designed to be gas-tight and sealed for the life of the equipment. The new substation may include a small control equipment enclosure.

The Proponent plans to plant a vegetated screening on the western and northern boundaries of the onshore substation site; the vegetated screening along the western edge would provide visual screening for existing residences. The eastern boundary may be utilized for part of the perimeter access drive, and the abutting land is undeveloped wooded land. Since the southern property line extends into ROW #343, no vegetated screening will be possible in that location. Substation construction may require initial clearing of the entire site, but revegetation along the onshore substation site boundaries would occur outside of the substation boundary/screening wall. The entire site will have a perimeter access fence, and the westerly side may have sound attenuation walls, if necessary.

The Proponent has secured an option to purchase a 0.004 km^2 (1 acre) parcel at 6 Shootflying Hill Road, which is located immediately northeast of the proposed substation site at 8 Shootflying Hill Road (see Figure 3.2-11). Assuming that the Proponent is able to acquire the property, 6 Shootflying Hill Road will be used for an improved access road to the onshore substation site in lieu of an access road from the northeast corner of 8 Shootflying Hill Road. The access road on 6 Shootflying Hill Road will allow for a wider turning radius into the substation site from Shootflying Hill Road (improving access for construction vehicles, emergency vehicles, and heavy equipment transport) and locates this vehicular traffic further from residential abutters west of the substation. The improved access road also allows site elevations to be reduced by up to 3 m (10 ft), which will reduce or eliminate the need to import fill onto the site and may generate material to be exported from the site.

In addition, the Proponent has secured an approximately 0.011 km^2 (2.8 acre) parcel of land, assessor map parcel #214-001 (“Parcel #214-001”), located immediately southeast of the West Barnstable Substation (see Figure 3.2-11). Parcel #214-001 is entirely forested and is surrounded by Route 6 to the south, Eversource’s West Barnstable Substation property to the west and north, and undeveloped land to the east; there are no residences or other sensitive receptors in proximity to the parcel. While this parcel will likely be utilized as the northern terminus of a trenchless crossing across Route 6 (see Section 3.3.1.10.3), it also provides some flexibility regarding the proposed substation design. The Proponent is considering an alternative that would involve relocating some of the onshore substation equipment (e.g. static synchronous compensators [STATCOMS], shunt reactors) from the 8 Shootflying Hill Road onshore substation site to Parcel #214-001.

The Proponent plans to provide full-volume (110%) containment systems for any substation components using dielectric fluid located at the onshore substation site and Parcel #214-001. The containment sumps will be designed to fully contain the dielectric fluid in the very unlikely event of a complete, catastrophic failure of the transformer or other equipment. To provide additional containment for an extreme rain event, if requested by the Town of Barnstable, the Proponent will increase the 110% containment volume to account for the simultaneous Probable Maximum Precipitation (PMP) event in a 24-hour period, which will be determined for the onshore substation site and Parcel 214-001 in consultation with the Town. Also included in the design as additional mitigation is a common drain system that routes each individual containment area, after passing through an oil-absorbing inhibition device, to an oil/water separator before draining to the infiltration basin.

A stormwater management system at the onshore substation site, 6 Shootflying Hill Road, and Parcel 214-001 will include low-impact development (LID) strategies (e.g. grass water quality swales to capture and convey site runoff, deep sump catch basin(s) to pretreat surface runoff, etc.), which are designed to capture, treat, and recharge stormwater runoff.

Outdoor lighting at the onshore substation site, 6 Shootflying Hill Road, and Parcel #214-001 will typically be equipped with light shields to prevent light from encroaching into adjacent areas. There are typically a few lights illuminated for security reasons on dusk–to-dawn sensors as well as a few on motion-sensing switches, depending on the application needed for the site. The majority of lights will be used for emergency situations only. The Proponent will work closely with the Town of Barnstable to ensure that the lighting scheme complies with Town requirements.

3.2.2.4 Grid Interconnection Cables and Grid Interconnection

Phase 1 of New England Wind will connect into the ISO-NE electric grid via Eversource's existing 345 kV West Barnstable Substation. From the onshore substation, the onshore grid interconnection cables will follow one of two potential Grid Interconnection Routes (with variants) to the existing West Barnstable Substation:

- ROW #343 to #381 Grid Interconnection Route
- In-Road Grid Interconnection Route

The Grid Interconnection Route will be 0.9 to 2.9 km (0.6 to 1.8 mi) long. These routes are shown on Figure 3.2-11 and described in more detail below. The grid interconnection cables will be installed within an underground duct bank along the selected Grid Interconnection Route. The grid interconnection cables and duct bank are described in Section 3.2.2.4.2 below.

As described in Section 3.2.2.4.3, some modifications to the grid interconnection point at the West Barnstable Substation will be necessary to accommodate Phase 1.

3.2.2.4.1 Grid Interconnection Routes

ROW #343 to ROW #381 Grid Interconnection Route

The ROW #343 to ROW #381 Grid Interconnection Route follows three short sections of existing utility ROW westward from the Phase 1 onshore substation. The route begins on the south side of the onshore substation site, enters ROW #343, and then turns southwesterly onto ROW #345. From ROW #345, the route turns north/northwesterly onto ROW #381 and enters Parcel #214-001 located immediately southeast of the West Barnstable Substation before entering the substation site. The segment along ROW #381 includes a crossing of Route 6; Section 3.3.1.10.3 provides a description of highway crossing techniques. The total length of the ROW #343 to ROW #381 Grid Interconnection Route is 1.2 km (0.7 mi), and the route is located entirely within existing utility ROWs.

The Proponent is also considering three variants of this Grid Interconnection Route:

- Variant 1 (Service Road to ROW #381) shortens the length of existing utility ROW used by exiting the northern side of the onshore substation site onto Shootflying Hill Road and following Service Road before turning north and crossing Route 6 within ROW #381. At 1.2 km (0.7 mi), this variant is the same length as the ROW #343 to ROW #381 Grid Interconnection Route. The proposed duct bank would be installed within existing roadway layouts (either beneath pavement or within 3 m [10 ft] of pavement) along almost the entire length of Variant 1. However, use of this variant could conflict with the Town of Barnstable's future plans for a bike path parallel to Shootflying Hill Road and Service Road, MassDOT's plans for widening Route 6, and/or the existing natural gas line and planned natural gas main upgrade within the roadway layout of Service Road.

- Variant 2 (ROW #343 to ROW #342) follows the same exit from the onshore substation site on ROW #343 but then follows ROW #342 across Route 6 and enters the West Barnstable Substation at its northeast corner. This route has a total length of 0.9 km (0.6 mi). This variant crosses Route 6 within ROW #342 rather than ROW #381; this more eastern crossing of Route 6 would be more challenging than the crossing proposed for the ROW #343 to ROW #381 Grid Interconnection Route. This variant would be used if it proves infeasible to use ROW #345, ROW #381, or Service Road but Eversource grants a co-location request for ROW #342.

- Variant 3 (Service Road to ROW #342) exits the onshore substation to the north, following Shootflying Hill Road and Service Road before entering ROW #342, crossing Route 6, and continuing to the West Barnstable Substation. This route has a total length of 1 km (0.6 mi). Variant 3 shortens the amount of existing utility ROW occupied by the duct bank, but requires using the more challenging crossing of Route 6 within ROW #342. This variant would be used if the substation design warrants the 345 kV cables exiting to the north and if it proves infeasible to use ROW #345, ROW #381, and Service Road but Eversource grants a co-location request for ROW #342.

In January 2020, a co-location request was submitted to Eversource for the ROW #343 to ROW #381 Grid Interconnection Route and its variants that describes the proposed use of the existing ROWs and initiates Eversource's review process.

In-Road Grid Interconnection Route

The In-Road Grid Interconnection Route provides an all in-road alternative for connecting the Phase 1 onshore substation to West Barnstable Substation. The route follows Shootflying Hill Road eastward from the onshore substation site to Route 132. Then, the route turns northwest on Route 132 and crosses under Route 6 before reaching Oak Street. There, the route turns southwest onto Oak Street, which it follows to the West Barnstable Substation. The total length of the In-Road Grid Interconnection Route is 2.9 km (1.8 mi), and the route is located entirely within public roadway layouts. The duct bank would be installed either beneath pavement or within 3 m (10 ft) of pavement.

3.2.2.4.2 Grid Interconnection Cable and Duct Dank Design

The 345 kV grid interconnection cables will be the same type of cable as the onshore export cables (i.e. copper or aluminum conductor singe-core cables; see Figure 3.2-12). The 345 kV grid interconnection cables will be installed in an underground duct bank with the same maximum dimensions as those described for the onshore export cables in Section 3.2.2.2.2 above.

3.2.2.4.3 Grid Interconnection Point

The 345 kV West Barnstable Substation will be the Phase 1 grid interconnection point and New England Wind has an ISO-NE queue position for that interconnection (see Table 5.1-1).

Some modifications to the 345 kV West Barnstable Substation will be necessary to accommodate the interconnection from Phase 1. The Proponent is consulting with Eversource on the specific design and location of these modifications. Based on the original Feasibility Study results for interconnecting Phase 1, the new equipment required at the West Barnstable Substation would include a new 345 kV breaker and half bus arrangement, two 345 kV feeders, a second 345/115kV Autotransformer, and a 115 kV breaker bay. Based on a more recent System Impact Study, and a subsequent regional ISO-NE cluster study, additional system upgrades to be constructed by Eversource have been identified that will also include added electric grid capacity for interconnection of Phase 2 and achieving adequate system stability.

The actual design of the West Barnstable Substation expansion will be formulated in collaboration with Eversource, ISO-NE, and in consultation with the Town of Barnstable. However, based on the Feasibility Study results, the Proponent's preliminary design is contained on the Eversource property just northeast of the existing West Barnstable Substation equipment and south of the Oak Street Substation.

3.2.2.5 Port Facilities & Construction Staging Areas

The Proponent has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used for major Phase 1 construction staging activities. In addition, some components, materials, and vessels could come from Canadian and European ports. A complete list of the possible ports that may be used for major construction staging activities can be found in Table 3.2-7 and are shown on Figure 3.2-13. The Proponent is identifying a wide range of ports that could be used for Phase 1 because numerous entities have publicized plans to develop or upgrade port facilities to support offshore wind construction in the time frame of Phase 1. The Proponent also anticipates an increased demand for ports by other Northeast offshore wind developers around the time of Phase 1 construction. These factors lead to uncertainty regarding which ports may be available under the Phase 1 schedule. It is not expected that all the ports identified would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.

The Proponent expects to use one or more of these ports for frequent crew transfer and to offload shipments of components, store components, prepare them for installation, and then load components onto jack-up vessels or other suitable vessels for delivery to the SWDA for installation.[34] Some component fabrication and assembly may occur at these ports as well. The greatest distance from a port used for major construction staging activities to the SWDA is approximately 619 km (334 NM).

Some activities such as refueling,[35] restocking supplies, sourcing parts for repairs, vessel repairs, vessel mobilization/demobilization, some crew transfer, and other construction staging activities may occur out of ports other than those listed in the table below. These activities would occur at industrial ports suitable for such uses and would be well within the realm of normal port activities.

See Table 3.2-8 in Section 3.2.2.6 for a discussion of ports used during Phase 1 operations and maintenance (O&M).

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34 Monopiles may not be loaded onto vessels for transport but may instead be pulled by tugs while floating in the water.

35 Some refueling could also occur offshore.

Table 3.2-7 Possible Ports Used During Phase 1 Construction

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Harbor
Brayton Point Commerce Center
Vineyard Haven
Fall River
Salem Harbor
Rhode Island Ports
Port of Davisville
Port of Providence (ProvPort)
South Quay Terminal
Connecticut Ports
Bridgeport
New London State Pier
New York Ports
Capital Region Ports (Port of Albany, Coeymans, & NYS Offshore Wind Port)
Staten Island Ports (Arthur Kill & Homeport Pier)
South Brooklyn Marine Terminal
GMD Shipyard
Shoreham, Long Island
New Jersey Ports
Paulsboro
Canadian Ports[1]
Halifax
Sheet Harbor
Saint John
Miscellaneous European Ports

Note:

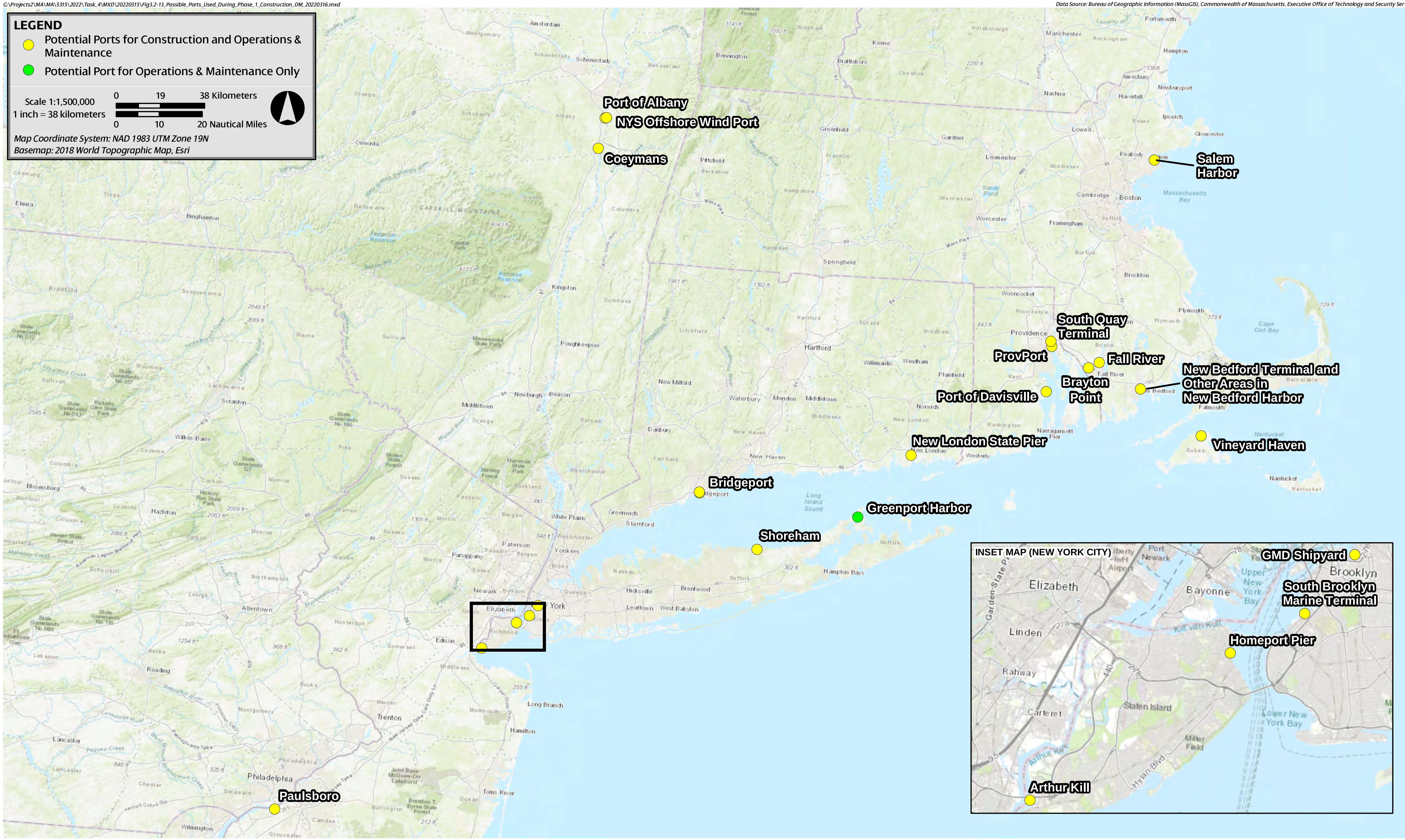
1. Analysis of potential Canadian ports that may be used is ongoing.

Each port facility under consideration for Phase 1 is either already located within an industrial waterfront area with sufficient existing infrastructure or is identified as an area where other entities intend to develop infrastructure with the capacity to host construction activities under the Phase 1 schedule. The activities conducted at each port and combination of ports used is highly dependent on the final Phase 1 construction logistics schedule, the infrastructure that is ultimately available at each port, other users of each port, supply chain availability, and the potential for synergies between the Proponent's projects.

Construction of Phase 1 will likely require port facilities with high load-bearing ground and deck capacity, adequate vessel berthing parameters, and suitable laydown and fabrication space. Site-specific modifications performed by the site owner/lessor may be required to meet those requirements. Grading and resurfacing of land-side areas, for example, may be required to accommodate materials and equipment used during construction and installation. The port

G:\Projects2\MA\MA\5315\2022\Task_4\MXD\20220315\Fig3.2-13_Possible_Ports_Used_During_Phase_1_Construction_OM_20220316.mxd

Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services



New England Wind

AVANGRID RENEWABLES

Figure 3.2-13

Possible Ports Used During Phase 1 Construction and O&M

facility may also require shoreline stabilization, maintenance dredging, and installation of miscellaneous equipment to berth construction and installation vessels. New structures to accommodate workforce and equipment needs may also be required.

The Proponent will not implement any port improvements that may be made. Although the Proponent may financially support a port's redevelopment as part of an economic incentive package, any port would be developed independent of New England Wind (all permits and approvals will be obtained by the site owner/lessor) and the port could be used by multiple developers once any necessary upgrades are made by the owner/lessor.

Each United States (US) port that may be used for major Phase 1 construction staging activities is described in more detail below:

- **New Bedford Marine Commerce Terminal, New Bedford, MA:** The 0.12 km^2 (29 acre) New Bedford Marine Commerce Terminal ("New Bedford Terminal") is owned and operated by the Massachusetts Clean Energy Center (MassCEC). It is located on the City's extensive industrial waterfront and was purpose-built to support offshore wind energy projects.

- **Other areas in New Bedford Harbor, MA:** The Proponent may use other areas in the Port of New Bedford, including, but not limited to, those identified by MassCEC's (2017) *2017 Massachusetts Offshore Wind Ports and Infrastructure Assessment* as potentially viable offshore wind ports, if necessary upgrades are made by the owner/lessor. For example, the Eversource Energy/Sprague Oil Facility is a 0.12 km^2 (29 acre) site that could be used by the Proponent, subject to the facility's acquisition and redevelopment by a private and or public entity. Rehabilitation work for this site could include, but would not be limited to, removal of all existing structures (including oil tanks and buildings) to provide a finished high bearing capacity graveled surface suitable for supporting offshore wind components; upgrades to the quayside; and dredging and filling operations to support mooring and berthing of specialized offshore wind component transport vessels. Use of other sites in the harbor would also require redevelopment efforts by the owner(s)/lessor(s) to make the respective facilities suitable for Phase 1 activities.

- **Brayton Point Commerce Center, Somerset, MA:** The Brayton Point Commerce Center is located on the site of the former coal-fired Brayton Point Power Plant. Brayton Point is a 1.2 km^2 (307 acre) property located in Mount Hope Bay less than 1.6 km (1 mi) from Interstate 195. Commercial Development Company, Inc. and its affiliate Brayton Point, LLC are in the process of transforming the former power plant site into a world-class logistics port, manufacturing hub, and support center for the offshore wind industry. Commercial Development Company, Inc. has signed an agreement with Patriot Stevedoring + Logistics LLC to manage operations of the marine commerce terminal (Froese 2019).

- **Vineyard Haven, Martha's Vineyard, MA:** Vineyard Haven already provides a number of services to vessels as large as 84 m (275 ft) in length and has onshore facilities that house multiple business entities. The owner of the marina is currently upgrading the facilities to accommodate additional marine industrial uses as well as to increase the existing facility's protection from storms. The Proponent understands that this work includes, but is not necessarily limited to, the removal and replacement of an existing solid-filled pier with a pile-supported pier; installation of catwalks, barge ramps, and a bulkhead; beach nourishment; and dredging and filling activities. The design, permitting, and construction of these upgrades is being conducted by the site owner and not by the Proponent. Vineyard Haven would likely be used for crew transfer and potentially temporary storage of offshore cables.

- **Fall River, MA:** The Proponent may use port facilities in Fall River if the necessary upgrades are made by the owner/lessor. Potential ports could include, but are not limited to, those identified by MassCEC's (2017) *2017 Massachusetts Offshore Wind Ports and Infrastructure Assessment* as potentially viable offshore wind ports.

- **Salem Harbor, MA:**[36] When the recently commissioned Salem Harbor Power Station natural gas power plant replaced a coal and oil plant in 2018 along the Salem waterfront, it opened 0.17 km^2 (42 acres) for development. The Salem Harbor Power Station mostly bisects the area available for development; the north side of the site is approximately 0.06 km^2 (13.7 acres) and the south side is approximately 0.12 km^2 (29 acres). The site includes shared access to a 244 m (800 ft) deep water wet berth that is periodically used for visiting cruise ships. The area also includes approximately 700 m (2,300 ft) of frontage on Salem Harbor, which hosts active commercial, recreational, and water transportation facilities. The site is located approximately 35 km (22 miles) northeast of Boston.

- **Port of Davisville, North Kingstown, RI:** The Port of Davisville offers five terminals, 1,372 linear meters (4,500 linear feet) of berthing space at two 366 m (1,200 ft) long piers, a bulkhead, on-dock rail, and 0.23 km^2 (58 acres) of laydown and terminal storage. The Port of Davisville also has heavy lift capacity, including a 150 metric ton mobile harbor crane. Located near the mouth of Narragansett Bay, vessels access the Port of Davisville through a shipping channel that is not maintained by the Army Corps of Engineers (QDC 2019). Ongoing renovations to the Port's Pier 2 include construction of a new steel bulkhead, dredging Narragansett Bay to accommodate larger ships, and extending Pier 2 by 71 m (232 ft), which will create a third berth to increase the port's overall capacity and provide necessary infrastructure for the offshore wind industry (King 2020).

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36 During appropriate time periods, New England Wind-related vessels traveling to/from Salem Harbor will transit at 18.4 km per hour (10 knots) or less within National Oceanic and Atmospheric Administration (NOAA)-designated North Atlantic right whale critical habitat and outside critical habitat.

- **ProvPort, Providence, RI:** The Port of Providence (ProvPort) is a privately-owned marine terminal located within the City of Providence that occupies approximately 0.47 km^2 (115 acres) along the Providence River. ProvPort provides 1,280 m (4,200 ft) of berthing space, 12,077 square meters (m^2) (130,000 square feet [ft^2]) of covered storage, and more than 0.08 km^2 (20 acres) of open lay down area. ProvPort also has on-dock rail service and is located 1.6 km (1 mi) from the interstate (ProvPort 2020). Marine transportation into ProvPort is facilitated by a federally-maintained navigational channel, which was dredged in 2005 to -12.2 m (-40 ft) mean low water, allowing the port to accommodate deep-draft vessels (RICRMC 2010).

- **South Quay Terminal, East Providence, RI:** The South Quay Terminal is an over 0.12 km^2 (30 acre) greenfield site located on the Providence River in East Providence. Waterfront Enterprises, LLC has announced plans to develop a staging area for offshore wind construction at the site as well as other mixed uses (Faulkner 2020).

- **Bridgeport, CT:** The Barnum Landing site owned by the McAllister Towing and Transportation Company consists of approximately 0.06 km^2 (15 acres) of industrial waterfront property along Bridgeport Harbor. The Proponent may use the site to accommodate secondary steel fabrication and final outfitting and storage of TPs as well as a long-term O&M base. The site would require redevelopment to accommodate offshore wind vessels and operations. Other areas in Bridgeport, such as another port facility off of Seaview Avenue just north of Barnum Landing, could be used for Phase 1, if the necessary upgrades are made by the owner/lessor.

- **New London State Pier, New London, CT:** There are plans to redevelop the New London State Pier, located on the Thames River, for offshore wind as specified in the Harbor Development Agreement between the Connecticut Port Authority, Gateway New London LLC, and North East Offshore LLC. The ~0.12 km^2 (~30 acre) site has no air draft restrictions, direct access to a federally maintained deep water channel, and access to rail and highway (Lamont 2020). The Proponent may use the state-owned New London State Pier for Phase 1 if the site is developed and available at the time it is needed.

- **Capital Region Ports, NY:** The Port of Coeymans is an existing 1.6 km^2 (400 acre) privately-owned marine terminal on the Hudson River south of Albany that is used for large-scale construction projects. The marine terminal has a 660 ton crawler crane that can be used to lift offshore wind farm components (Maritime Executive 2019). Just north of Coeymans, the Albany Port District Commission is proposing to expand the Port of Albany by developing ~0.33 km^2 (~81.5 acres) of riverfront property in Glenmont, NY that could be used as an assembly and staging area for offshore wind farm components (Cagara 2019). On the opposite side of the Hudson River, the New York Offshore Wind Port in East Greenbush, NY is being proposed for development to support the needs of the offshore wind industry. The site consists of ~0.45 km^2 (~112 acres) with over 1,188 m (3,900 ft) of riverfront (NYoffshorewind 2019). Phase 1 may use any of these ports, if the necessary upgrades are made by the owner/lessor.

- **Staten Island Ports, NY:** The proposed Arthur Kill Terminal is a greenfield site on Staten Island that would be developed into an over 0.13 km^2 (32 acre) port facility designed for the staging and assembly of offshore wind farm components. The proposed facility would have a 396 m (1,300 ft) quayside and a warehouse for equipment and spare part storage (Atlantic Offshore Terminals 2020). Homeport Pier is located on Staten Island just north of the Verrazano-Narrows Bridge and is the former site of a 0.14 km^2 (35 acre) Naval Base with a 430 m (1,410 ft) pier. New York City Economic Development Corporation has requested expressions of interest from parties interested in developing the facility for the offshore wind industry (Waterwire 2019).

- **South Brooklyn Marine Terminal, Brooklyn, NY:** The ~0.26 km2 (~65 acre) South Brooklyn Marine Terminal has two piers with 1,950 m (6,400 ft) of water frontage on the Upper Bay of New York Harbor. The port is proposed to be upgraded to support staging, installation, and maintenance of offshore wind farms (Kassel R 2020).

- **GMD Shipyard, Brooklyn, NY: T**he GMD Shipyard is located within the Brooklyn Navy Yard on the East River. The shipyard has the largest dry dock facility in New York City, ~335 m (~1100 ft) of wet berth, and numerous cranes (GMD Shipyard Corp c2017).

- **Shoreham, Long Island, NY:** The 2.8 km^2 (700 acre) site of the decommissioned Shoreham Nuclear Power Plant has been identified by the New York State Energy Research and Development Authority (NYSERDA) as a potential site for offshore wind port facilities. The site, located adjacent to Long Island Sound on Long Island, would require significant investment and upgrades because the facility is not currently a functioning waterfront terminal. The site would only be used by Phase 1 if such improvements were made by the owner/lessor.

- **Paulsboro, NJ:** Paulsboro, located on the Delaware River, may become the site of a monopile foundation factory (Stromsta 2019). Thus, Phase 1 may use port facilities in the vicinity of the proposed factory if those facilities were developed by the owner/lessor in time for Phase 1.

3.2.2.6 Operations & Maintenance Facilities/Ports

The Proponent expects to use one or more facilities in support of operations and maintenance (O&M) activities for Phase 1. The O&M facilities may include management and administrative team offices, a control room, office and training space for technicians and engineers, and/or warehouse space for parts and tools. The O&M facilities will also include pier space for crew transfer vessels (CTV) and/or other larger support vessels, such as service operation vessels (SOVs).[37] See Section 3.3.2.6 for further description of vessels, vehicles, and aircraft used during O&M.

For Phase 1, the Proponent will likely establish a long-term SOV O&M base in Bridgeport, Connecticut. The SOV O&M base would be the primary homeport for the SOV and would likely be used for some crew exchange, bunkering,[38] spare part storage, and load-out of spares to the SOV and/or other vessels. Related support infrastructure, warehousing, and a control room may also be located near the SOV O&M base. One of the existing industrial ports identified in Table 3.2-8 may be needed as alternative SOV O&M base on interim basis if the facilities in Bridgeport, Connecticut are not available by the start of Phase 1 O&M. In addition to the SOV O&M base, the Proponent has worked with its local partner, Vineyard Power, and the communities of Martha's Vineyard with the intention to base certain O&M activities on Martha's Vineyard. Current plans anticipate that CTVs and/or the SOV's daughter craft would operate out of Vineyard Haven and/or New Bedford Harbor during O&M.

Although the Proponent plans to locate the Phase 1 O&M facilities in Bridgeport, Vineyard Haven and/or New Bedford Harbor, the Proponent may use other ports listed in Table 3.2-8 below to support O&M activities. As with the construction ports, some activities such as refueling, restocking supplies, sourcing parts for repairs, vessel repairs, vessel mobilization/demobilization, and potentially some crew transfer (activities well within the realm of normal port activities) may occur out of ports other than those listed in Table 3.2-8. During O&M, there is no planned use of Canadian ports. While not anticipated, use of Canadian or other US ports could occur to support an unplanned significant maintenance event, if such maintenance activity could not be accomplished using one of the US ports identified in the Construction and Operations Plan (COP).

37 SOV, as the term is used in the COP, includes similar vessel types that can provide offshore accommodations such as floatels and service accommodation vessels (SATVs).

38 Some refueling could also occur offshore.

Table 3.2-8 Possible Ports Used During Phase 1 O&M

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Harbor
Brayton Point Commerce Center
Vineyard Haven
Fall River
Salem Harbor
Rhode Island Ports
Port of Davisville
Port of Providence (ProvPort)
South Quay Terminal
Connecticut Ports
Bridgeport
New London State Pier
New York Ports
Capital Region Ports (Port of Albany, Coeymans, & NYS Offshore Wind Port)
Staten Island Ports (Arthur Kill & Homeport Pier)
South Brooklyn Marine Terminal
GMD Shipyard
Long Island Ports (Shoreham and Greenport Harbor)
New Jersey Ports
Paulsboro
Miscellaneous European Ports

With the exception of Greenport, all ports listed above may also be used for Phase 1 construction and are described in Section 3.2.2.5. Greenport Harbor, located on the tip of Long Island, is home to numerous commercial docks that could be rented to offshore wind developers and used for provisioning, crew changes, weather standby, repairs, equipment change, and possibly fuel and water delivery (Nalepinski 2019).

3.2.3 Design, Engineering, and Fabrication

The Phase 1 facilities will undergo an extensive and well-vetted structural design process based on site-specific conditions. The design process will also ensure that the Phase 1 facilities can be decommissioned in accordance with the Decommissioning and Site Clearance Procedures described in Section 3.3.3. As described in Section 3.2.3.1 below, the offshore facilities are designed to international and US standards, which are identified in the Hierarchy of Standards (see Appendix I-E).

Once the majority of the engineering and design has been finalized, the Proponent will develop a Facility Design Report (FDR) and Fabrication and Installation Report (FIR) for Phase 1. The FDR contains the specific details of the offshore facilities' design, including structural drawings, justification for referenced design standards, all design and load calculations, and summaries of the environmental, engineering, geotechnical data used as the basis for the designs. The FIR describes how the components of each structure will be manufactured and installed in accordance with the design criteria in the FDR. Both the FDR and FIR will be reviewed by a third-party CVA that certifies the design conforms to all applicable standards (see Section 3.2.3.1).

3.2.3.1 Design Standards

BOEM's COP Guidelines recognize that "[t]he BOEM's renewable energy regulations are not prescriptive regarding the design standards that must be used for an offshore wind energy installation" (COP Guidelines Appendix C, Section I). Further, the guidelines state that "[f]or offshore wind turbines, BOEM will accept a "design-basis" approach whereby the applicant proposes which criteria and standards to apply, and then justifies why each particular criterion and standard is appropriate" (COP Guidelines Appendix C, Section I).

[redacted]

3.2.3.2 Certified Verification Agent

The third-party CVA certifies that the facilities' design conforms to all applicable standards identified in the Hierarchy of Standards and oversees the fabrication and installation of the facilities' components.

Phase 1 CVA Nomination Statement

The Proponent has nominated a CVA for the Phase 1 FDR and FIR as required by 30 CFR § 585.706(a).

Phase 1 CVA Qualification Statement

The CVA's Statement of Qualifications is provided as Appendix I-C. The Statement of Qualifications addresses:

- Previous experience of the nominated CVA in third-party verification and BOEM procedures
- Technical capabilities of the CVA and staff members

- Size and type of organization
- Availability of technology
- Ability to perform
- Conflict of interest
- Professional Engineer supervision

CVA Scope of Work and Verification Plan

The CVA Scope of Work and Verification Plan for Phase 1 is provided as Appendix I-D. The scope specifies the level of work to be performed by the CVA at all steps of the verification process and identifies the high-level list of documents and subject matter that the CVA will review.

3.2.3.3 Technologies Considered Commercially or Technically Infeasible for Phase 1

3.2.3.3.1 Introduction

Phase 1 of New England Wind is intended to deliver commercially sustainable, clean, and renewable offshore wind power to the ISO-NE electric grid. In order to ensure that Phase 1 meets its objective (see Section 3.1.1.1), the Proponent evaluated numerous technologies and designs for their technical and commercial feasibility. The main elements driving the concept for the Phase 1 Envelope are the: (1) WTGs; (2) WTG foundations; and (3) ESP(s).

3.2.3.3.2 Wind Turbine Generators

Phase 1 is anticipated to use the latest generation offshore WTGs that are available on the market at the time of Phase 1 procurement in order to maximize Phase 1 power production given a fixed WTG layout (see Section 2.2). The Phase 1 WTG Envelope was selected based on an analysis of offshore wind industry trends and predicted Original Equipment Manufacturer (OEM) technology roadmaps for WTG development through the coming years (with some added contingency for accelerated growth scenarios).

3.2.3.3.3 WTG Foundations

The WTG foundation's conceptual design begins with an assessment of the feasibility of various foundation concepts. Once one or more foundation concepts are selected, more detailed oceanographic, meteorological, geophysical, and geotechnical site assessment data are used to perform iterative modeling of environmental loads and loads from the candidate WTG designs on the selected foundation type(s). All site conditions data and load modeling are then reviewed and approved by the CVA. After the load models are verified by the CVA, the final sizing of structural members is completed and secondary structures are designed, taking into account site conditions, local laws and regulations, and maintenance requirements. Lastly, the final design is reviewed and approved by the CVA.

Using the extensive knowledge and experience within the company, its affiliates, and their consultants, the Proponent evaluated numerous foundation types for technical and commercial feasibility: (1) monopile foundations, (2) jacket foundations (with piles or suction buckets), (3) bottom-frame foundations (with piles, gravity pads, or suction buckets), (4) gravity-based foundations, and (5) floating foundations. The Phase 1 Envelope includes two of the foundation concepts evaluated: monopiles and piled jackets. As discussed in more detail below, suction bucket jackets and all bottom-frame foundation types are not preferable for Phase 1. In addition, gravity-based foundations and floating foundations are not considered appropriate for Phase 1 based on the site-specific conditions of the Phase 1 portion of the SWDA.

Suction Bucket Jacket Foundations

Due to the current relative immaturity of suction bucket technology for large scale deployment combined with the anticipated Phase 1 construction schedule and the availability of other, more proven WTG foundation options, suction bucket jackets are not included in the Phase 1 Envelope. Large areas within the Phase 1 portion of the SWDA contain variable sediment conditions and low permeability sediment layers overlaying dense sands, which are known to pose a high risk of suction bucket refusal during installation.

There have been two small demonstration projects using suction bucket jackets in Europe: Ørsted's Borkum Riffgrund II and Vattenfall's Aberdeen Offshore Wind Farm. Although both demonstration projects were ultimately successfully installed, both were beset by challenges, resulting in the cancellation of a planned deployment by Ørsted at the Hornsea One offshore wind farm. More recently, the installation of a suction mono-bucket foundation type at Deutsche Bucht offshore wind farm in the German North Sea was abandoned due to technical issues during installation, which caused significant financial losses. Due to the possibility of further development and refinement of suction buckets, suction buckets could be suitable for Phase 2 and are thus included in the Phase 2 Envelope.

Bottom-Frame Foundations

A bottom-frame foundation is a triangular space-frame type structure that consists of a central vertical column, which supports the WTG tower, connected to three members that radiate horizontally from the base of the vertical column towards the feet of the foundation. Each foot is secured to the seafloor using driven piles, gravity pads, or suction buckets. A bottom-frame foundation is similar to a conventional jacket foundation, but generally has fewer, larger structural tubular members, no small-diameter lattice cross-bracing, and a single central vertical tubular column. Taking into consideration the anticipated size of the Phase 1 WTGs and fabrication supply chain availability at the time of Phase 1 construction, bottom-frame foundations are not preferred for Phase 1, given that more economical and proven foundation options (i.e. monopiles and piled jackets) are available for Phase 1. However, given that bottom-frame foundation technology is expected to evolve over the next few years, bottom-frame foundations could be suitable for Phase 2 and are thus included in the Phase 2 Envelope.

Gravity-Based Foundations

Gravity-based foundations were used during the early years of the offshore wind energy industry at shallow sites located in benign wave climates, particularly in the Baltic Sea. Since then, their use has become less frequent as the economic and practical benefits of other foundation types (particularly monopiles) have become more widely appreciated. The Phase 1 portion of the SWDA is relatively deep, with water depths ranging from 43 to 55 m (141 to 180 ft), whereas gravity-based foundations have only been used in water depths of up to approximately 30 m (98 ft). In addition to being relatively deep, the Phase 1 portion of the SWDA is exposed to North Atlantic metocean conditions; these factors would increase the size of the gravity-base considerably. In addition, since soft sediments are prevalent throughout the Phase 1 portion of the SWDA, installation of gravity-based foundations would require substantial dredging to remove the soft sediments, leveling, and the installation of a large gravel bed to provide a strong flat surface that can support and distribute the foundation's substantial weight. To date, the offshore wind industry has had no experience with gravity-based foundations at sites with conditions similar to the Phase 1 portion of the SWDA. As gravity-based foundations have had limited application and require large fabrication and staging facilities, supply chains are not readily available. There would be significant lead times and excessive costs required to establish suitable port facilities, establish a fabrication yard, and transport the gravity-based foundations to the SWDA.

Floating Foundations

Due to the water depths across the Phase 1 portion of the SWDA and the relatively immature status of floating foundations, the Proponent did not perform a detailed analysis on their use for Phase 1. Although there are a number of floating wind demonstration projects successfully operating around the world, these are typically in deeper waters. Since costs are not yet competitive with fixed foundations, floating foundations are not considered viable for offshore wind projects participating in competitive power auctions.

3.2.3.3.4 Electrical Service Platforms

The number and potential locations of the ESPs consider reliability and cost. The Phase 1 Envelope proposes one or two ESP(s) to enable the Proponent to maximize reliability and electrical design. Cost considerations are driven by the distance to shore, which determines the offshore export cable length and transmission technology, and optimizing the inter-array cable layout. For this reason, the ESP(s) may be placed in the northwestern corner of the Phase 1 portion of the SWDA (to minimize offshore export cable length) or in the center of the Phase 1 portion of the SWDA (to minimize inter-array cable length). Potential ESP locations are illustrated on Figure 3.1-4.[39]

ESP foundation concepts were evaluated as described in Section 3.2.3.3.3 above.

3.2.3.4 Fabrication

The Phase 1 components will be fabricated by skilled manufacturers in the US, Europe, or elsewhere. The manufacturers will be determined through a competitive procurement process in order to ensure most economic pricing, while continuing to look for opportunities for locating manufacturing in the Northeastern US. The Proponent has also used the knowledge and information gained during the development of Vineyard Wind 1 to identify cost-effective opportunities for locating component manufacturing/fabrication in New England.

Fabrication for Phase 1 is summarized in Table 3.2-9 below. Table 3.2-9 summarizes some of the potential locations for the manufacturing of components, but this list is not final or exhaustive.

Table 3.2-9 [redacted]

[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted] Europe.

[39] Although the positions shown in the overlapping area between Phase 1 and Phase 2 on Figure 3.1-4 are shown as potential ESP positions, the Proponent does not expect to use those positions for a Phase 1 ESP.

Table 3.2-9 [redacted]

[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 3.2-9 [redacted]

[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted] [redacted]	[redacted] [redacted]

3.3 Phase 1 Construction, Operation, and Decommissioning Activities

3.3.1 Construction Activities

3.3.1.1 Construction Approach Overview

The discussion of Phase 1 construction and installation is organized by offshore activities followed by onshore activities.

The discussion of offshore construction activities follows the general plan of installation set forth in the construction schedule, beginning with scour protection and proceeding through installation of offshore export cables, foundations, electrical service platform(s) (ESP[s]), inter-array and inter-link cables, and wind turbine generators (WTGs). The Phase 1 onshore construction schedule is discussed in more detail below. A high-level overview of the construction and commissioning schedule is provided in Section 3.1.1.3, specifically Figure 3.1-3. As shown on Figure 3.1-3, there may be considerable overlap in the installation periods for each component of Phase 1.

3.3.1.1.1 Onshore Construction Hours and Schedule

For the installation of the onshore duct bank and cables, construction is anticipated to occur during typical work hours (7:00 AM to 6:00 PM) on Monday through Friday, though in specific instances at some locations, or at the request of the Barnstable Department of Public Works (DPW), the Proponent may seek municipal approval to work at night or on weekends. Nighttime work will be minimized and performed only on an as-needed basis, such as when crossing a busy road, and will be coordinated with the Town of Barnstable.

For work at the landfall site, the proposed horizontal directional drilling (HDD) construction schedule is from 7:00 AM to 7:00 PM on Monday through Saturday, though during conduit pull-in the contractor will likely need to work around the clock since once that process is started it cannot be stopped. Should the Proponent need to extend construction work beyond those hours and/or days (i.e. on Sunday), with the exception of emergency circumstances on a given day that necessitate extended hours, the Proponent will seek prior permission from the Town of Barnstable.

The Proponent will adhere to the general summer limitations on construction activities on Cape Cod. Activities at the landfall site are not expected to be performed during the months of June through September unless authorized by the Town of Barnstable. Activities along the Onshore Export Cable Route and Grid Interconnection Route (particularly where the route follows public roadway layouts) will also likely be subject to significant construction limitations from Memorial Day through Labor Day unless authorized by Barnstable, but could extend through June 15 subject to consent from the DPW. The Proponent will consult with the Town of Barnstable regarding the construction schedule.

3.3.1.2 Scour Protection Installation

As described in Section 3.2.1.4, one or two layers of rocks may be placed on the seabed at each WTG and ESP foundation location. Rock is the most widely used scour protection in the offshore wind industry. Scour protection dimensions are presented above in Tables 3.2-5 and 3.2-6.

Scour protection may be installed up to several months prior to the start of foundation installation and/or after foundation installation following the multi-step process outlined below:

1. A pre-construction survey of the bottom bathymetry is conducted.

2. Based on the results of the survey, seabed preparation may be required prior to scour protection or foundation installation. This could include the removal of large obstructions and/or leveling of the seabed.

3. The scour protection is loaded onto the scour protection installation vessels in a designated harbor or directly at the quarry’s harbor and is transported to the SWDA.

4. The scour protection material is placed on the seafloor. If needed, a mud mat may be placed below the scour protection.

5. A post-lay seabed survey of bottom bathymetry is conducted; additional material is added, if needed, to provide the necessary coverage and thickness.

6. If a two-layer scour protection system is used, Steps 3 through 5 are repeated to install a second layer of scour protection around the foundation before or after the foundation is installed.

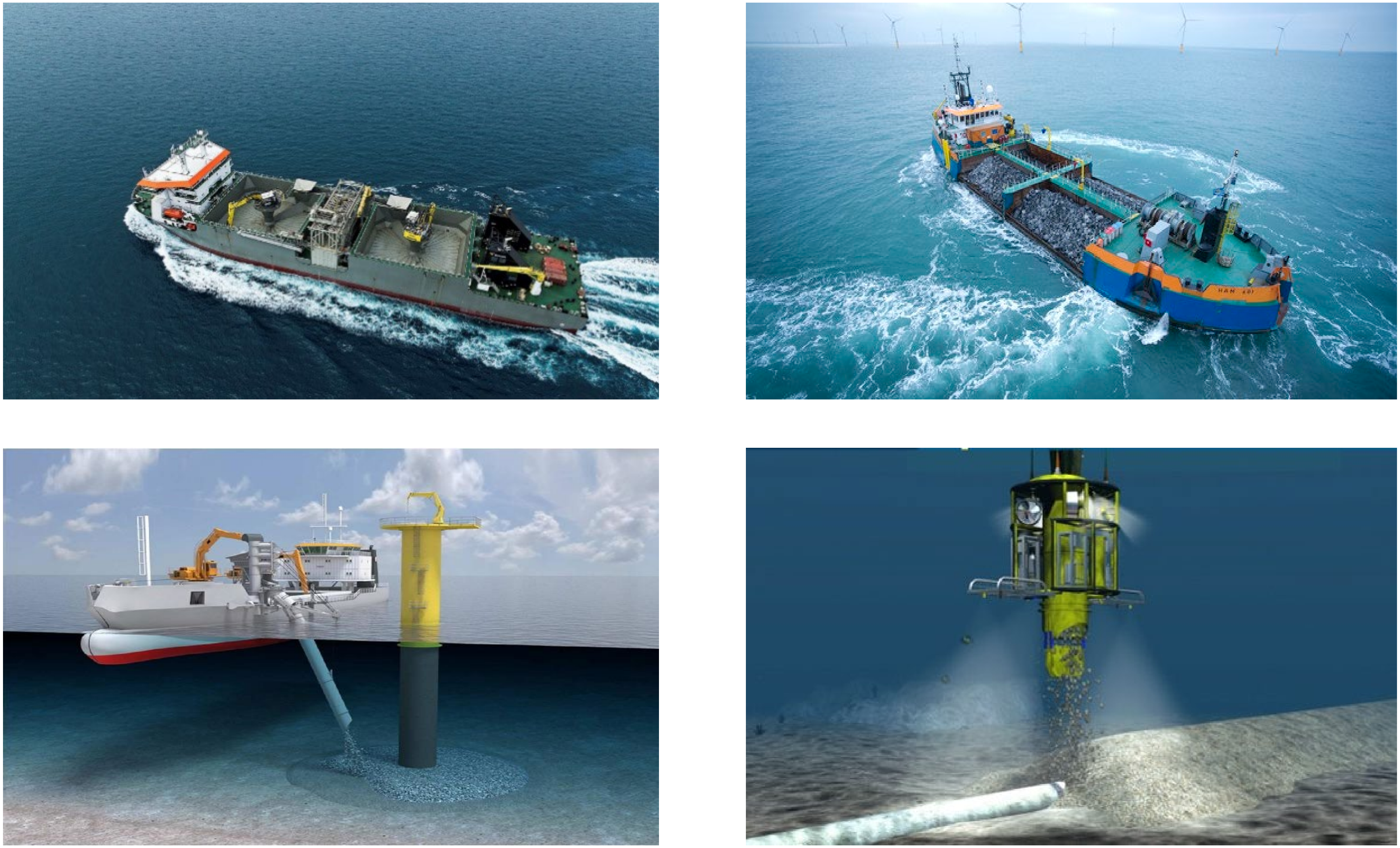
Several techniques for placing scour protection exist, including fall-pipes, side dumping, and placement using a crane/bucket. The fall-pipe method, in which a pipe extends from the vessel to the seafloor near the intended foundation location, is the most precise technique and will be used wherever possible. A remotely operated vehicle (ROV) located at the bottom of the fall-pipe would likely be used to control the lateral movement of the fall-pipe and monitor the installation process. The installation vessel will move along a predetermined pattern to ensure even distribution of the rock material, likely using dynamic positioning (DP). Figure 3.3-1 provides illustrations of typical scour protection vessels.

3.3.1.3 Offshore Export Cable Installation

3.3.1.3.1 Overview

As described in Section 3.2.1.5, two offshore export cables will be installed for Phase 1. The offshore export cables will likely be transported directly to the Offshore Development Area in a cable laying vessel, on an ocean-going barge, or on a heavy transport vessel (which may also transport the cable laying vessel overseas) and installed by the cable laying vessel upon arrival. Vessel types under consideration for cable installation activities are presented in Table 3.3-1.

Prior to cable laying, a pre-lay grapnel run and pre-lay survey will be performed to clear obstructions, such as abandoned fishing gear and other marine debris, and inspect the route. Large boulders along the route may need to be relocated prior to cable installation. Some dredging of the upper portions of sand waves may also be required prior to cable laying to achieve sufficient burial depth below the stable sea bottom. Following the route clearance activities and any required dredging, offshore export cable laying is expected to be performed primarily via simultaneous lay and bury using jetting techniques (e.g. jet plow or jet trenching) or mechanical plow. However, depending on bottom conditions, water depth, and contractor preferences, other specialty techniques may be used in certain areas to ensure sufficient burial depth (see Section 3.3.1.3.6). No blasting is proposed for cable installation.



Note: Figures of scour protection placement are for illustrative purposes only. As described in Section 3.3.1.2 of Volume I, scour protection may be placed prior to foundation installation.

Figure 3.3-1
Typical Scour Protection Installation Vessels

The offshore export cables can either be installed from the shore towards the ESP(s) or in the opposite direction. The installation will likely require two or three joints (splices) per cable due to the overall length of each offshore export cable. At the ESP(s), the cable will be pulled in typically via J-tubes. A cable entry protection system will likely be installed at the interface between an ESP and offshore export cable.

The specific steps to install the offshore export cables are described in more detail below.

3.3.1.3.2 Boulder Relocation

Any large boulders along the final offshore export cable alignments (see Section 3.2.1.5.2) may need to be relocated prior to cable installation, facilitating installation without any obstructions to the burial tool and better ensuring sufficient burial. Boulder relocation is accomplished either by means of a grab tool suspended from a vessel's crane that lifts individual boulders clear of the route or by using a plow-like tool that is towed along the route to push boulders aside (this may occur during the cable installation process). Boulders will be shifted perpendicular to the cable route; no boulders will be removed from the site.

Avoidance of surficial coarse deposits with boulders will occur where feasible. It is currently anticipated that boulders larger than approximately 0.2–0.3 m (0.7–1 ft) will be avoided or relocated outside of the final installation corridor to create an installation corridor wide enough to allow the installation tool to proceed unobstructed along the seafloor. Tools for moving the boulders are available to accomplish this for boulders up to approximately 2 m (7 ft) in size. If there are boulders along the final route that cannot be moved, a reasonable buffer of up to 5 m (16 ft) could be utilized. This buffer size will be defined based on the appointed installation contractor's operating procedures and burial tool(s) in addition to any further engineering analysis.

3.3.1.3.3 Pre-lay Grapnel Run

The pre-lay grapnel run will consist of a vessel towing equipment (i.e. a grapnel train) that hooks and recovers obstructions such as fishing gear, ropes, and wires from the seafloor. The grapnel train consists of a series of different sized and shaped hooks that are dragged across the seafloor. Continuous measurement of the grapnel train's towing tension will give an indication of whether debris is caught by the grapnel. Depending on the size and type, debris will be either removed from the route or recovered to the vessel deck.

The pre-lay grapnel run may begin up to two months before cable installation commences. Prior to offshore export cable laying preparatory activities, the Proponent will communicate with the fishing industry following the protocols outlined in the Fisheries Communication Plan provided in Appendix III-E to help avoid interactions with fishing vessels and fishing gear (see Section 3.3.4.2).

3.3.1.3.4 Pre-lay Surveys

Shortly before offshore export cable installation, the Proponent will conduct pre-lay surveys along the planned cable alignments. These surveys, which are expected to include high resolution multi-beam echosounder and visual inspection, would be used to confirm that the cable route is free of obstructions and verify seabed conditions.

3.3.1.3.5 Dredging

As described in Volume II, multiple seasons of marine surveys have confirmed that segments of the OECC contain sand waves. Portions of these sand waves may be mobile over time; therefore, the upper portions of the sand waves may need to be removed so the cable laying equipment can achieve sufficient burial depth below the sand waves into the stable sea bottom.

Dredging will be limited only to the extent required to achieve adequate cable burial depth during cable installation. Where dredging is necessary, it is conservatively assumed that the dredge corridor will typically be 15 m (50 ft) wide at the bottom (to allow for equipment maneuverability) with approximately 1:3 sideslopes for each of the two cables. However, the depth of dredging will vary with the height of sand waves; hence the dimensions of the sideslopes will likewise vary with the depth of dredging and sediment conditions. This dredge corridor includes the up to 1 m (3.3 ft) wide cable installation trench and the up to 3 m (10 ft) wide temporary disturbance zone from the tracks or skids of the cable installation equipment. The average dredge depth is approximately 0.5 m (1.6 ft) and may range up to 5.25 m (17 ft) in localized areas. The total vertical disturbance within sand waves is up to 8 m (26 ft), which includes dredging and cable installation.

For both offshore export cables combined, dredging may impact approximately 0.21 km^2 (52 acres)[40] along ~15.3 km (~8.3 NM) and may include up to approximately 134,800 cubic meters (176,300 cubic yards) of dredged material. Actual dredge volumes will depend on the final cable alignments and cable installation method(s); a cable installation method that can achieve a deeper burial depth will require less dredging. Appendix III-P provides the maximum extent of dredging.

Dredging could be accomplished by several techniques. European offshore wind projects have typically used a trailing suction hopper dredge (TSHD). A TSHD vessel contains one or more drag arms that extend from the vessel, rest on the seafloor, and suction up sediments. Dredges of this type are also commonly used in the US for channel maintenance, beach nourishment, and other projects (see Figure 3.3-2). For Phase 1 of New England Wind, a TSHD would be used to remove

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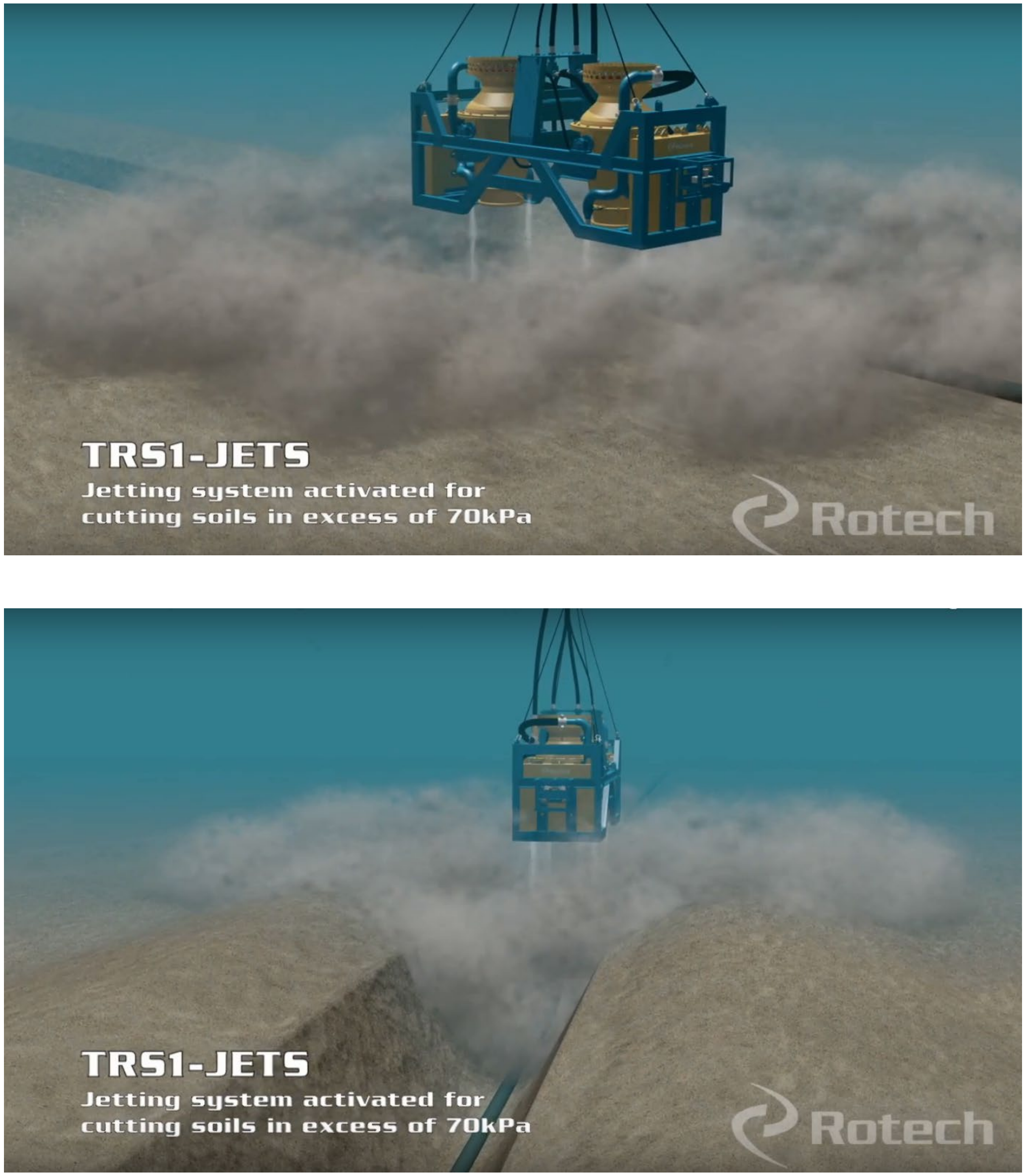
40 Since the dredging area will overlap with the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) wide temporary disturbance zone from the tracks or skids during cable installation (see Section 3.3.1.3.6), these areas have been subtracted from the dredging area to avoid double-counting impacts. The total dredging area including the cable installation trench is approximately 0.27 km^2 (67 acres).



Source: http://www.rotech.co.uk/subsea-video-gallery.html

Jetting

Source: https://www.flickr.com/photos/jaxstrong/albums/72157637944233765

Trailing Suction Hopper Dredge

enough of the top of a sand wave to allow subsequent cable installation into the stable seabed using one of the techniques described in Section 3.3.1.3.6 below. Should a TSHD be used, it is anticipated that the TSHD would dredge along the cable alignment until the hopper was filled to an appropriate capacity; then, the TSHD would sail several hundred meters away and deposit the dredged material within the OECC. Bottom dumping of dredged material would only occur within sand waves (see Figure 3.3-3).[41]

A second dredging technique involves jetting by controlled flow excavation. Controlled flow excavation uses a pressurized stream of water to push sediments to the side (see Figure 3.3-2). The controlled flow excavation tool draws in seawater from the sides and then propels the water out from a vertical downpipe at a specified pressure and volume. The downpipe is positioned over the cable alignment, enabling the stream of water to fluidize the sediments around the cable, which allows the cable to settle into the trench. This process causes the top layer of sediments to be sidecast to either side of the trench. In this way, controlled flow excavation simultaneously removes the top of the sand wave and bury the cable. Typically, a number of passes are required to lower the cable to the minimum sufficient burial depth.

A TSHD can be used in sand waves of most sizes, whereas the controlled flow excavation technique is most likely to be used in areas where sand waves are less than 2 m (6.6 ft) high. Therefore, sand wave dredging could be accomplished entirely by the TSHD on its own or through a combination of controlled flow excavation and TSHD, with controlled flow excavation used for smaller sand waves and TSHD used to remove larger sand waves.

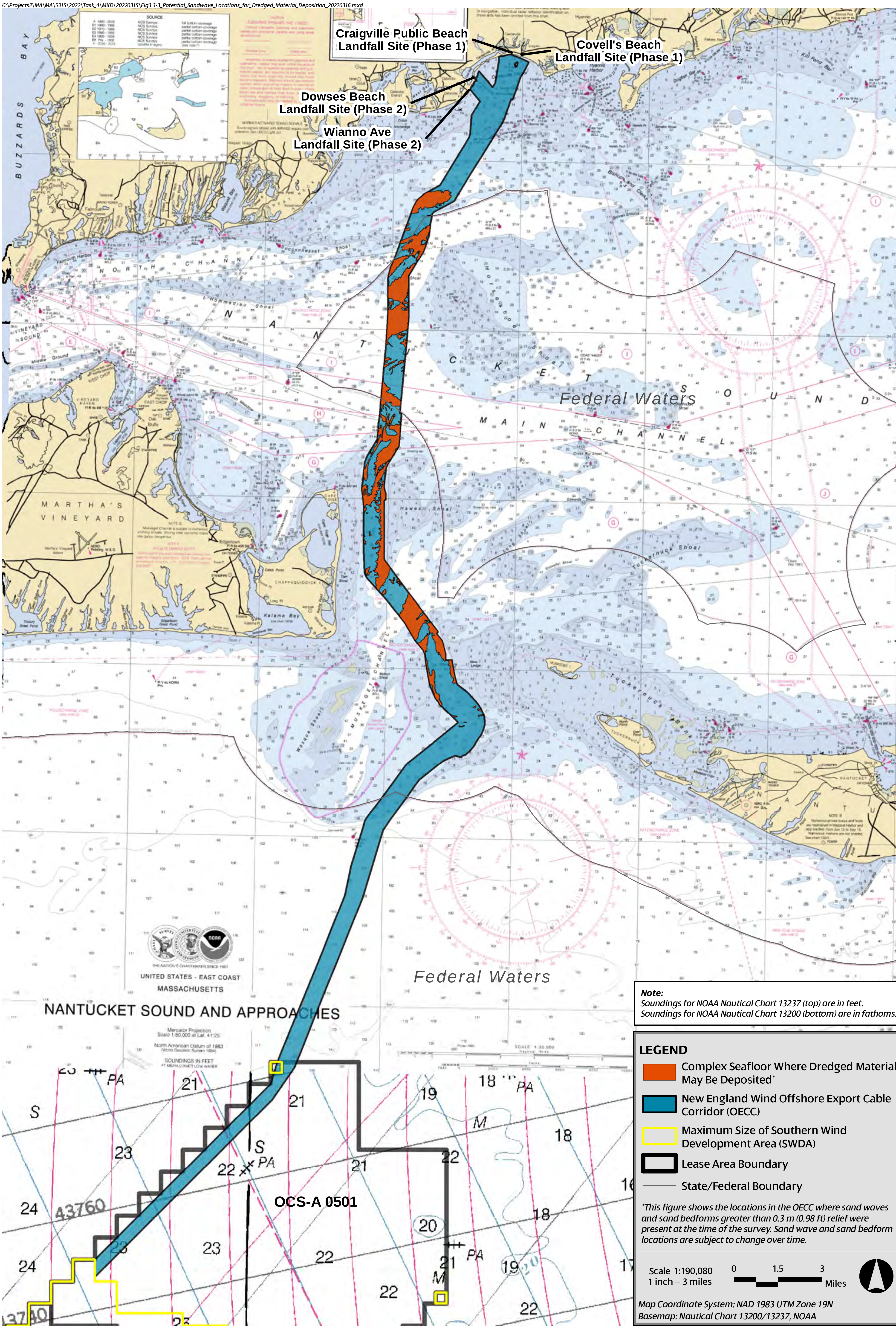
3.3.1.3.6 Cable Installation

The offshore export cables will have a target burial depth of 1.5 to 2.5 m (5 to 8 ft) below the seafloor, which the Proponent's engineers have determined is more than twice the burial depth required to protect the cables from fishing activities and also provides a maximum of 1 in 100,000 year probability of anchor strike, which is considered a negligible risk (see Appendix III-P).

Several possible techniques may be used during cable installation to achieve the target burial depth (see further description below). Generally, jetting methods are better suited to sands or soft clays whereas a mechanical plow or mechanical trenching tool is better suited to stiffer soil conditions (but is also effective in a wide range of soil conditions). While the actual offshore export cable installation method(s) will be determined by the cable installer based on site-specific environmental conditions and the goal of selecting the most appropriate tool for achieving adequate burial depth, the Proponent will prioritize the least environmentally impactful cable installation alternative(s) that is/are practicable for each segment of cable installation.

41 Figure 3.3-3 shows the locations in the OECC where sand waves and sand bedforms greater than 0.3 m (1 ft) relief were present at the time of the survey. Sand wave and sand bedform locations are subject to change over time.

G:\Projects2\MA\MA\5315\2022\Task_4\MXD\20220315\Fig3.3-3_Potential_Sandwave_Locations_for_Dredged_Material_Deposition_20220316.mxd



New England Wind
AVANGRID RENEWABLES

Figure 3.3-3

Potential Sand Wave Locations for Dredged Material Deposition

In addition to selecting an appropriate tool for the site conditions, the Proponent will work to minimize the likelihood of insufficient cable burial. For example, if the target burial depth is not being achieved, operational modifications may be required. Subsequent attempts with a different tool (such as controlled flow excavation) may be required where engineering analysis indicates subsequent attempts may help achieve sufficient burial. As discussed in Section 3.3.1.3.10, while every effort will be made to achieve sufficient burial, limited portions of the offshore export cables may not achieve sufficient burial depth and will require cable protection.

The majority of the offshore export cables are expected to be installed using simultaneous lay and bury via jetting techniques (e.g. jet plow or jet trenching) or mechanical plow. Both cable installation methods are described below under "Typical Techniques." However, additional specialty techniques are retained as options to maximize the likelihood of achieving sufficient burial depth (such as in areas of coarser or more consolidated sediment, rocky bottom, or other difficult conditions) while minimizing the need for possible cable protection and accommodating varying weather conditions. Additional techniques that may be used more rarely are described below under "Other Possible Specialty Techniques."

Typical Techniques

- **Jetting techniques (e.g. jet plowing or jet trenching):** Jetting tools may be deployed using a seabed tractor, a sled, or directly suspended from a vessel. Jetting tools typically have one or two arms that extend into the seabed (or alternatively a share that runs through the seabed) equipped with nozzles which direct pressurized seawater into the seafloor. As the tool moves along the installation route, the pressurized seawater fluidizes the sediment allowing the cable to sink by its own weight to the appropriate depth or be lowered to depth by the tool. Once the arm or share moves on, the fluidized sediment naturally settles out of suspension, backfilling the narrow trench. Depending on the actual jet-plowing/jet-trenching equipment used, the width of the fluidized trench could vary between 0.4–1 m (1.3–3.3 ft). While jet-plowing will fluidize a narrow swath of sediment, it is not expected to result in significant sidecast of materials from the trench. Offshore cable installation will therefore result in some temporary elevated turbidity, but sediment is expected to remain relatively close to the installation activities (see Section 5.2.2 of COP Volume III for a discussion of sediment dispersion modeling).

- **Mechanical plowing:** A mechanical plow is pulled by a vessel (or barge) and uses cutting edge(s) and moldboard, possibly with water jet assistance, to penetrate the seabed while feeding the cable into the trench created by the plow. While the plow share itself would likely only be approximately 0.5 m (1.6 ft) wide, a 1 m (3.3 ft) wide trench disturbance is also conservatively assumed for this tool. This narrow trench will infill behind the tool, either by slumping of the trench walls or by natural infill, usually over a relatively short period of time.

Other Possible Specialty Techniques

- **Mechanical trenching:** Mechanical trenching is typically only used in more resistant sediments. A rotating chain or wheel with cutting teeth/blades cuts a trench into the seabed. The cable is laid into the trench behind the trencher and the trench collapses and backfills naturally over time.

- **Shallow-water cable installation vehicle:** While any of the "Typical Techniques" described above could be used in shallow water, the Phase 1 Envelope also includes specialty shallow-water tools (if needed). These entail deployment of either "Typical Technique" from a vehicle that operates in shallow water in places where larger cable laying vessels cannot efficiently operate. The cable is first laid on the seabed, and then a vehicle drives over or alongside the cable while operating an appropriate burial tool to complete installation. The vehicle is controlled and powered from a shallower-draft vessel that holds equipment and operators above the waterline.

- **Pre-pass jetting:** Prior to cable installation, a pre-pass jetting run using a jet plow or jet trencher may be conducted along targeted sections of the cable route with stiff or hard sediments. A pre-pass jetting run is an initial pass along the cable route by the cable installation tool to loosen sediments without installing the cable. A pre-pass jetting run maximizes the likelihood of achieving sufficient burial during a subsequent pass by the cable installation tool when the cable is installed. Pre-pass jetting run impacts are largely equivalent to the cable installation impacts from jetting, which are described under "Typical Techniques" above.

- **Pre-trenching:** Pre-trenching is typically used in areas of very stiff clays. A plow or other device is used to excavate a trench, the excavated sediment is placed next to the trench, and the cable is subsequently laid into the trench. Separately or simultaneously to laying the cable, the excavated sediment is returned to the trench to cover the cable. It is unlikely that the Proponent will use a pre-trench method because site conditions are not suitable (i.e. sandy sediments would simply fall back into the trench before the cable-laying could be completed).

- **Pre-lay plow:** In limited areas of resistant sediments or high concentrations of boulders, a larger tool may be necessary to achieve cable burial. One option is a robust mechanical plow that would push boulders aside while cutting a trench into the seabed for subsequent cable burial and trench backfill. Similar to pre-trenching, this tool would only be used in limited areas if needed to achieve sufficient cable burial.

- **Precision installation:** In situations where a large tool is not able to operate or where another specialized installation tool cannot complete cable installation, a diver or ROV may be used to complete installation. The diver or ROV may use small jets or other small tools to complete installation.

- **Jetting by controlled flow excavation:** As described in Section 3.3.1.3.5, jetting by controlled flow excavation can be used for cable installation as well as dredging. A controlled flow excavation tool draws in seawater from the sides and then propels pressurized water downward over the cable alignment, enabling the stream of water to fluidize the sediments around the cable and allowing the cable to settle into the trench. This process causes the top layer of sediments to be sidecast to either side of the trench. This method will not be used as the conventional burial method for the offshore export cables, but may be used in limited locations, such as to bury cable joints or bury the cable deeper and minimize the need for cable protection where initial burial of a section of cable does not achieve sufficient depth. Typically, a number of passes are required to lower the cable to the minimum sufficient burial depth, resulting in a wider disturbance than use of a jet-plow or mechanical plow. Jetting by controlled flow excavation is not to be confused with jet plowing or jet trenching (a typical cable installation method described above).

Impacts from cable installation are expected to include an up to 1 m (3.3 ft) wide cable installation trench and an up to 3 m (10 ft) wide temporary disturbance zone from the skids/tracks of the cable installation equipment that will slide over the surface of the seafloor (each skid/track is assumed to be approximately 1.5 m [5 ft] wide). The skids or tracks have the potential to disturb benthic habitat; however, because they are not expected to dig into the seabed, the impact is expected to be minor relative to the trench. The trench is expected to naturally backfill as sediments settle out of suspension and no separate provisions to facilitate restoration of a coarse substrate are required.

Typical cable installation speeds are expected to range from 100 to 200 meters per hour (5.5 to 11 feet per minute) and it is expected that offshore export cable installation activities will occur 24 hours per day. Once offshore export cable installation has begun, to preserve the integrity of the cable, cable installation will ideally be performed as a continuous action along the entire cable alignment between splices.

Anchored cable laying vessels may be used along the entire length of the offshore export cables due to varying water depths throughout the OECC and SWDA. Anchoring during installation of the offshore export cables is expected to require the use of a nine-point anchoring system. A nine-point anchor spread provides greater force on the cable burial tool than a spread with fewer anchors thereby enabling greater burial depth. On average, anchors are assumed to reposition approximately every 400 m (1,312 ft); however, anchor resetting is highly dependent on final contractor selection and the contractor's specific vessel(s). Each anchor is estimated to disturb approximately 30 m^2 (323 ft^2), such that a vessel equipped with nine anchors would disturb approximately 270 m^2 (2,906 ft^2) of the seafloor each time the vessel repositions its anchors.[42]

[42] The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the early planning stages of Phase 1.

Anchored vessels may be equipped with spud legs that are deployed to secure the cable laying vessels while its anchors are being repositioned. The spud legs would disturb up to approximately 10 m^2 (108 ft^2) each time they are deployed. To install the cable close to shore using tools that are best optimized to achieve sufficient cable burial, the cable laying vessel may temporarily ground nearshore, impacting an area of up to 9,750 m^2 (2.4 acres) per cable. A jack-up vessel may be used to facilitate pulling the offshore export cables through HDD conduits installed at the landfall site (see Section 3.3.1.8 for a description of HDD).[43] Any anchoring, jacking-up, spud leg deployment, or grounding will occur within areas of the OECC and SWDA that will have been surveyed. The total seafloor disturbance from offshore export cable installation is quantified for Phase 1 in Section 3.3.1.13.

Prior to the start of construction, contractors will be provided with a map of sensitive habitats with areas to avoid so they can plan their mooring positions accordingly. Vessel anchors and legs will be required to avoid known eelgrass beds and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable's installation. Where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, use of mid-line anchor buoys will be considered, where feasible and considered safe, as a potential measure to reduce and minimize potential impacts from anchor line sweep (see Section 6.5.2.1.6 of COP Volume III).

3.3.1.3.7 Cable Splicing

Due to the length of the offshore export cables and other considerations, the offshore export cables will likely require two or three joints (splices). Upon reaching the splicing location, a cable will be retrieved from the seabed and brought inside the cable laying vessel or other specialized vessel (e.g. jack-up vessel). Inside a controlled environment (i.e. a jointing room) aboard the vessel, the two ends of the cable will be spliced together. Once cable splicing is completed, the offshore export cable will be lowered to the seafloor. Depending on the design of the cable and joint, the splicing process may take several days, in part, because the jointing process can only be performed during good weather. Prior to retrieving the cable ends from the seabed for cable splicing, cable protection may be temporarily placed over the cable ends to protect them. Permanent cable protection may also be installed over the joint once splicing is complete (see Section 3.2.1.5.4).

If a jack-up vessel is used for cable splicing operations, the vessel would impact approximately 600 m^2 (0.15 acres) of seafloor each time the vessel jacks-up. Any jacking-up will occur within surveyed areas of the OECC and SWDA. The total area of seafloor disturbance from jacking-up is provided in Section 3.3.1.13.

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[43] Any seafloor disturbance resulting from a jack-up vessel used for cable pulling operations would be within the total seafloor disturbance from offshore export cable installation provided in Section 3.3.1.13.

3.3.1.3.8 Cable Pull-in, Termination, and Commissioning

As described in Section 3.2.1.5.3, the ends of the offshore export cable will likely be protected using a cable entry protection system. The cable entry protection system will be mounted around the cable on board the cable laying vessel and secured to the end of the cable before the cable is pulled into the ESP.

Depending on the final construction schedule, the ends of the offshore export cables can be temporarily wet-stored or directly pulled into the ESP. To commence cable pull-in into the ESP, a ROV will likely recover a pre-installed messenger wire from the base of the foundation and connect it to the end of the offshore export cable. Using the messenger wire, a winch on the ESP will then begin to pull the cable up through the foundation into the ESP topside.

Once inside the ESP, the cable termination team will strip the cables to expose the power cores and fiber optic cables and then connect the cables to the electrical infrastructure in the ESP. After termination is completed, the export cables will be fully tested and commissioned to confirm that they can be energized. Jack-up vessels may be used for pull-in and commissioning work at the ESPs.

3.3.1.3.9 Post-Burial Cable Survey

The specific, as-built cable alignment will be monitored by the cable installation tool during installation to record the precise location (x and y) of each offshore export cable as well as the achieved burial depth (z). If the depth of burial cannot be clearly established from any of the installation techniques, additional survey work may be undertaken.

3.3.1.3.10 Cable Protection

Cable protection may be used to protect cable joints, to secure the cable entry protection system in place, if the cables need to cross other infrastructure (e.g. existing cables, pipes, etc.), or if sufficient burial depths cannot be achieved. While every effort will be made to achieve sufficient burial, it is conservatively estimated that approximately 6% of the offshore export cables within the OECC may not achieve sufficient burial depth and will require cable protection (see Section 3.2.1.5.4 for a description of cable protection methods).

Rock protection will likely be transported and installed by a DP fall-pipe vessel purpose-built for installing rock material in a controlled and accurate manner on the seafloor (similar to scour protection installation described in Section 3.3.1.2). An ROV located at the bottom of the fall-pipe would likely be used to control the lateral movement of the fall-pipe and monitor the installation process. The vessel would hold position or would be guided along a predefined track by the vessel's DP system.

Gabion rock bags would be deployed (and recovered) from a vessel using a lifting point incorporated into the design of the bags. Mattresses would be deployed by a vessel's crane or excavator arm using an installation frame to ensure accurate placement. Half-shell pipes (or similar), if used, would be fixed around the offshore export cable on board the cable laying vessel before the cable is laid on the seabed.

3.3.1.3.11 Cable Crossings

No cable crossings are planned for Phase 1. In the event a cable crossing becomes necessary, it would likely include the following steps:

1. Perform a full desktop study of any as-built and post-construction survey data for the previously installed cable.

2. Upon identification of a suitable crossing point that is agreed to by the cable owner, perform a full survey and inspection of the proposed crossing location and the existing cable using an ROV, diver-held instrument, or similar.

3. Carefully remove any existing debris surrounding the crossing point.

4. Depending on the depth of the existing cable and the cable owner's requirements, there may be a concrete mattress or other means of cable protection (see Section 3.2.1.5.4) placed between the existing cable and the Phase 1 cable. Alternatively, if there is sufficient vertical distance between the existing cable and the Phase 1 cable, there may be no manmade physical barrier between the cables.

5. During installation of the Phase 1 offshore export cable, on approach to the crossing location, the cable will be graded out of burial with the cable installation tool. At this point, some form of protection (e.g. half-shell pipe or similar) would likely be applied to the cable which is then surface laid across the seabed over the existing cable and any previously laid cable protection. Once the Phase 1 cable has been laid over the existing cable and clears the crossing location, no further protection will be applied to the cable and the cable will be returned to burial using the cable installation tool.

6. Soon after installing the cable at the crossing, the surface-laid section of the Phase 1 cable would be protected with either additional concrete mattresses, controlled rock placement, or a similar physical barrier (see Sections 3.2.1.5.4 and 3.3.1.3.10). Remedial post-lay burial of the Phase 1 cable on either side of the crossing may be performed to lower the cable below seabed level to ensure their protection.

7. If necessary, additional cable protection will be carefully placed on and around the crossing.

8. A final as-built survey of the completed crossing will be conducted to confirm the exact location of Phase 1's surface-laid cable and the cable protection laid over the crossing. As-built positions for the cable crossing will be shared with the existing cable's owner and provided to the National Oceanic and Atmospheric Administration for charting purposes.

Cable protection used for cable crossings may be wider than typical cable protection, but the total seafloor disturbance from cable protection will be within the area provided in Section 3.3.1.13. Cable protection methods will be designed to protect the offshore export cables against mechanical impact from above and respect the vertical distance and physical barrier (if any) to the existing cable. The cable crossing will also be designed to minimize the risk of fouling or snagging of fishing equipment. The design of the crossing structure, as well as any survey at the crossing, will be defined, planned, executed, evaluated, and documented in agreement with the cable's owner.

3.3.1.4 WTG Foundation Installation

3.3.1.4.1 Monopile Foundations

Seabed preparation may be required prior to foundation installation or scour protection installation (see Section 3.3.1.2). This could include the removal of large obstructions and/or leveling of the seabed.

After fabrication, monopile foundation components (i.e. monopile, transition piece [TP], and any secondary items) will be transported to a port facility (see Section 3.2.2.5) or directly to the SWDA. The installation concept and method of bringing components to the SWDA will be based on supply chain availability and final contracting. The monopiles are expected to be installed by one or two heavy lift or jack-up vessel(s). The main installation vessel(s) will likely remain at the SWDA during the installation phase and supply vessels, jack-up vessels, barges, and/or tugs will provide a continuous supply of foundations to the SWDA. In this scenario, the monopiles may also be floated out to the SWDA using tugboats. In addition, a tugboat may remain at the SWDA to assist feeder vessels' approach to the main installation vessel. The foundation components could be picked up directly in a US port (if Jones Act compliant vessels are available) or Canadian port by the main installation vessel(s).

One or two DP, anchored, or jack-up vessels may be used for installation of the foundations. To estimate the maximum seafloor disturbance from WTG foundation installation vessels, it is assumed that the vessels would jack-up and/or anchor up to three times at each WTG foundation, disturbing up to approximately 3,600 m^2 (0.89 acres) per foundation.[44] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. The total seafloor disturbance from jacking-up and anchoring is quantified for Phase 1 in Section 3.3.1.13.

At the SWDA, the main installation vessel will use a crane to upend and lower the monopile to the seabed. To stabilize the monopile's vertical alignment before and during piling, a pile frame may be placed on the seabed (atop the scour protection) or a pile gripper may extend from the side of the installation vessel. After the monopile is lowered to the seabed through the pile gripper/frame, the weight of the monopile will enable it to "self-penetrate" a fraction of the target penetration depth into the seafloor. The crane hook will then be released, and the hydraulic hammer will be lifted and placed on top of the monopile. Figure 3.3-4 shows a vessel lowering a monopile and typical jack-up installation vessels.

Next, impact pile driving will commence, beginning with a soft-start[45]. A soft-start utilizes an initial set of low energy strikes from the impact hammer followed by a waiting period. Additional strike sets gradually increase energy to what is needed to install the pile (usually less than hammer capability). A soft-start ensures a monopile remains vertical and also allows any motile marine life to leave the area before pile driving intensity is increased. The intensity (i.e. hammer energy level) will be gradually increased based on the resistance that is experienced from the sediments. The maximum hammer energy for monopiles is up to 6,000 kilojoules (kJ); however, for the large majority of monopiles, the maximum hammer energy is expected to be 5,000 kJ. Noise mitigation systems are expected to be applied during pile driving (see Sections 6.7 and 6.8 of COP Volume III). The typical pile driving operation is expected to take several hours to achieve the target penetration depth. It is anticipated that a maximum of two monopiles can be driven into the seabed per day.

In order to initiate impact pile driving the pile must be upright, level, and stable. The preferred option to achieve this is by utilizing a pile frame or pile gripper as described above. In the unlikely scenario that both preferred options have unforeseen challenges, vibratory hammering may be utilized as a contingency. Vibratory pile driving would only occur for very short periods of time and only if the Proponent's engineers determine that vibratory driving is required to stabilize the pile so impact driving can begin.

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44 It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for WTG foundation installation is calculated based on vessels jacking-up three times.

45 Soft-start procedures are also employed for surveys using sonar equipment less than 200 kHz in frequency (i.e. sub-bottom profilers).

New England Wind
AVANGRID RENEWABLES

Figure 3.3-4
Typical Foundation Installation Vessels

Based on soil condition surveys, drilling of monopiles is not anticipated, but could be required if a large boulder or monopile refusal is encountered. If drilling is required, a rotary drilling unit will be mobilized to the monopile top. The interior sediment will then be drilled out and deposited on the seabed adjacent to the scour protection material until the monopile is no longer obstructed. Monopile installation will then recommence until the monopile reaches target depth. After drilling is complete, the interior sediment may be re-deposited into the monopile to provide additional stability. Alternatively, the interior of the monopile may be filled with medium/coarse sand, grout, or concrete.

After installation of the monopile, the TP will be picked up and placed on the monopile (unless an extended monopile concept is used). The connection between the monopile and the TP will be grouted, bolted, slip-jointed, or use a combination of these methods. If the main connection is established by bolts, grout is foreseen in a "skirt" holding the boat landing, with the following purposes:

- Support for the lower part of the boat landing
- Protecting against water ingress to the bolted connection
- Corrosion protection underneath the skirt

Grout material will be mixed either on the installation vessel or a separate grouting vessel. Grout will be pumped through hoses into the TP structure to fill the annulus between the monopile and the TP, and will be contained at the lower extremity of the TP by a high strength rubber grout seal. The design will ensure that any overflow of grout during grouting will be directed to the inside of the foundation. Grout spill management procedures are described in Section 3.3.4.5.

If the time between the installation of the monopile and TP is longer than a few days, the amount of marine growth must be assessed and marine growth may need to be removed with a high pressure washing tool or similar equipment prior to installing the TP. Anti-fouling paint in contrasting colors may be used in select areas on the monopile (e.g. surrounding apertures) to prevent build-up of marine growth and increase visibility for ROVs performing cable pull-in operations.

3.3.1.4.2 Jacket Foundation Installation

The installation concept and method of bringing jacket components to the SWDA is similar to that for the monopiles. As with monopiles, seabed preparation may be required prior to scour protection or foundation installation.

After fabrication, the jacket components will be transported to a port facility (see Section 3.2.2.5) or directly to the SWDA on the installation vessel or a separate transport vessel. Once delivered to the SWDA, the jacket will be lifted off the transport or installation vessel and lowered to the seabed with the correct orientation. As further described in Section 3.3.1.4.1 above, anchored, DP, and/or jack-up vessels may be used for installation of the WTG foundations. The installation vessels could impact up to 3,600 m^2 (0.89 acres) for each WTG foundation installation; any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. Total seafloor disturbance from WTG foundation installation is provided in Section 3.3.1.13.

Once the jacket structure is set on the seabed, the pin piles will be lifted and driven through the pile sleeves to the engineered depth. Alternatively, the piles may be driven prior to lowering the jacket by using a frame to orient the piles.

Impact pile driving will commence with a soft-start, as described above for the monopiles. The maximum hammer energy for jacket piles is up to 3,500 kJ. A maximum of one complete piled jacket (up to four pin piles) is expected to be installed per day. As noted above, no drilling is anticipated but it could be required if pile refusal is encountered. Similarly, use of a vibratory hammer is not anticipated, but could be used for very short periods of time if deemed appropriate by the installation contractor.

Once all piles are driven to the target depth, the jacket will be leveled and the piles will be fixed in the pile sleeves, most likely by the use of grouting. Grout material will be mixed either on the installation vessel or a separate grouting vessel. Grout will then be pumped through hoses into the jacket structure to fill the annulus between the sleeves and piles and will be contained at the lower extremity of the sleeve by a high strength rubber grout seal. The grout level will be monitored visually using underwater cameras and when grout reaches the top of the sleeve, grouting will be halted. Grout spill management protocols similar to those for monopile foundations will also be used for jacket foundations (see Section 3.3.4.5).

3.3.1.5 Electrical Service Platform (Topside and Foundation) Installation

Each ESP is comprised of two primary components: the topside that contains the electrical components and the foundation substructure.

Either a monopile or piled jacket foundation will be used to support the weight of each ESP topside. ESP foundation installation is similar to WTG foundation installation described in Sections 3.3.1.4.1 and 3.3.1.4.2 above. Either a monopile is driven vertically into the seabed or a jacket foundation is secured to the seabed with pin piles. Like WTG foundations, the maximum hammer energy for monopiles and jackets is up to 6,000 kJ and 3,500 kJ, respectively, although energy use is anticipated to be less. Up to two monopiles or four jacket piles will be driven per day for both WTGs and ESPs. As with WTG foundations, seabed preparation may be required prior to scour protection or foundation installation.

The ESP topside(s) will likely be transported directly to the SWDA. Alternatively, the ESP(s) could be transported to a harbor (see Section 3.2.2.5) and moved offshore on a vessel. Topside installation may be carried out by the same vessel that installs the foundation. First, the installation vessel will position itself next to the foundation. The ESP topside will arrive on a separate transport vessel (or will have been transported on the deck of the installation vessel) and the installation vessel's crane will lift the topside and place it on the foundation. The topside and the foundation will be connected using bolted connections and/or welding. Figure 3.2-5 shows construction work being performed on an ESP.

ESP foundation and topside installation may be performed by a DP, anchored, or jack-up vessel. To estimate the maximum seafloor disturbance from ESP installation vessels, it is assumed that vessels would anchor and/or jack-up up to eight times at each ESP and would disturb up to approximately 9,600 m^2 (2.4 acres) per ESP.[46] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed.

After ESP mechanical installation is complete, the inter-array cables, offshore export cables, and inter-link cables (if used) will be pulled into place and terminated at each ESP. These cables will be routed through J-tubes (or a J-tube alternative) located on the foundation or will be routed through the interior of the foundation. If required, once the cables are connected to the ESP(s), the corrosion protection/control system will be installed around the ESP foundation structure(s) utilizing a similar design as the WTG foundations.

Following topside installation, the ESP(s) will be commissioned. ESP commissioning, which entails conducting tests of the electrical infrastructure and safety systems on the ESP(s) prior to commercial operations, may last several months. During the commissioning period, a jack-up vessel may be positioned adjacent to the ESP(s) to provide accommodations for workers performing commissioning activities. The total seafloor disturbance from jacking-up and anchoring during ESP installation and commissioning is quantified for Phase 1 in Section 3.3.1.13.

3.3.1.6 Inter-Array and Inter-Link Cable Installation

"Strings" of multiple WTGs will be connected to the offshore ESP(s) using 66–132 kV inter-array cables (see Figure 3.2-10). Inter-array cable installation typically commences following the start of, and occurs partially in parallel with, foundation installation and normally precedes WTG installation at a given WTG location. If two ESPs are installed, an inter-link cable may also be installed to connect the ESPs together.

Prior to inter-array cable and inter-link cable installation, a pre-lay grapnel run and pre-lay survey will be performed to inspect the cable route and locate and clear obstructions (see Sections 3.3.1.3.3 and 3.3.1.3.4 for a description of these activities). Based on preliminary survey data for the SWDA, dredging and boulder clearance may not be necessary prior to inter-array or inter-link cable laying, but this will be confirmed through additional data analyses.

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46 It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for ESP installation is calculated based on vessels jacking-up eight times.

The inter-array cables could be transported in a cable laying vessel and directly installed at the SWDA upon arrival, or they could be stored temporarily onshore and transferred to a cable laying vessel. Upon arrival at the SWDA, the first end of an inter-array cable will be pulled into a WTG or ESP foundation using winches installed on the foundation. Once the first end of the cable is secured inside the foundation, the cable laying vessel will install the inter-array cable as it moves towards the next foundation in the inter-array cable string. At the second end of the inter-array cable, the cable will be pulled through the J-tube or similar connection (see Figure 3.2-8) for subsequent linking to the WTG. Cable pull-in will be conducted at each foundation location and followed by cable termination works.

Inter-link cable transportation and installation will follow a process similar to inter-array or offshore export cable transportation and installation, except that the cable will be installed between ESPs. Whereas inter-array cable installation is expected to use a DP vessel, inter-link cable installation may be performed using an anchored vessel. Like the offshore export cable laying vessel (see Section 3.3.1.3.6), each anchor is estimated to disturb approximately 30 m^2 (323 ft^2), such that a vessel equipped with nine anchors would disturb approximately 270 m^2 (2,906 ft^2) of the seafloor each time the vessel repositions its anchors.[47] In addition, anchored vessels may be equipped with spud legs that would disturb up to approximately 10 m^2 (108 ft^2) each time its anchors are being repositioned. On average, anchors are assumed to reposition every approximately 400 m (1,312 ft). The total seafloor disturbance from inter-link cable installation is quantified for Phase 1 in Section 3.3.1.13.

For the inter-array cables, the expected installation method is to lay the cable section on the seafloor and then subsequently bury the cable using a jetting technique (this is referred to as "post-lay burial"), but the cables could be installed using any techniques listed in Section 3.3.1.3.6 above. The inter-link cables will also be installed using one of the techniques listed in Section 3.3.1.3.6 above. As with the offshore export cables, the inter-array and inter-link cables will have a target burial depth of 1.5–2.5 m (5–8 ft). The Proponent expects that the position of the inter-array and inter-link cables will be documented either at the time of installation or shortly thereafter with an as-built survey.

As described in Section 3.2.1.6, each end of the inter-link and inter-array cables will likely be protected using a cable entry protection system. The cable entry protection system will be mounted around the cable on board the cable laying vessel and secured to the end of the cable before the cable is pulled into the WTGs or ESP(s). Additional cable protection may be placed over the cable entry protection system to secure it in place and limit movement of the cable. Although unlikely, cable protection may also be required for sections of the inter-array and inter-link cables where burial was not possible or where cable crossings are required (see Section

47 The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the early planning stages of Phase 1.

3.2.1.6). If required, cable protection for the inter-array and inter-link cables will be installed using the same methods described for the offshore export cables in Sections 3.3.1.3.10 and 3.3.1.3.11.

3.3.1.7 Wind Turbine Generator Installation

Prior to the commencement of installation, WTG components will likely be transported to one of the ports listed in Section 3.2.2.5 to create a sufficient stock of components in order to maintain a steady pace of installation activities. Some WTG preparatory work/assembly at the port may be needed. Feeder vessels would then transport WTG components from the port to the SWDA. Although less likely, WTG components may be delivered to the SWDA directly from Europe.

The WTGs are expected to be installed by one or two main installation vessels, which may be a jack-up, anchored, or DP vessel. The WTG components will be lifted using the main installation vessel's crane and/or a "climbing crane" that crawls up the WTG tower (using the tower for support). The tower will first be erected followed by the nacelle and finally the hub, inclusive of the blades. Alternatively, the nacelle and hub could be installed in a single operation followed by the installation of individual blades. In case the tower consists of more than one section, the sections will be joined with a bolted connection.

To estimate the maximum seafloor disturbance from WTG installation vessels, it is assumed that the vessels would jack-up and/or anchor up to four times at each WTG, disturbing up to approximately 4,800 m^2 (1.2 acres) per WTG.[48] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. The total seafloor disturbance from jacking-up and anchoring is quantified for Phase 1 in Section 3.3.1.13.

WTG installation will be followed by the commissioning period where the WTGs will be prepared for operation and energized. The WTG commissioning and testing phase will likely be conducted in parallel with the WTG installation phase. Service operation vessels or crew transfer vessels may be used to transport crew to and from the WTGs during commissioning activities.

The WTG installation phase typically represents the most intense period of vessel traffic in the Offshore Development Area with WTG foundations, inter-array cables, and WTGs being installed and commissioned in parallel.

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48 It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for WTG installation is calculated based on vessels jacking-up four times.

3.3.1.8 Landfall Site Construction

The Phase 1 offshore export cables will make landfall at the Craigville Public Beach Landfall Site or the Covell's Beach Landfall Site. At either landfall site, the ocean-to-land transition will be made using horizontal directional drilling (HDD) to avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion.

The HDD staging area would be setup in either the Craigville Public Beach or Covell's Beach parking lot, and the drill would be advanced seaward. An approach pit at the HDD staging area will provide the contractor with access to the proper trajectory for drilling and will also serve as a reservoir for drilling fluids (i.e. a slurry consisting predominantly of water and bentonite, a naturally-occurring, inert and non-toxic clay) used to extract material from the drill head.

The HDD process begins with drilling bore holes between the HDD staging area at the landfall site and an offshore HDD exit point. One bore is needed for each offshore export cable. The length of the drill or bore depends on the width of the dune and beach area, the proximity of the HDD staging area, the extent of any nearshore sensitive resources (e.g. eelgrass), bathymetry, and geologic conditions. At either landfall site, the HDD would be approximately 300–365 m (1,000–1,200 ft) in length and would be angled offshore to avoid an area of hardbottom and co-located eelgrass. Although the HDD trajectory is still undergoing engineering refinement, it is estimated that the trajectory will result in the HDD passing at a depth of approximately 9 m (30 ft) below the ground surface at Mean High Water (MHW).

Once the bore holes are completed, a plastic conduit is inserted into the bores. To facilitate cable pull-in and expose the conduit end, a shallow "pit" would be excavated at the HDD exit point using techniques such as controlled flow excavation. At the HDD exit point, the contractor may lower a gravity cell to the seafloor that would capture any incidental drilling fluid released from the end of the HDD drill. Divers will then insert the offshore export cables into the conduits, and the cables will be pulled through the conduit towards land. The seaward end of the conduit would then be reburied beneath the seafloor, likely using divers with hand-jets (i.e. using a narrow, high-pressure stream of water). If softer sediments are present, silt curtains will be employed in and around the area of hand-jetting to contain turbidity. Between the HDD entry pit and the transition vault(s), the export cables will be installed beneath the parking lot in open trenches.

Thermal grout may be used to fill the interstitial space between the offshore export cable and the cable conduit to enhance the thermal characteristics of the cable (i.e. to enhance heat dissipation from the cable). Grout would be pumped from an offshore vessel into the interstitial space between the cable and the conduit, and the non-hazardous mixture of displaced water, grout, and sand would be stored, dewatered, and disposed of per the proper regulations. If grout is not used, a mix of seawater and/or sand will occupy the interstitial space between the cable and conduit.

HDD will require use of a drilling fluid (i.e. a slurry consisting predominantly of water and bentonite, which is a naturally occurring, inert, and non-toxic clay) to cool and lubricate the drill bit, stem, and other equipment as well as seal the sides of the bore. This benign, natural material would pose little to no threat to water quality or ecological resources in the rare instance of seepage around the HDD operations.

The HDD installation method will produce a slurry of two co-mingled byproducts: drill cuttings and excess drill fluids. During drilling, this slurry will be collected from the reservoir pit and will be processed through a recycling system where drill cuttings (solids) will be separated from reusable drill fluids. Non-reusable material consisting of drill cuttings and excess drill fluids will be trucked to an appropriate disposal site; this material is typically classified as clean fill that can be disposed of at gravel pits or farm fields/pastures. Filtered water will be released if it meets water quality requirements. Measures to minimize the already-remote potential for seafloor disturbance through drilling fluid seepage (i.e. frac-out) are described in Section 8.6 of COP Volume III.

The Proponent will restore the HDD staging area to match existing conditions. Any paved areas that have been disturbed will be properly repaved.

Activities at the landfall site are not expected to be performed during the months of June through September unless authorized by the Town of Barnstable (see Section 3.3.1.1.1).

3.3.1.9 Onshore Substation Construction and Grid Interconnection Point Expansion

The Phase 1 onshore substation will be constructed on an approximately 0.027 km^2 (6.7 acre) commercial property off Shootflying Hill Road (see Section 3.2.2.3). As described in Section 3.2.2.3, some of the onshore substation equipment may be relocated from the 8 Shootflying Hill Road onshore substation site to Parcel #214-001 located immediately southeast of the West Barnstable Substation. Aside from initial site preparation work to clear the property, substation construction would advance similarly on either site. The Proponent also plans to construct an access road on 6 Shootflying Hill Road to reach the 8 Shootflying Hill onshore substation site.

Construction of the onshore substation will include the following steps:

- Install perimeter construction fencing, a security gate, and erosion controls.
- Prepare the site for construction, which entails removing the existing motel building and associated paved areas, clearing and grading the site, installing retaining walls (if needed), and excavating areas required for drainage swales, basins required for site drainage, major component foundations, full volume containment, grounding grid, and spread footings.
- Construct transformer foundations, containment sumps, and spread footings for other equipment.

- Deliver and place major equipment using appropriate heavy-load vehicles and equipment.

- Deliver and place other electrical equipment and a prefabricated control equipment enclosure.

- Trench areas for underground cabling, install duct bank, and backfill.

- Install grounding grid and place crushed stone in yard area.

- Complete buswork and begin cabling including bringing the 220–275 kV onshore export cables into the site and bringing the 345 kV grid interconnection cables to the West Barnstable Substation.

- Complete cabling, control wiring, and installation of protection systems.

- Test and commission the onshore substation.

- Install permanent perimeter security fencing and screening, restore and landscape at the periphery of the site, and remove construction stage erosion controls.

Construction and commissioning of each onshore substation is scheduled to take approximately 18 to 24 months.

Ground disturbing activities during onshore substation construction include excavation and grading. The Proponent anticipates that the entire approximately 0.027 km^2 (6.7 acre) onshore substation site at 8 Shootflying Hill Road will need to be cleared to accommodate grading and access during construction;[49] approximately 0.012 km^2 (3.0 acres) of the site are currently undeveloped and contain Pitch Pine-Oak forest. The Proponent plans to plant vegetated screening at the 8 Shootflying Hill Road onshore substation site following construction, pursuant to final design plans. To construct the access road on 6 Shootflying Hill Road, the Proponent may need to grade and clear the entire parcel (up to 0.004 km^2 [1 acre]).[50]

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49 Ground disturbing activities may occur up to 3 m (10 ft) beyond the 8 Shootflying Hill Road parcel boundaries to enable construction equipment access and account for minor disturbance associated with activities occurring near the perimeter of the parcel.

50 Ground disturbing activities may occur up to 3 m (10 ft) beyond the 6 Shootflying Hill Road parcel boundaries to enable construction equipment access and account for minor disturbance associated with activities occurring near the perimeter of the parcel.

As noted above, some onshore substation equipment may be relocated from the onshore substation site to Parcel #214-001. Under a maximum build-out scenario, all of the approximately 0.011 km^2 (2.8 acre) Parcel #214-001 would be cleared.[51]

Lastly, modifications at the West Barnstable Substation will also be required to accommodate the Phase 1 interconnection. The design and schedule of this work will be determined by the results of the ISO-NE System Impact Study and coordinated with Eversource. It is anticipated that the West Barnstable Substation expansion could occur between the existing 345 kV substation and the Oak Street Substation on the northern part of the same parcel, where it would avoid significant tree clearing.

3.3.1.10 Onshore Export and Grid Interconnection Cable Installation

3.3.1.10.1 Typical Onshore Cable Installation

As described in Section 3.2.2.2, underground onshore export cables will connect the Phase 1 landfall site to the new onshore substation. Then, onshore grid interconnection cables will connect the onshore substation to Eversource's existing 345 kV West Barnstable Substation (see Section 3.2.2.4).

Installation of the onshore cables will occur in two steps. The first step will consist of installing the concrete duct bank and splice vaults that will house the onshore cables and associated infrastructure. The second step will consist of pulling/installing the onshore cables through the duct bank conduits, followed by splicing and terminating the cables. Construction of the duct bank system will be performed via open trenching with conventional construction equipment (e.g. hydraulic excavator, loader, dump trucks, flatbed trucks to deliver PVC/HDPE pipe, crew vehicles, cement delivery trucks, and paving equipment). The onshore cables will be pulled into place from underground vaults using a cable reel transport vehicle, a pulling rig, and the necessary crew and support vehicles. Installation of the in-road underground cabling will typically be performed during the off-season, where feasible, to minimize traffic disruption. All work will be performed in accordance with local, state, and federal safety standards, as well as any company-specific requirements.

More specifically, installation of the duct bank and onshore cables along the selected Onshore Export Cable Route and Grid Interconnection Route includes the following steps:

- Survey and mark splice vault and duct bank locations.
- Set up erosion and siltation controls, including silt sacks or similar protection for existing storm drains.

[51] Ground disturbing activities may occur up to 3 m (10 ft) beyond the boundaries of Parcel #214-001 to enable construction equipment access and account for minor disturbance associated with activities occurring near the perimeter of the parcel.

- Set up traffic management measures in coordination with local police and public works officials.

- Open roads and remove pavement (if needed), excavate and shore trenches via open trenching, and excavate splice vault locations. Excavated material will be hauled away in trucks daily and recycled or disposed of in accordance with state regulations.

- Install HDPE or PVC pipes (pipes may be stockpiled in a local staging area or along the road), pour concrete duct bank, and install prefabricated vaults.

- Backfill the trenches. Trenches that are not backfilled by day’s end will be secured with steel plates that are set in place to cover and protect the trench overnight. Openings in the shoulder will be protected and barricaded to ensure traffic and pedestrian safety. Subject to local permit conditions, temporary pavement will be placed at completed trench sections.

- Pull the onshore cables into the duct bank and splice the cables together.

- Test and energize the onshore cables.

- Repave roads in accordance with MassDOT and Town specifications to as-new conditions and restore disturbed vegetated areas to match pre-existing vegetation.

- Clean up the work area and remove erosion controls.

The duct bank layout, and hence the excavated trench dimensions, will vary along the Onshore Export Cable Route and Grid Interconnection Route (see Sections 3.2.2.2 and 3.2.2.4). The proposed duct bank will be formed using cast-in-place concrete installed in open trenches measuring up to approximately 2.4 m (8 ft) in depth, 1.7 m (5.5 ft) in width at the bottom, and 3.4 m (11 ft) in width at the top. In locations where splice vaults are necessary, the excavated area will be larger (approximately 6 m [20 ft] wide by 15 m [50 ft] long) to accommodate a pre-cast concrete splice vault. Both the duct bank and the splice vaults may be installed anywhere within the Onshore Export Cable Route and Grid Interconnection Route; therefore, the maximum extent of disturbance along the entire route within roadway layouts will be based on the dimensions of the area excavated for splice vaults. The top of the duct bank typically has a minimum of 0.9 m (3 ft) of cover comprised of properly compacted sand topped by pavement. However, if required due to existing conditions (e.g. at certain utility crossings), the minimum cover will be 0.8 m (2.5 ft).

Trenching will occur primarily within existing roadway layouts where excavation will occur within paved areas or within 3 m (10 ft) of pavement. Minimal tree trimming and/or tree clearing may be needed where the routes follow existing roadway layouts, depending on the final duct bank alignment.

Certain onshore route variants also utilize existing utility rights-of-way (ROWs). Installation of duct bank and splice vaults within these ROWs would require clearing and grading within a corridor wide enough to accommodate excavation and stockpiling of soils and provide space for construction equipment access along the work zone. The work, however, will be confined to as narrow a corridor as possible and will not impact adjacent wildlife habitat located outside of that corridor elsewhere within the utility ROW. Some stretches of existing utility ROWs may also require tree clearing where those ROWs have not been maintained to their full widths. For construction within the utility ROW, any disturbed vegetated areas will be loamed and seeded to match pre-existing vegetation.

Dewatering of the duct bank trench will be necessary in areas where groundwater is encountered, where soils are saturated, or at times when the trench is affected by storm water. Areas where groundwater may be encountered will be identified as part of the pre-construction environmental investigation of soils. In these areas, groundwater would be pumped from one or more sumps within the trench or vault using submersible pumps. Trench dewatering management will be accomplished using a combination of best management practices to avoid pumping sediment-laden water from the excavated areas; collected water will be passed through a dewatering fractionization tank (frac tank) and filtered prior to release. Standard erosion control practices will be employed to minimize erosion during trenching operations and construction activities in general.

3.3.1.10.2 Centerville River Crossing

As described in Section 3.2.2.2.1, both Onshore Export Cable Routes for Phase 1 will require crossing the Centerville River where there is an existing bridge on Craigville Beach Road. Given that the existing bridge deck cannot support the additional weight of the onshore export cables and it is not feasible to maintain existing hydraulic clearance beneath the bridge with the addition of the cables, the Proponent is not proposing to install the onshore cables within the existing bridge deck to maintain reliability and avoid potential risk during storm conditions.

Based on engineering considerations and consultations with the Town of Barnstable and MassDOT, the current preferred crossing option is microtunnel, followed by two other trenchless crossing options (HDD and direct pipe), and finally construction of an independent utility bridge.

Microtunneling is a pipe jacking operation that uses a microtunnel boring machine (MTBM), which is pushed into the earth by hydraulic jacks mounted and aligned in a jacking shaft. The jacking shaft and staging area would be located on the southwest side of the Centerville River Bridge on a property identified as 2 Short Beach Road (see Figure 3.3-5a). To accomplish the Centerville River crossing, a single approximately 130 m (430 foot) long microtunnel drive would be used to install a 122 cm (48 in) reinforced concrete pipe under the river. The concrete pipe would house the onshore export cable and fiber optic cable conduits and any interstitial space between the concrete pipe and conduits would be grouted using thermal cellular grout to dissipate heat. As the MTBM is advanced along the planned alignment, segments of the concrete pipe are lowered into the shaft and inserted into the bore. A minimum depth of 3 m (10 ft) of cover between the top of the casing and the bottom of the Centerville River is needed to complete the microtunnel drive and maintain tunnel face stability. Once the MTBM completes the microtunnel drive beneath the river, it will be recovered from a receiving shaft north of the river. The receiving shaft will be located entirely within the Town of Barnstable roadway layout; the final location of the receiving shaft will be coordinated with the Town of Barnstable to avoid any conflicts with future sewer projects planned for the area. An auger bore or open cut excavation could be used to transition the cable at depth up to the duct bank depending on geotechnical and hydrogeological conditions, duct bank connection locations, and the available staging area. Depending on the microtunnel alignment, an existing 10 cm (4 in) gas main may require relocation; the Proponent would work with the relevant utility to minimize or eliminate service interruptions to gas customers. All activities would occur outside the river and riverbanks.

Alternatively, HDD beneath the Centerville River would follow the same general process described for the Phase 1 landfall sites (see Section 3.3.1.8). Two approximately 200 m (660 ft) HDD bores would be drilled beneath the river (see Figure 3.3-5b). Once the bore holes are completed, four flexible polyvinyl chloride (FPVC) power conduits and up to four HDPE conduits for communication/grounding cables would be inserted into the bores. The HDD entry pit would be located on the southeast side of the Centerville River, at least 61 m (200 ft) from the riverbank, to minimize disruption to residents and vehicles traveling on Craigville Beach Road, and to achieve a sufficient depth of cover before crossing under the Centerville River. HDD operations would require closing approximately 120 m (400 ft) of Craigville Beach Road's westbound lane for the duration of HDD operations and would temporarily block a single driveway on Craigville Beach Road for approximately 12 hours, which would be coordinated with the landowner.

A direct pipe trenchless drilling method uses a drill head welded to a pipe casing, and as drilling progresses the pipe casing is extended. Once the drill path beneath the river is complete, the drill head is cut off and the pipe remains in place, becoming the casing for the cables. For the Centerville River crossing, the direct pipe option would commence at the Craigville Public Beach parking lot within the same general area as the landfall site (see Figure 3.3-5c). A minimum 1 m (42 in) diameter MTBM would be required to complete the approximately 427 m (1,400 ft) long drive from the parking lot to the northern side of the Centerville River. This would accommodate eight FPVC conduits and three conduits for communications/ground cables. The annular space may be grouted. This option would limit disruption to Craigville Beach Road by avoiding duct bank installation south of the Centerville River crossing. However, the staging area at the Craigville Public Beach parking lot could extend onto the beach itself and also occupy a significant portion of the parking lot. On areas of the beach used for staging, geotextiles and matting would be used to avoid beach compaction or penetration, and the beach would be restored to preexisting conditions following completion of the direct pipe.

New England Wind

AVANGRID RENEWABLES

Figure 3.3-5a

Centerville River Crossing Options (Microtunnel)

New England Wind

AVANGRID RENEWABLES

Figure 3.3-5b

Centerville River Crossing Options (HDD)

Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

New England Wind
AVANGRID RENEWABLES

Figure 3.3-5c

Centerville River Crossing Options (Direct Pipe)

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Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

New England Wind

AVANGRID RENEWABLES

Figure 3.3-5d

Centerville River Crossing Options (Utility Bridge)

Although not anticipated, the river crossing could also be accomplished by constructing a new, independent utility bridge immediately north of the existing Centerville River Bridge. The parallel utility bridge will be at least 0.9 m (3 ft) from the existing bridge. The utility bridge would be a one-unit precast pre-stressed concrete section that would require two new approximately 4 m by 8 m (13 ft by 25 ft) foundations consisting of cast-in-place concrete abutments on piles. The new foundations could also be constructed by extending the foundations of the existing adjacent bridge. The new abutment/foundation would require new piles to be driven within the existing riprap and some riprap would also need to be removed and replaced. Based on the current conceptual design, the new abutment/foundation would result in a small amount of temporary and permanent impacts to salt marsh (see Figure 3.3-5d and Section 6.1.2.1.1 of COP Volume III). The utility bridge would be visible from the adjacent sidewalk, and an anti-climb fence would need to be installed on the north side of the existing bridge to prevent pedestrians from climbing from one to the other. Routine bridge inspections every two years would require temporary power shutdown or full electromagnetic field shielding to allow inspection personal hands-on access to the adjacent existing bridge for a duration of six to eight hours. In addition, temporary lane closures would be required for crane operations while the utility bridge is being erected. Overhead electrical and communication lines on the north side of the existing bridge would require temporary relocation during construction.

3.3.1.10.3 Highway Crossing

As described in Section 3.2.2.4.1, the ROW #343 to ROW #381 Grid Interconnection Route will cross under Route 6 (the Mid-Cape Highway) within ROW #381 to Parcel #214-001. The duct bank would then enter the West Barnstable Substation from Parcel #214-001.

The trenchless crossing of Route 6 will be accomplished via pipe jacking. Pipe jacking uses hydraulic jacks to thrust a specially designed casing pipe through the ground, led by a guidance system, to excavate a tunnel from a jacking shaft to a receiving shaft. Pipe jacking methodologies include microtunnel, earth pressure balance machines, conventional non-pressurized tunnel-boring machines, and open shield machines. The open shield method is preferred for the Route 6 crossing because it allows for the removal of any large boulders (using pneumatic jack hammers) and is most appropriate for the expected low groundwater application and the relative depth of cover under Route 6.

To accomplish the Route 6 crossing for the ROW #343 to ROW #381 Grid Interconnection Route, a single approximately 240 m (464 ft) long drive would be used to install either a 1.5 m (60 in) or 1.8 m (72 in) diameter steel casing pipe under the highway between the jacking shaft constructed on Parcel #214-001 and the receiving shaft constructed south of Route 6 immediately south of Service Road. The steel casing pipe will contain eight FPVC power conduits and three HDPE conduits for communication and ground cables. The casing will be filled with thermal grout to dissipate heat. Some tree clearing may be required to accomplish the Route 6 crossing within ROW #381.

Should Variant 1 of the ROW #343 to ROW #381 Grid Interconnection Route be used, which would also require crossing Route 6 within ROW #381, the receiving shaft could be relocated immediately north of Service Road to optimize the duct bank routing. As described above in Section 3.2.2.4.1, Variants 2 and 3 would cross Route 6 within ROW #342, east of the crossing within ROW #381. It is likely that the same crossing methodology would be used for either highway crossing, although the crossing within ROW #342 would be more challenging due to topography and space constraints.

3.3.1.10.4 Construction Staging Areas

The contractor will identify laydown/construction staging areas necessary to complete construction. These construction staging areas will not be located within 30 m (100 ft) of any wetland resource areas, within 61 m (200 ft) of perennial waterways, or within the Zone I area of any public water supply wells.

3.3.1.11 Surveys, Equipment Inspections, and Environmental Monitoring

Offshore and nearshore geophysical surveys will be conducted just prior to construction, during construction, and post-construction for activities such as pre-lay surveys, verifying site conditions, ensuring proper installation of Phase 1 components, conducting as-built surveys, inspecting the depth of cable burial, and inspecting foundations. Unexploded ordnance (UXO) surveys may also be conducted prior to the installation of the offshore facilities. In instances where avoidance, physical UXO removal, or deflagration is not feasible due to layout restrictions or personnel safety, UXO may need to be detonated in situ. Geophysical instruments may include, but are not limited to, side scan sonar, single and multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers. A detailed list of geophysical survey equipment that may be used during Phase 1 is provided as Appendix I-H.

Surveys will be performed in accordance with the stipulations in Lease OCS-A 0534, National Marine Fisheries Service's (NMFS's) *Project Design Criteria (PDC) and Best Management Practices (BMPs) for Threatened and Endangered Species for Site Characterization and Site Assessment Activities to Support Offshore Wind Projects*, and/or any requirements imposed by NMFS where an Incidental Take Authorization is sought, as applicable. See the best management practices outlined in Table 4.2-2 of COP Volume III as well as Sections 6.7 and 6.8 of COP Volume III for a discussion of measures to protect marine mammals and sea turtles during survey work.

Offshore geotechnical work would only be conducted in areas already reviewed and cleared for cultural resources. Any unanticipated discoveries of cultural resources would be managed in accordance with the Section 106 Memorandum of Agreement.

To monitor weather and sea state conditions during Phase 1 construction, the Proponent expects to temporarily deploy one or more meteorological oceanographic ("metocean") buoys in up to 50 locations within the SWDA (only within areas that will have been surveyed). These buoy(s) will provide forecasting and current weather conditions to inform contractors if conditions (especially wave height) are suitable for installation activities (i.e. allow for safe and controlled lift of foundations and other components from vessels).

The floating metocean buoy(s) are expected to be anchored to the seafloor using a steel chain connected to a single concrete or steel mooring weight on the seafloor. The mooring weight will occupy an expected seafloor footprint of approximately 4 m^2 (43 ft^2) and is expected to vertically penetrate to a depth of approximately 2.5 m (8 ft). The total maximum temporary seafloor disturbance from metocean buoys during Phase 1 construction is 200 m^2 (2,153 ft^2).[52] The selected metocean buoy(s) will not use fuel oil to avoid the risk of accidental release and emissions into the environment. The buoy(s) will be equipped with the proper lighting, marking, and signaling equipment per USCG Private Aid to Navigation (PATON) requirements. The location of the buoy(s) will be monitored daily using a Global Positioning System (GPS) and Automatic Identification System (AIS) devices.

3.3.1.12 Vessels, Vehicles, and Aircraft

3.3.1.12.1 Offshore Construction

Deployment of the necessary vessels and construction equipment will be sequenced based on the construction schedule (see Sections 3.1.1.3 and 3.3.1.1).

Offshore construction will require an array of vessels, many of which are specifically designed for offshore wind construction and cable installation. In general, while performing construction work, vessels may anchor, moor to other vessels or structures, operate on DP, or jack-up. DP enables a vessel to maintain a very precise position by continuously adjusting the vessel's thrusters and propellers to counteract winds, currents, and waves. Jack-up vessels are self-propelled or non-self-propelled vessels with legs that extend to the ocean floor to elevate the hull to provide a safe, stable working platform.[53] In addition to vessels, helicopters may be used for crew transfer and fast response visual inspections and repair activities during both construction and operations.

For each major element of construction (scour protection, foundation installation, WTG installation, cable laying, etc.), the expected vessel types have been provided in Table 3.3-1. Table 3.3-1 is organized by major construction element and includes the basic data on anticipated vessel type and use. All specifications are subject to change. Vessel data is highly speculative at this stage of the development process. Vessel details are anticipated to be further refined in the Fabrication and Installation Report (FIR). Due to variable availability and limitations associated with the Jones Act, vessels may even be changed just prior to or during construction.

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[52] The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.

[53] Jacking-up may also occur in port.

For these reasons, it is challenging to precisely quantify the number of vessels and vessel trips from each port at the early planning stages of Phase 1. The estimates of vessel counts and vessel trips presented below, which are based on current understanding of a potential Phase 1 schedule, are likely conservative and subject to change.

During Phase 1 offshore construction, assuming the maximum design scenario, it is estimated that an average of ~30 vessels would operate at the SWDA or along the OECC at any given time.[54] Commencement of the WTG installation and commissioning phase typically represents the most intense period of vessel traffic in the Offshore Development Area, with foundations, inter-array cables, and WTGs being installed and commissioned in parallel. During the most active period of construction, it is conservatively estimated that a maximum of approximately 60 vessels could operate in the Offshore Development Area at one time. However, the number of vessels present at any given time during Phase 1 offshore construction is highly dependent on the final construction schedule, the number of WTGs and ESPs installed, the final design of the offshore facilities, the ports ultimately used, and the logistics solution used to achieve compliance with the Jones Act.

Specific to offshore export cable installation, an approximate average of seven vessels may be used for cable laying activities along the OECC in any given month, although as many as approximately 15 vessels may be used for cable laying activities in any one month. Since many of the cable installation activities are sequential, these vessels would not all operate along the OECC simultaneously.

For the maximum design scenario of Phase 1, approximately 3,200 total vessel round trips[55] are expected to occur for Phase 1 offshore construction, which equates to an approximate average of six vessel round trips per day under an 18-month offshore construction schedule. During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur. See Section 7.8 of COP Volume III and the Navigation Safety Risk Assessment in Appendix III-I for further discussion of vessel activity during construction.

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[54] It is possible that Phase 2 construction could begin immediately following Phase 1 construction. Under this scenario, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g. Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). The number of vessels present at the SWDA or along the OECC during Phase 1 construction accounts for the possibility of Phase 1 and Phase 2 vessels being present at the same time.

[55] For the purposes of estimating vessel trips, tugboats and barges are considered one vessel.

Table 3.3-1 Representative Vessels Used for Phase 1 Construction

			Approx. Size		Displacement		Approximate Vessel Speed					
Role	Vessel Type	#	Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed	Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device (MSD)	Crew Size
Foundation Installation												
Scour Protection Installation	Scour Protection Installation Vessel (e.g. Fall-pipe Vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	International Maritime Organization (IMO) compliant	20–60
Overseas Foundation Transport	Heavy Transport Vessel	2–5	24–56 m (79–184 ft)	120–223 m (394–732 ft)	12,000–25,000 t (13,228–27,558 US tons)	10,000–62,000 t (11,023–68,343 US tons)	12–18 kn	12–18 kn	Blade propeller system / blade thrusters	260,000–1,800,000 L (68,680–475,510 gal)	MSD: Type II and Type III, IMO compliant	15–25
Foundation Installation (Possibly Including Grouting	Jack-up Vessel or Heavy Lift Vessel	1–2	40–106 m (131–346 ft)	154–220 m (505–722 ft)	20,000–50,000 t (22,046–55,116 US ton)	10,000–80,000 t (11,023–88,185 US ton)	0–10 kn	6.5–14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	25–374
Tugboat to Support Main Foundation Installation Vessel(s)	Tugboat	1	6–10 m (20–33 ft)	16–35 m (52–115 ft)	75–500 t (83–551 US tons)	50–200 t (55–220 US tons)	10–14 kn	10–14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	not specified	5–10
Transport of Foundations to SWDA	Barge	2–5	~25 m (82 ft)	100 m (328 ft)	N/A	9,600 t (10,582 US tons)	N/A	N/A	N/A	N/A	N/A	N/A
Transport of Foundations to SWDA	Tugboat	3–4	~10 m (33 ft)	~35 m (115 ft)	200–500 t (220–551 US tons)	200–300 t (220–331 US tons)	8–10 kn	10–14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	5–10
Secondary Work and Possibly Grouting	Support Vessel or Tugboat	1	~10 m (33 ft)	30–80 m (98–262 ft)	500–900 t (551–992 US tons)	120 t (132 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	10–100
Crew Transfer	Crew Transfer Vessel	1–3	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 (2,110 gal)	IMO compliant	2–24
Noise Mitigation	Support Vessel or Anchor Handling Tug Supply vessel	1	~15 m (49 ft)	65–90 m (213–295 ft)	1,900–3,000 t (2,094–3,307 US tons)	2,200–3,000 t (2,425–3,307 US tons)	10 kn	13 kn	Blade propeller system / blade thrusters	~740,000 L (195,490 gal)	IMO compliant	5–14
Acoustic Monitoring	Support Vessel or Tugboat	1	~10 m (33 ft)	~30 m (98 ft)	50–500 t (55–551US tons)	20 t (22 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	Non-IMO	5–10
Marine Mammal Observers and Environmental Monitors	Crew Transfer Vessel	2–6	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
ESP Installation												
ESP Installation	Heavy Lift Vessel	1	40–106 m (131–346 ft)	154–220 m (505–722 ft)	N/A	10,000–48,000 t (11,023–52,911 US tons)	0–12 kn	6.5–14 kn	N/A	N/A	Non-IMO	20–374
Overseas ESP Transport	Heavy Transport Vessel	1–2	24–40 m (79–131 ft)	20–223 m (66–732 ft)	12,000–50,000 t (13,228–55,116 US tons)	10,000–62,000 t (11,023–68,343 US tons)	10–18 kn	13–18 kn	Blade propeller system / blade thrusters	260,000–1,800,000 L (68,680–475,510 gal)	MSD: Type II and Type III, IMO compliant	15–25
ESP Transport to SWDA (if required)	Tugboat	2–4	~10 m (33 ft)	~35 m (115 ft)	200–500 t (220–551 US tons)	200–300 t (220–331 US tons)	0–14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	5–10
Crew Transfer	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Service Boat	Crew Transfer Vessel or Support Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Refueling Operations to ESP	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Crew Accommodation Vessel During Commissioning	Jack-up	1	~40 m (131 ft)	~55 m (180 ft)	500 t (551 US tons)	N/A	0-6 kn	6 kn	Blade propeller system / blade thrusters	~280,000 L (73,970 gal)	Non-IMO	20–100
	Accommodation Vessel		10–12 m (33–39 ft)	70–100 m (230–328 ft)	800–9,000 t (882–9,921 US tons)	120–4,500 t (132–4,960 US tons)	10 kn	13.5 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	50–201

Table 3.3-1 Representative Vessels Used for Phase 1 Construction (Continued)

			Approx. Size		Displacement		Approximate Vessel Speed					
Role	Vessel Type	#	Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed	Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device	Crew Size
Offshore Export Cable Installation												
Pre-Lay Grapnel Run	Support Vessel	1	8–15 m (26–49 ft)	30–70 m (98–230 ft)	700–4,000 t (772–4,409 US tons)	2,200–2,500 t (2,425–2,756 US tons)	4–15 kn	15 kn	Blade propeller system / blade thrusters	~120,000 L (31,700 gal)	IMO compliant	2–25
Pre-Lay Survey	Survey vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 liters ("L") (2,110–13,800 gallons ["gal"])	IMO compliant	2–70
Cable Laying (and Potentially Burial)	Cable Laying Vessel	1–2	22–35 m (72–115 ft)	80–150 m (262–492 ft)	7,000–16,500 t (7,716–18,188 US tons)	1,200–1,5000 t (1,323–16,535 US tons)	5–8 kn	14 kn	Blade propeller system / blade thrusters	~1,200,000 L (317,010 gal)	IMO compliant	15–45
Boulder Clearance	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2500–8000 t (2756–8818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	5–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Support Main Vessel with Anchor Handling	Tugboat or Anchor Handling Tug Supply Vessel	1–3	6–15 m (20–49 ft)	16–65 m (52–213 ft)	75–1,900 t (83–2,094 US tons)	50–2,200 t (55–2,425 US tons)	5–14 kn	10–14 kn	Blade propeller system / blade thrusters	120,000–150,000 L (31,701–39,626 gal)	not specified	5–20
Trenching	Cable Laying Vessel or Support Vessel	1	~25 m (82 ft)	~128 m (420 ft)	N/A	~7,500 t (8,267 US tons)	10 kn	15 kn	Blade propeller system / blade thrusters	~2,000,000 L (528,344 gal)	IMO compliant	N/A
Crew Transfer	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Install Cable Protection	Cable Protection Installation Vessel (e.g. Fall-pipe vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	20–60
Dredging	Dredging Vessel	1	~30 m (98 ft)	~230 m (755 ft)	33,423 t (36,843 US tons)	59,798 t (65,916 US tons)	10–16 kn	16 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	30–60
Cable Landing	Tugboat or Jack-up Vessel	1	6–15 m (20–49 ft)	16–65 m (52–213 ft)	75–1,900 t (83–2,094 US tons)	50–2,200 t (55–2,425 US tons)	10–14 kn	10–14 kn	Blade propeller system / blade thrusters	120,000–150,000 L (31,701–39,626 gal)	not specified	5–20
Shallow Water Cable Burial	Cable Laying Vessel	1	13 m (43 ft)	34 m (112 ft)	499 t (550 US tons)	N/A	0–10 kn	10 kn	N/A	220,000 L (58,118 gal)	N/A	19
Safety Vessel	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Inter-Array Cable Installation												
Pre-Lay Grapnel Run	Support Vessel	1	8–15 m (26–49 ft)	30–70m (98–230 ft)	700–4,000 t (772–4,409 US tons)	2,200–2,500 t (2,425–2,756 US tons)	4–15 kn	15 kn	Blade propeller system / blade thrusters	~120,000 L (31,700 gal)	IMO compliant	2–25
Pre-Lay Survey	Survey Vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 L) (2,110–13,800 gal)	IMO compliant	2–70
Cable Laying (and Potentially Burial)	Cable Laying Vessel	1	22–35 m (72–115 ft)	80–150 m (262–492 ft)	7,000–16,500 t (7,716–18,188 US tons)	1,200–15,000 t (1,323–16,535 US tons)	5–8 kn	14 kn	Blade propeller system / blade thrusters	~1,200,000 L (317,010 gal)	IMO compliant	15–45
Cable Installation Support	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2,500–8,000 t (2,756–8,818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	5–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Crew Transfer	Crew Transfer Vessel	2	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24

Table 3.3-1 Representative Vessels Used for Phase 1 Construction (Continued)

Role	Vessel Type	#	Approx. Size		Displacement		Approximate Vessel Speed		Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device	Crew Size
			Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed				
Inter-Array Cable Installation (Continued)												
Cable Termination and Commissioning	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2,500–8,000 t (2,756–8,818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	10–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Trenching	Cable Laying Vessel or Support Vessel	1	21–25 m (69–82 ft)	95–128 m (311–420 ft)	N/A	4,700–7,500 t (5,180–8,267 US tons)	10–15 kn	15 kn	Blade propeller system / blade thrusters	1,2000,000–2,000,000 L (317,010–528,344 gal)	IMO compliant	N/A
Install Cable Protection	Cable Protection Installation Vessel (e.g. Fall-pipe vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	20–60
Safety Vessel	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
WTG Installation												
Overseas WTG Transport	Heavy Transport Vessel	1–5	15–20 m (49–66 ft)	130–150 m (427–492 ft)	6,300–8,600 t (6,945–9,480 US tons)	8,000–9,400 t (8,818–10,362 US tons)	14–18 kn	14–18 kn	Blade propeller system / blade thrusters	455,000–1,090,000 L (120,200–287,950 gal)	IMO compliant, MSD Type II	15–19
Overseas Transport of WTG Installation Vessel(s)	Heavy Transport Vessel	1	~56 m (184 ft)	~214 m (702 ft)	N/A	~64,900 t (71,540 US tons)	10–11.5 kn	11.5 kn	N/A	N/A	N/A	~40
WTG Transport to SWDA	Jack-up Vessels[56] or Tugboat	2–6	6–50 m (20–164 ft)	35–100 m (115–328 ft)	4,000 t (4,409 US tons)	2,000–8,000 t (2,205–8,818 US tons)	0–10 kn	13–14 kn	Blade propeller system / blade thrusters	215,000–280,000 L (56,800–73,970 gal)	IMO compliant	15–80
WTG Transport Assistance	Tugboat	1–6	6–12 m (20–40 ft)	15–38 m (49–125 ft)	75–500 t (83–551 US tons)	50–200 t (55–220 US tons)	0–10 kn	13–14 kn	Blade propeller system / blade thrusters	215,000–598,000 L (56,800–158,000 gal)	N/A	4–8
WTG Installation	Jack-up Vessel or Heavy Lift Vessel	1–2	35–55 m (115–180 ft)	85–165 m (279–541 ft)	15,000–25,000 t (16,535–27,558 US tons)	4,500–20,000 t (4,960–22,046 US tons)	0–10 kn	8–13 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	80–150
Crew Transfer	Crew Transfer Vessel	3	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
WTG Commissioning												
WTG Commissioning Vessel	Service Operation Vessel	1	~18 m (59 ft)	~80 m (262 ft)	N/A	~2,500 t (2,756 US tons)	10–12 kn	13 kn	Blade propeller system / blade thrusters	1,140,000 L (301,156 gal)	N/A	~27
Crew Transfer	Crew Transfer Vessel	1–4	6–12 m (20–39 ft)	15–30 m (49–98 ft)	10–50 t (11–55 US tons)	6–20 t (7–22 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	N/A	2–24
Miscellaneous Construction Activities												
Refueling	Crew Transfer Vessel or Support Vessel	1	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Safety Vessel	Crew Transfer Vessel	1	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Geophysical and Geotechnical Survey Operations	Survey Vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 liters ("L") (2,110–13,800 gallons ["gal"])	IMO compliant	2–70

Notes:

Vessel descriptions/dimensions are based on the specification sheets of vessels that are representative of the type of vessels that will be used during Phase 1 construction; not all specification sheets provided information for each category. All values provided are subject to change.

"t" = metric tons

56 Jacking-up in ports may occur.

3.3.1.12.2 Onshore Equipment

Onshore construction equipment will be similar to that used during typical public works projects (e.g. road resurfacing, storm sewer installation, transmission line installation).

With respect to construction of the onshore substation, a complement of conventional construction equipment and vehicles will be used. Any clearing and grading would be performed using conventional land clearing equipment. Construction of the onshore substation itself will begin with excavation/foundation placement, using standard equipment (e.g. hydraulic excavators, backhoes, form trucks, concrete delivery trucks and support vehicles). The remaining work includes delivering and setting the major components (transformers, breakers, etc.), erection of the bus system, and performing the necessary cabling/insulator installation. This element of the onshore substation work involves special over-the-road delivery trucks for the heavy/oversize components, normal delivery vehicles for other materials and parts, a large crane to set the transformers, rough terrain cranes, a variety of mobile lifts, and support vehicles.

Construction and installation of the onshore cable system involves one complement of equipment for construction of the duct bank (excavators, dump trucks, delivery trucks, front end loader, concrete delivery trucks, crew vehicles, etc.) and a second complement of vehicles to support the cable pulling and splicing (cable reel trucks, winch, crew vehicles, etc.). Construction equipment used for HDD and other trenchless crossings are described in Sections 3.3.1.8 and 3.3.1.10.

3.3.1.13 Summary of Phase 1 Area of Potential Seafloor Disturbance

Tables 3.3-2 and 3.3-3 summarize the maximum area of potential seafloor disturbance within the SWDA and OECC, respectively, during construction of Phase 1.

Table 3.3-2 Phase 1 Maximum Area of Potential Seafloor Disturbance During Construction at the SWDA

SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO STRUCTURES OR CABLE/SCOUR PROTECTION							
Foundations and Scour Protection	**Max Number of Foundations**		**Max Area of Scour Protection per Foundation[1] (m^2)**		**Total Area of Scour Protection**		
					m^2	**km^2**	**acres**
WTG Foundations and Scour Protection	62		4,624		286,688	0.29	71
ESP Foundations and Scour Protection	2		6,023		12,046	0.01	3
Cable Protection[2]	**Max Length of Cable (m)**	**Percentage Requiring Cable Protection**	**Length of Cable Protected (m)**	**Width of Cable Protection (m)**	**Total Area of Cable Protection**		
					m^2	**km^2**	**acres**
Inter-link Cable[3]	20,000	2%	400	9	3,600	0.00	1
Inter-array Cables	225,000	2%	4,500	9	40,500	0.04	10
Offshore Export Cables (within SWDA)	36,000	2%	720	9	6,480	0.01	2
					Total Scour + Cable Protection		
					m^2	**km^2**	**acres**
TOTAL BOTTOM DISTURBANCE DUE TO STRUCTURES OR CABLE/SCOUR PROTECTION IN THE SWDA					**349,314**	**0.35**	**86**
SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS							
Jack-up and/or Anchored Vessels	**Max Area Impacted by Each Jack-up or Anchored Vessel (m^2)**		**Max No. of Jack-ups/Anchor Sets**	**Max No. of WTGs/ESPs**	**Total Area of Vessel Disturbance**		
					m^2	**km^2**	**acres**
WTG Foundation Installation[4]	1,200		3 per WTG	62	223,200	0.22	55
WTG Installation[4]	1,200		4 per WTG	62	297,600	0.30	74
ESP Topside and Foundation Installation[4]	1,200		8 per ESP	2	19,200	0.02	5
Inter-link Cable Installation[5]	280		50	N/A	14,000	0.01	3
Offshore Export Cable Installation (within SWDA)[5]	280		90	N/A	25,200	0.03	6
Cable Installation	**Max Length of Cable[6] (m)**		**Trench Width (m)**	**Total Skid/Track Width (m)**	**Total Area of Cable Installation Disturbance**		
					m^2	**km^2**	**acres**
Inter-link Cable	20,000		1	3	80,000	0.08	20
Inter-array Cables	225,000		1	3	900,000	0.90	222
Offshore Export Cables (within SWDA)	36,000		1	3	144,000	0.14	36

Table 3.3-2 Phase 1 Maximum Area of Potential Seafloor Disturbance During Construction at the SWDA (Continued)

SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS (CONTINUED)					
Metocean Buoys	**Max Area Impacted by Each Buoy Anchor (m^2)**	**No. of Buoys**	**Total Area of Buoy Disturbance**		
			m^2	**km^2**	**acres**
Metocean Buoy Anchors	4	50	200	0.00	0
			Total Vessel + Cable Installation + Buoys		
			m^2	**km^2**	**acres**
BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS IN THE SWDA			**1,703,400**	**1.70**	**421**
TOTAL SEAFLOOR DISTURBANCE IN THE SWDA[7]			**2,030,234**	**2.03**	**502**

Notes:

1. The area of scour protection includes the physical footprint of the foundation.
2. The majority of the cable entry protection system and any cable protection placed over it would lie on top of the scour protection (if used) and is therefore largely included in the area of scour protection. The estimate of inter-array cable protection includes any length of the cable entry protection system beyond the scour protection.
3. The inter-link cable may not be used.
4. Vessels may be jack-up, anchored, or DP vessels. It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance is calculated assuming all vessels jack-up.
5. Conservatively assumes a nine-anchor spread where each anchor impacts 30 m^2 (323 ft^2) and two spud legs that impact 10 m^2 (108 ft^2). The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.
6. Maximum total Phase 1 cable lengths.
7. To avoid double-counting impacts, the total seafloor disturbance in the SWDA does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width for the length of cable covered by cable protection.

Table 3.3-3 Phase 1 Maximum Area of Potential Seafloor Disturbance During Construction along the OECC

OFFSHORE EXPORT CABLE CORRIDOR – BOTTOM DISTURBANCE DUE TO CABLE PROTECTION							
Cable Protection	**Maximum Length of Cable (m)**	**Percentage Requiring Cable Protection[1]**	**Length of Cable to be Protected (m)**	**Width of Cable Protection[2] (m)**	**Total Area of Cable Protection**		
					m^2	**km^2**	**acres**
Offshore Export Cables (Outside SWDA)	166,000	~6%	10,060	9	90,540	0.09	22
TOTAL BOTTOM DISTURBANCE DUE TO CABLE PROTECTION IN THE OECC					**90,540**	**0.09**	**22**
OFFSHORE EXPORT CABLE CORRIDOR – BOTTOM DISTURABCE DUE TO VESSELS, CABLE INSTALLATION, AND DREDGING							
Jack-up Vessels	**Area Impacted by Each Jack-up (m^2)**		**No. of Jack-ups per Splice**	**Max No. of Splices**	**Total Area of Jack-up Disturbance**		
					m^2	**km^2**	**acres**
Jack-up Vessels for Cable Splicing	600		1	6 (3 per cable)	3,600	0.00	1
Anchoring and Grounding of Cable-Laying Vessels	**Area Impacted by Each Anchor Set/Vessel Grounding (m^2)**		**Distance Between Repositioning (m)**	**No. of Anchor Sets/Groundings**	**Total Area of Anchoring Disturbance**		
					m^2	**km^2**	**acres**
Anchoring for Offshore Export Cable Installation (Outside SWDA)[3]	280		400	415	116,200	0.12	29
Vessel Grounding for Offshore Export Cable Installation (Outside SWDA)[4]	9,750		1 per cable	2	19,500	0.02	5
Cable Installation and Preparatory Work[5]	**Max Length of Cable[6] (m)**		**Trench Width (m)**	**Total Skid/Track Width (m)**	**Total Area of Cable Installation Disturbance**		
					m^2	**km^2**	**acres**
Offshore Export Cable Installation (Outside SWDA)	166,000		1	3	664,000	0.66	164
Dredging					**Total Area of Dredging Disturbance[7]**		
					m^2	**km^2**	**acres**
Dredging Prior to Cable Installation					211,064	0.21	52
					Total Vessels + Cable Installation + Dredging		
					m^2	**km^2**	**acres**
BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND DREDGING IN THE OECC					**1,014,364**	**1.01**	**251**
TOTAL SEAFLOOR DISTURBANCE IN THE OECC[8]					**1,064,664**	**1.06**	**263**

Table 3.3-3 Phase 1 Maximum Area of Potential Seafloor Disturbance During Construction along the OECC (Continued)

Notes:

1. The percent of the offshore export cable requiring cable protection is based on the OECC route length (i.e. ~78 km per cable) rather than the length of cable with micro-siting (i.e. ~83 km).
2. The cable protection used in limited areas to cover offshore export cable joints or cable crossings may be wider, but the total cable protection area will remain the same.
3. Conservatively assumes a nine-anchor spread where each anchor impacts 30 m^2 (323 ft^2) and two spud legs that impact 10 m^2 (108 ft^2). The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.
4. Based on the footprint of a 150 x 50 m (492 x 164 ft) vessel, with extra contingency to account for multiple groundings at the same location.
5. Some pre-pass jetting may occur along limited sections of the offshore export cable alignment; however, impacts will occur within the same geographical space as cable installation.
6. Maximum total Phase 1 cable lengths.
7. To avoid double-counting impacts, the total area of dredging disturbance does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width counted above. The total dredging area including the cable installation trench is approximately 0.27 km^2 (67 acres).
8. To avoid double-counting impacts, the total seafloor disturbance in the OECC does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width for the length of cable covered by cable protection.

3.3.2 Operations & Maintenance Activities

3.3.2.1 Purpose and Objectives

The Proponent's primary O&M objective is to operate safe and efficient offshore wind energy facilities. This objective will be achieved through detailed planning, the use of well-thought-out procedures, reliance on experienced and well-trained personnel and contractors, a strong focus on preventive maintenance, data analysis to predict/prevent corrective maintenance, and continuous review and improvement. The O&M philosophy for New England Wind Phase 1 is based on the following principles:

- **Health, Safety and Environment (HSE) First Principles:** Putting the health and safety of people and the environment at the forefront of all O&M activities.

- **Compliance with Consents, Laws, and Regulations:** Ensuring that personnel and contractors comply with all statutory and industry regulations.

- **Continuous Improvement:** Regularly reviewing procedures and performance, identifying lessons learned, and implementing improvements.

- **Maximize Plant Reliability and Availability:** Ensuring the diligent design and selection of robust, reliable components and implementing a maintenance regime in which preventive (i.e. scheduled) maintenance reduces or eliminates the requirements for corrective (i.e. unscheduled) maintenance. In this regard, the aim is to deliver reliable offshore wind energy facilities with high production.

- **Knowledge Transfer:** Ensuring that, wherever possible, the Proponent learns from other offshore projects, wider business experience, experienced partners and contractors, and the wider industry to develop new skills in order to achieve O&M objectives.

3.3.2.2 Daily WTG Monitoring and Control

The Phase 1 WTGs will be designed to operate without attendance by any operators. Continuous monitoring will be conducted using a supervisory control and data acquisition (SCADA) system from a remote location. Parameters that could be monitored include temperature limits, vibration limits, current limits, voltage, etc. The WTGs also include self-protection systems that will be activated if a WTG operates outside its specifications or the SCADA system fails. These self-protection systems may curtail or halt WTG production or disconnect WTGs from the grid.

The Proponent and/or the selected WTG original equipment manufacturer (OEM) will be responsible for the 24/7 operation and monitoring of the WTGs. This is expected to be achieved by utilizing both the Proponent's O&M facilities and a 24/7 control center owned and operated by Avangrid Renewables.

3.3.2.3 Preventive Maintenance & Proactive Surveys

The Proponent will ensure that the Phase 1 preventive maintenance strategy aligns with best industry practice. This preventive maintenance strategy will be regularly reviewed to ensure maintenance objectives are met and continuously improved. Ultimately, preventive maintenance aims to reduce or eliminate the need for corrective maintenance and contribute to the objective of maintaining good reliability and high availability. Analysis of SCADA data and, in particular, condition monitoring systems are essential to identify potential equipment failures in advance.

In addition to the physical preventive maintenance, proactive inspections will be undertaken on a routine basis to ensure that the offshore facilities remain in a safe condition so that maintenance activities can be carried out. Geophysical survey work will likely be conducted to ensure adequate understanding of seabed conditions, particularly in areas of seabed change, and monitor components such as cables and scour protection. Geophysical instruments may include, but are not limited to, side scan sonar, single and multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers (see Appendix I-H for a detailed list of potential survey equipment).

Scheduled inspections, surveys, and maintenance activities will generally include the following tasks:

WTGs

- Annual inspections of components/equipment and proactive repair/replacement of components due to wear and tear (e.g. brake system, pitch system, bolt tightening, blades).
- Statutory inspections of high-voltage equipment, lifting equipment, safety equipment, hook-on points, etc., which are expected to occur annually.

Foundations

- Annual visual inspections of external platforms, including ladders and boat landing structures, and internal structures (e.g. corrosion measurement, etc.).
- Statutory inspections of lifting equipment, safety equipment, hook-on points, etc., which are expected to occur annually.

- Underwater inspections of foundations and scour protection.[57] The inspections may be conducted by ROV or other techniques (e.g. divers).

- Removal of marine growth and guano.

ESP(s)

- Inspection and service of high-voltage equipment (e.g. transformers, switchgears, earthing systems) and auxiliary systems (e.g. fire protection system, communication system, heating and ventilation system).

- Statutory inspections of lifting equipment, safety equipment, hook-on points, etc.

Inter-Array Cables, Inter-Link Cable, Offshore Export Cables, and Landfall Site

- High resolution geophysical surveys and monitoring cable exposure and/or depth of burial. It is expected that the cables will be surveyed within six months of commissioning, at years one and two, and every three years thereafter. This monitoring schedule may be adjusted over time based on results of the ongoing surveys. As described in Section 3.2.1.5.1, the cable design may include a Distributed Temperature System (DTS) to monitor the temperature of the cable at all times; significant changes in temperature recorded by the DTS may also be used to indirectly indicate cable exposure.

Onshore Substation

- Inspection and service of high-voltage equipment (e.g. main transformer, switchgears, earthing systems) and auxiliary systems (e.g. fire protection system, communication system, heating and ventilation system).

3.3.2.3.1 Development of Detailed Preventive Maintenance Plans

The Proponent will develop O&M plans and processes specific to Phase 1 of New England Wind. The starting point for all maintenance plans and processes will be the recommendations and instructions set out in the OEM manuals and maintenance schedules. The Proponent will also draw from Avangrid Renewables and its affiliates' experience gained working on similar projects operating globally.

Indicatively, the O&M plans and processes will cover at least the following topics:

- General Operations

[57] The Proponent expects to conduct underwater inspections for 20% of foundations each year during the first five years of operation (i.e. all foundations are expected to be inspected once during the first five years). After the first five years of operations, the frequency of surveys may be adjusted over time based on results of the ongoing surveys.

- Preventive and Corrective Maintenance
- Emergency Response Plan
- Local Operations
- Back up Control Room
- Planning and Monitoring of Works
- Warehouse Management
- Design Modifications
- Marine Coordination
- Warranty and Insurance management and claims
- Maintenance of control room systems
- Permit to work

Maintenance schedules that set forth the frequency of specific maintenance activities will be developed for each primary component (WTG, ESP, onshore substation, etc.) along with a scheduled maintenance checklist and/or method statements for each scheduled task. These checklists and method statements may be developed by the Proponent and/or its contractors.

The final strategy for execution of maintenance work will largely depend on the contracting strategy implemented for maintenance work at the various stages of the offshore facilities' life cycle. However, the following principles will be central to the execution of the maintenance:

- Ensuring that experienced operations personnel and/or contractors participate in all steps of the maintenance.
- Ensuring the spare parts and consumables strategy is sufficiently robust and managed such that spares' availability is high, allowing for quick repair times in the event of a failure.
- Ensuring that robust maintenance plans/procedures are in place and are continually reviewed and updated.
- Ensuring that the organization is structured to efficiently execute the maintenance strategy and to allow for knowledge transfer and continuous improvement.
- Planning and executing maintenance proactively to reduce or eliminate the need for corrective interventions.

3.3.2.4 Corrective Intervention/Repairs

Although preventive maintenance will reduce the need for corrective maintenance, some unscheduled, corrective maintenance will be required. The worst-case scenario, with respect to corrective intervention, is a major component failure (e.g. failure of gearbox, blades, transformers, or export cables). In this event, a potentially significant period of downtime could be experienced for a portion of Phase 1. Other potential repair activities include replacement of small components, minor structural repairs, and electrical repairs.

When corrective maintenance is required, the goals will be to:

- Minimize lost production of Phase 1;
- Minimize cost incurred during intervention and revenue loss; and
- Determine the cause in order to limit potential repetition of the failure event.

If a repair is needed, there could be seafloor disturbance from the vessels and equipment used to perform the repair as well as the repair activities themselves. For example, if an offshore export cable repair is required, there could be seafloor disturbance associated with uncovering and extracting the cable from the seabed, the vessels used to splice and rejoin the cable segments, and the cable installation tool(s) used to rebury the repaired cable. The types of activities and vessels/equipment used for corrective maintenance are similar to those during construction (see Section 3.3.1), but the impacts from repair activities would be much smaller in extent and duration.

By its nature, corrective maintenance is difficult to accurately predict. As such, being adequately prepared for corrective maintenance is essential. The Proponent will work to maintain in-house knowledge of component failure rates, maintenance requirements for such failures, repair periods, and spare part requirements. As further described below, key preparations in order to efficiently implement corrective maintenance center on: (1) spare part availability, (2) workforce availability, and (3) site accessibility (i.e. weather conditions).

Spare Part Availability

It is envisioned that a stock of recommended spare parts will be purchased along with the major components (e.g. WTGs, ESPs, cables, etc.). While this stock would be based on OEM recommendations, it is likely that the Proponent may request additional items based on its own experience. Smaller spare parts and consumables will mostly be stored at the O&M facilities, while larger spare parts are likely to be stored at either the OEM facilities or other storage facilities, as required. Alternatively or additionally, the Proponent may have in place a concept where contractors/suppliers make spare parts available within a short time frame. The Proponent, together with its contractors and service providers, will constantly monitor the use of spare parts to maintain recommended stock levels and, where applicable, increase stock levels and or purchase additional parts, as necessary.

Workforce Availability

An ample workforce is expected to be available given the significant marine industries and strong engineering and technology component present in the New England region. The rest of the US also has well-established renewable energy and offshore oil and gas sectors with workforces that can readily transition to the offshore wind industry. While some offshore work may initially need to be supported from the European or global supply chain, the local workforce and supply chain are expected to develop quickly. For additional discussion of workforce implications, see Section 7.1. of COP Volume III.

Site Accessibility (i.e. Weather Conditions)

Remote repairs are expected to be the most common form of corrective repair. However, some corrective events will require physical intervention offshore. The Proponent will utilize the extensive metocean information described in Volume II to ensure safe and effective offshore maintenance work. The Proponent will engage a contractor to provide regular weather forecasts and the ESP(s) may include a small weather station to provide operations personnel an indication of real-time conditions offshore (see Section 3.3.2.5.1).

3.3.2.5 O&M Systems and Tools

3.3.2.5.1 Weather and Sea Monitoring Systems

The Proponent will engage appropriate professionals to provide regular weather forecasts. These forecasts will cover key parameters, including meteorological parameters, such as wind, temperature, visibility, and warnings (e.g. lightning), and oceanographic parameters, such as wave conditions. In addition, it is likely that a small weather station, with wind and temperature sensors, will be installed on the ESP(s) to provide operations personnel an indication of real-time conditions offshore to support the planning and execution of work.

3.3.2.5.2 Communication Systems

A communications system designed to provide coverage within the WTGs and ESP(s) will be implemented for Phase 1 to facilitate voice communications within the SWDA. In addition to this dedicated system, normal marine and aviation communications channels will be used for the respective logistics options (e.g. marine very high frequency [VHF] radio for ships). Standard emergency channels will also be available.

Emergency protocols will be in place for both construction and O&M and will be developed as part of the HSE Management System. These protocols will include steps for external stakeholders, such as the USCG and fishermen, to alert the Proponent of concerns related to Phase 1 at any time. A draft of the HSE Management System, which is discussed further in Section 3.3.4.1, is provided in Appendix I-B.

3.3.2.5.3 Equipment

While it is difficult to predict the precise equipment that would be used to perform O&M activities, the following table identifies representative equipment that could be used for the O&M activities listed below.

Table 3.3-4 O&M Activities and Equipment Types

Potential Activity Type	Potential Equipment
Marine inspections and surveys: • Offshore and nearshore multi-beam echosounder inspections • Offshore and nearshore side scan sonar inspections • Offshore and nearshore magnetometer inspections • Offshore and nearshore depth of burial inspections • Other geophysical surveys • Geotechnical surveys • Environmental surveys	ROV or remotely operated towed vehicle (ROTV) deployed from a survey vessel. For geotechnical surveys, sampling instrumentation deployed from a survey vessel with a geotechnical spread. For a detailed list of potential geophysical survey equipment, see Appendix I-H. Cable toner survey. Aircraft or drones (autonomous underwater/ surface vessels or aerial)
Cathodic protection inspection and repair	ROV deployed from a survey vessel or divers
Hot work (welding) and ancillary equipment (including subsea)	Crew deployed to the WTG or divers deployed from diving vessel for subsea arc welding
Removal of marine growth and guano	Using a brush to break down the marine growth (where required) followed by high-pressure jet wash (sea water only). Technicians or deck hands will be deployed from crew transfer vessels (CTVs) or similar vessels.
External surface preparation and external protective coating repair	Technicians and equipment deployed from CTVs or similar vessels. Surface preparation to break down existing surface coating and any associated rust via blaster.
Grouted connections (if any) • Intrusive core samples • Re-grouting	Intrusive core samples: ROV deployed from a survey vessel or divers Re-grouting: Injected via one of several redundant grouting injection tubes from the TP
Component replacement or repair (e.g. WTG blade replacement, cable repair, electrical repair, etc.)	Varies according to component in question, and could include CTVs, a diving spread, construction vessels (e.g. jack-up vessel, cable laying vessel), and/or various construction equipment (e.g. cranes, cable installation tools, ROV).

3.3.2.6 O&M Logistics – Vessels, Vehicles, and Aircraft

The Proponent expects to use a service operation vessel (SOV) to execute daily O&M activities for Phase 1. Typically, an SOV is equipped with a DP system and includes sleeping quarters, shop facilities, a large open deck, appropriate lifting and winch capacity, and possibly a helipad (see Figure 3.3-6 for photos of a representative SOV).[58] The SOV, which will provide accommodations and workspace for O&M workers, will remain offshore for several days/weeks at a time. Workers will then access the WTGs and ESP(s) to perform routine inspections and/or maintenance via a gangway directly from the SOV, a crew transfer vessel (CTV), and/or a smaller daughter craft that resides on the SOV. Daughter craft and/or CTVs would likely be used to transfer crew to and from shore.

Although less likely, if an SOV or similar accommodation vessel is not used, several CTVs and helicopters would be used to frequently transport crew to and from the Offshore Development Area for inspections, routine maintenance, and minor repairs. CTVs are purpose-built to support offshore wind energy projects and are designed to safely and quickly transport personnel, parts, and equipment (see Figure 3.3-7 for a photo of a representative CTV). Helicopters can be used when rough weather limits or precludes the use of CTVs and for fast response visual inspections and repair activities. The helicopters used to support O&M activities would ideally be based at a general aviation airport in reasonable proximity to the O&M facilities.

In addition to the SOV, CTVs, and/or daughter craft, other larger support vessels (e.g. jack-up vessels) may be used infrequently to perform some routine maintenance activities, periodic corrective maintenance, and significant repairs (if needed). These vessels are similar to the vessels used during construction (see Table 3.3-1). Surveys and inspections performed during O&M may be performed using vessels, aircraft, ROVs, remotely operated towed vehicles (ROTVs), or drones (autonomous underwater/surface vessels or aerial).

During the busiest year of Phase 1 O&M, an average of approximately five vessels are anticipated to operate in the Offshore Development Area at any given time; additional vessels may be required during certain maintenance or repair scenarios. Based on the maximum design scenario for Phase 1, approximately 290 vessel round trips are estimated to take place annually during Phase 1 operations. However, the estimates of vessel counts and vessel trips during Phase 1 O&M depends on the timing and frequency of activities, the number of WTGs and ESPs installed, the final design of the offshore facilities, and the logistics solution used during O&M. As noted above, helicopters may be used to supplement crew transport during O&M.

[58] SOV, as the term is used in the COP, includes similar vessel types that can provide offshore accommodations such as floatels and service accommodation vessels (SATVs).

Figure 3.3-6
Service Operation Vessel (SOV) Examples

New England Wind
AVANGRID
RENEWABLES

Figure 3.3-7

Crew Transfer Vessel (CTV) Examples

3.3.3 Decommissioning & Site Clearance Procedures

3.3.3.1 Decommissioning Plan Requirements

BOEM's decommissioning requirements are stated in Section 13, "Removal of Property and Restoration of the Leased Area on Termination of Lease," of Lease OCS-A 0534.

Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, the Proponent is required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved Site Assessment Plan (SAP), COP or approved Decommissioning Application and applicable regulations in 30 CFR Part 585. All offshore facilities would need to be removed 4.5 m (15 ft) below the mudline (see 30 CFR § 585.910(a)).

Prior to decommissioning Phase 1 of New England Wind, the Proponent will consult with BOEM and submit a decommissioning plan for review and approval. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies as well as other stakeholders.

3.3.3.2 Decommissioning Time Horizon

The WTGs, ESPs, foundations, supporting cabling, and onshore infrastructure will be robustly designed and carefully maintained. As is typical of utility-grade generation and transmission infrastructure, the Phase 1 offshore facilities are expected to have a physical life expectancy of 30 years or more. Decommissioning will occur at the end of the Phase 1 operating term.

3.3.3.3 General Decommissioning Concept

Upon receipt of the necessary BOEM approval and any other required permits, the Proponent would implement the decommissioning plan to remove and recycle equipment and associated materials. As currently envisioned, the decommissioning process for Phase 1 is essentially the reverse of the installation process. Decommissioning of the offshore facilities is broken down into several steps:

- Retirement in place (if authorized by BOEM) or removal of the offshore cable system (i.e. inter-array, inter-link, and offshore export cables) and any associated cable protection.
- Dismantling and removal of WTGs.
- Cutting and removal of foundations and removal of scour protection.
- Removal of ESP(s) (topsides and foundations).

The extent of the decommissioning of onshore components, such as the onshore export cables, is subject to discussions with the Town of Barnstable on the decommissioning approach that best meets the Town's needs and has the fewest environmental impacts. The onshore cables, the concrete encased duct bank itself, the transition vaults, and elements of the onshore substations and grid connections could be retired in place or retained for future use.

The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

3.3.3.4 Decommissioning Plan and Procedures

The following discussion outlines decommissioning procedures and methods that would be most appropriate given today's technology. However, it is reasonable to expect that by the time Phase 1 is decommissioned, decommissioning experience in the global offshore wind industry and, more generally, technological advances in methods and equipment servicing the offshore industry, may result in increased efficiency as well as a reduced level of environmental impacts.

The offshore cables could be retired in place or removed, subject to authorization by BOEM and discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts. If removal is required, the first step of the decommissioning process would involve disconnecting the inter-array cables from the WTGs. Next, the inter-array cables would be pulled out of the J-tubes (or similar connection) and extracted from their embedded position in the seabed. In some places, in order to remove the cables, it may be necessary to fluidize the sandy sediments covering the cables. Then, the cables will be reeled up onto vessels. Lastly, the cable reels will be transported to port for further handling and recycling. The same general process will likely be followed for the inter-link and offshore export cables. If cable protection were used to cover portions of the offshore cables, it would be removed prior to recovering the cable.

Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids, according to the established operations and maintenance procedures and the Oil Spill Response Plan (OSRP) (see Section 3.3.4.3). Removed fluids would be brought to a port for proper disposal and/or recycling. Any SF_6 in gas insulated switchgear would be carefully removed for reuse. Next, the WTGs would be deconstructed (down to the foundation) in a manner closely resembling the installation process. The blades, rotor, nacelle, and tower would be sequentially disassembled and transported to port for processing using vessels and cranes similar to those used during construction.

After removing the WTGs, the steel foundation components would be decommissioned. Sediments inside monopiles and/or jacket piles could be suctioned out and temporarily stored on a vessel to allow access for cutting. In accordance with the BOEM's removal standards (30 CFR § 585.910(a)), the steel foundations would likely be cut below the mudline using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or a high-pressure water jet. The portion of the foundation that remains below the cut will likely remain in place.

Depending upon the available crane's capacity, the foundation/TP assembly above the cut may be further cut into several more manageable sections to facilitate handling. The cut piece(s) would then be lifted out of the water and placed on a vessel for transport to an appropriate port for recycling. The sediments previously removed from the inner space of the pile would be returned to the depression left once the pile is removed. To minimize sediment disturbance and turbidity, a vacuum pump and diver or ROV-assisted hoses would likely be used.

As described in Section 3.2.1.4, each WTG and ESP foundation may be surrounded by scour protection, which the Proponent would remove during decommissioning. Rock scour protection would likely be excavated with a dredging vessel, set on a vessel, and transported to shore for reuse or disposal at an onshore location.

The ESP(s) are expected to be disassembled in a similar manner as the WTGs, using similar vessels. Prior to dismantling, the ESP(s) would be properly drained of all oils, lubricating fluids, and transformer oil according to the established O&M procedures and OSRP. Removed fluids would be brought to port for proper disposal and/or recycling. Similarly, any SF_6 in gas insulated switchgear would be carefully removed for reuse. Before removing the ESP(s), the offshore export cables and inter-link cables would be disconnected, as discussed for the inter-array cables above.

The ESP topside(s) would then be removed from the supporting monopile or jacket foundation and placed on a vessel for transport to port. Depending on the crane capacity available and design of the topside, some of the major electrical gear may be removed first. The ESP foundation(s) will likely be removed according to the same procedures used for the removal of the WTG foundations described above.

As noted above, the extent of the decommissioning of onshore components, such as the onshore export cables, will be determined in consultation with the Town of Barnstable, as many of the onshore components could be retired in place or retained for future use. If onshore cable removal is determined to be the preferred approach, the process will consist of pulling the cables out of the duct bank, loading them onto truck-mounted reels, and transporting them offsite for recycling or possible reuse. The splice vaults, conduits, and duct bank will likely be left in place, available for reuse. This approach will avoid disruption to the streets.

During decommissioning activities, a careful inventory of all components to be removed would be made. This inventory would include the WTGs, ESP(s), foundations, offshore export cables, inter-array cables, inter-link cables, cable protection, scour protection, and so forth. As they are removed from the site, the components would be counted and noted as removed in the inventory. This careful reporting system will ensure that all of the Phase 1 components are removed. The Proponent expects to conduct seabed surveys where the Phase 1 offshore facilities were located to verify site clearance per 30 CFR § 585.910(b).

Decommissioning of the offshore facilities would require the involvement of an onshore recycling facility with ability to handle the large quantities of steel and other materials. Such facilities currently in operate in New England. One example is the Prolerized New England, Inc. facility on

Boston Harbor in Everett, Massachusetts. This facility is located in a heavy industrial area and has deep water access, allowing for the foundations, WTGs, and other large components to be directly offloaded from the vessels, cut into manageable sections, shredded into smaller pieces, and then shipped to end-users as scrap metal. This facility also routinely handles large volumes of scrap metal from auto recycling and a variety of demolition projects. Currently, the fiberglass in the rotor blades has no commercial scrap value. Consequently, it is anticipated that the fiberglass from the blades would be cut into manageable pieces and then disposed of at an approved onshore solid waste facility.

It is anticipated that the equipment and vessels used during decommissioning will be similar to those used during construction and installation. For offshore work, vessels would likely include heavy lift vessels, jack-up vessels, larger support vessels, tugboats, CTVs, and possibly vessels specifically built for installing WTGs. For onshore work, construction equipment would likely include truck-mounted winches, cable reels, and cable reel transport trucks.

3.3.3.5 Financial Assurance for Decommissioning

The Proponent will provide financial assurance for Phase 1 in accordance with the terms and conditions required by regulation or with approval from BOEM. To the extent feasible, the Proponent would like to develop a mechanism by which one financial assurance package covers decommissioning of all Phase 1 facilities regardless of whether the facilities are located within federal or state jurisdiction.

3.3.4 Health, Safety & Environmental Protection

The Proponent is firmly committed to safety and full compliance with applicable HSE protection regulations and codes. This commitment extends throughout the pre-construction, construction and installation, O&M, and decommissioning of Phase 1 of New England Wind.

3.3.4.1 Health, Safety, and Environmental Management System

During construction and O&M, New England Wind's Health, Safety, and Environmental Management System will be utilized (see the draft HSE Management System provided in Appendix I-B). The HSE Management System is a living document that contains HSE policies and procedures as well as the minimum requirements for working onsite for all New England Wind projects. The HSE Management System addresses the following requirements for a safety management system listed in 30 CFR § 585.810:

- Procedures to ensure the safety of personnel or anyone on or near the New England Wind facilities;
- Remote monitoring, control, and shut down capabilities;
- Emergency response procedures;

- Fire suppression equipment;
- Procedures for testing the safety management system; and
- Policies to ensure personnel who operate the New England Wind facilities are properly trained.

3.3.4.2 Marine Coordination

A marine coordination center will be established to control vessel movements throughout the Offshore Development Area. Expected daily vessel movements, CTV manifests, and no-go zones onsite will be handled by the Marine Coordinator. The Proponent will also hold daily coordination meetings to coordinate between contractors and avoid unnecessary simultaneous operations at the port facilities and routes to the Offshore Development Area.

The Marine Coordinator will manage all Phase 1 construction vessel logistics and implement communication protocols with external vessels at the harbor and offshore. The Marine Coordinator will use tools such as radio communications and safety vessels to address vessels entering construction zones. The Marine Coordinator will also work in advance of, and during construction, to coordinate activities with non-Phase 1 related vessels within and near the harbor(s). During construction, the Marine Coordinator will be the primary point of contact for day to day operations with the USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (including ferry, tourist, and fishing boat operators). As such, the Marine Coordinator will be responsible for coordination with USCG regarding any required Notice to Mariners. The responsibilities of the Marine Coordinator are discussed further in the draft HSE Management System (see Appendix I-B).

For all New England Wind projects, the Marine Operations Liaison Officer will serve as the strategic maritime liaison between the Proponent's internal parties and all external maritime partners and stakeholders, including USCG, US Navy, port authorities, state and local law enforcement, marine patrol, and commercial operators (e.g. ferry, tourist, fishing boat operators, and other offshore wind leaseholders). The Marine Operations Liaison Officer ensures compliance with permit requirements and applicable laws relating to the Proponent's vessel activities. The Marine Operations Liaison Officer is also expected to be responsible for coordinating and issuing Offshore Wind Mariner Update Bulletins to notify maritime stakeholders of the Proponent's offshore activities.

In addition, the Proponent has developed a Fisheries Communication Plan (included as Appendix III-E). The purpose of the Fisheries Communication Plan is to define outreach and engagement to potentially affected fishing interests during design, development, construction, operation, and final decommissioning of the Proponent's offshore wind projects. Fisheries communication is conducted through several roles including Fisheries Representatives (FRs) and Fisheries Liaisons (FLs). FLs are employed by the Proponent and are responsible for the implementation of the Fisheries Communication Plan whereas FRs represent the interests of different fisheries and fishing communities to the Proponent. The Proponent will communicate with the fishing industry following the protocols outlined in the Fisheries Communication Plan to help avoid interactions with fishing vessels and fishing gear. Additional information is provided in Section 7.6.3 of COP Volume III and Appendix III-E.

3.3.4.3 Oil Spill Response Plan and Emergency Response Plan

Before construction and installation activities begin, an Oil Spill Response Plan (OSRP) and an Emergency Response Plan (ERP) will be developed and issued to vessels and contractors working on Phase 1. A draft OSRP, which will be used for both Phases of New England Wind, is provided as Appendix I-F. The OSRP and ERP will provide a method/process for communication, coordination, containment, removal, and mitigation of unforeseen incidents that may occur during construction and O&M activities in the Offshore Development Area.

In the event of an actual spill or incident, vessels' and contractors' plans will be used to contain and/or stop an incident in compliance with the requirements of the New England Wind OSRP and ERP. As such, all plans will be reviewed by the Proponent to ensure they comply with regulatory and company-specific requirements. Routine training and exercises regarding the content of the New England Wind OSRP and ERP will also be carried out on a regular basis so that personnel are prepared to respond to emergencies, should they occur.

Annex 11 of the draft OSRP provides an oil spill modeling study to assess the trajectory and weathering of oil following a catastrophic release of all oil contents from the topple of an ESP (the largest oil-containing equipment). The oil spill modeling study identifies the worst-case discharge scenario, the longest period of time that the oil discharged would reasonably be expected to persist on the water's surface, and minimum travel times for the spill to reach shore.

3.3.4.4 Chemical Use, Waste Generation, and Disposal

Construction, commissioning, and operation of Phase 1 will generate some quantity of solid wastes and some small quantity of liquid wastes. Wastes and chemical products from construction and O&M can be broadly grouped into the following five primary categories:

- **Conventional Wastes from Equipment Installation and Maintenance:** During construction and installation, solid waste will primarily consist of short lengths of cable trimmings as well as material and equipment packaging or protective wrappings (paper, cardboard, plastics). Conventional wastes from equipment installation and maintenance (e.g. parts wrappings and packaging, small amounts of leftover paints and coatings, empty aerosol spray cans, etc.) will be returned to port and properly disposed of. Routine solid waste such as parts packaging (paper, cardboard, plastics) will be recycled as appropriate. Small amounts of leftover paints, coatings, and other potentially hazardous materials will be segregated for proper disposal.

- **Conventional Wastes from Vessels:** Conventional wastes from vessels include sanitary wastewater, domestic water, uncontaminated bilge and ballast water, deck drainage and sumps, food waste, and paper waste. The vessels used during construction and operation of Phase 1 will meet USCG bilge and ballast water management requirements, as further discussed in Section 5.2.2 of COP Volume III. Vessels will comply with relevant US regulations and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements.

- **Oil and Chemical Products for the WTGs:** The WTGs are large pieces of mechanical/electrical equipment that require chemical products to function properly and reliably. See Table 3.3-6 for a list of potential oils and chemical products used for the WTGs. The expected frequency of replacement and treatment, discharge, or disposal methods for each chemical type is also provided in Table 3.3-6.

- **Oil and Chemical Products for the ESP(s):** The ESP(s) include several complex mechanical and electrical systems that require oil and chemical products. The ESP(s) will likely include an oil/water separator. See Table 3.3-6 for a list of potential oils and chemical products used on the ESP(s). A preventative maintenance schedule similar to that of the WTGs is followed for the ESP(s) (see Table 3.3-6 below).

- **Chemical Products for the Onshore Substation:** Chemical products used at the onshore substations could include, but are not limited to, dielectric fluid (i.e. essentially a high-grade mineral oil), lead acid batteries, SF_6, and possibly lubricating oil. Planned or expected O&M wastes from the onshore substation will be limited to periodic change out of the battery bank and lubrication oil (if required for a synchronous condenser). See Section 3.2.2.3 for a description of the full-volume containment systems planned for the onshore substation equipment.

All waste materials, whether they are smaller volumes of conventional wastes generated on a regular basis or larger volumes of spent lubricants generated on a five to eight-year major maintenance cycle, will be carefully handled and disposed of (or recycled) in accordance with applicable regulations. The management and handling of hazardous substances used during Phase 1 will be reviewed to ensure compliance with regulatory requirements. This includes checking that appropriate containers, labeling, and equipment are used. Where possible, a hazardous substance will be substituted with a more environmentally-friendly alternative.

Table 3.3-5 below summarizes potential wastes to be produced during Phase 1 of New England Wind. Examples of potential chemical products to be used on the WTGs and ESP(s) are provided in Table 3.3-6 below. As planning and design proceeds, a detailed chemical and waste management plan will be developed and provided to BOEM. This plan will describe how each waste stream will be handled and stored, together with plans for proper disposal, recovery, recycling, or reuse.

Table 3.3-5 List of Wastes Expected to be Produced during Phase 1

Type of Waste and Composition	Approximate Total Amount Discharged[1]	Maximum Discharge Rate	Means of Storage or Discharge Method
Sewerage from vessel	95-114 liters (L)/person/day (25-30 gallons [gal]/person/day)	N/A	Tanks / Sewage Treatment Plant
Domestic water	114-151 L/person/day (30-40 gal/person/day)	N/A	Tanks or discharged overboard after treatment
Drilling cuttings, mud, grout or borehole treatment chemicals, if used	Dependent on final selection of HDD technique	N/A	N/A
Uncontaminated bilge water	Volume subject to vessel type	Rate subject to vessel size and equipment	Tanks or discharged overboard after treatment
Deck drainage and sumps	Volume subject to vessel type	Rate subject to vessel size and equipment	Discharged overboard after treatment
Uncontaminated ballast water	Volume subject to vessel type	Rate subject to vessel size and equipment	Discharged overboard
Uncontaminated fresh or seawater used for vessel air conditioning	N/A	N/A	Discharged overboard
Solid trash or debris	As generated	As generated	Onshore landfill (location to be determined [TBD])
Chemicals, solvents, oils, greases	Volume subject to vessel type	Rate subject to vessel size and equipment	Incineration or onshore landfill (location TBD)

Note:

1. Final discharge volumes and rates will be provided in the FIR following execution of contract with the construction contractor and the assignment of a Marine Coordinator.

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs						
Grease	Pinion & main bearing lubrication	Nacelle	1,452 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer cans to site	Approximately 500 L expected annually	To be brought to designated O&M port and disposed according to regulations and guidelines
Ester oil	Biodegradable transformer oil	Nacelle (within transformer)	11,400 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer the oil to the WTGs, either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Water / glycol	Cooling liquid for Heating, Ventilation, and Air Conditioning (HVAC) unit, Air Handling Unit, candidate for WTG tower damper fluid	Nacelle or Tower (top)	22,800 L per WTG	To be included at time of WTG installation	Expected to be topped up annually (if needed) and replaced every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Hydraulic oil	Oil used for hydraulic system (pitch, low-speed brake, cranes, & winches)	Nacelle or Tower	1,590 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer the oil to the WTGs, either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected to be topped up annually (if needed) and replaced every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Gearbox Oil	Lubrication for gearboxes, including yaw drive; not applicable to direct drive WTG concepts	Nacelle	5,300 L per WTG	To be included at time of WTG installation	Expected to be topped up annually (as needed); frequency of replacement depends on an oil analysis.	To be brought to designated O&M port and disposed according to regulations and guidelines
Lubricant	Candidate lubricant for Tower damper fluid	Tower (top)	16,400 L per WTG	To be included at time of WTG installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Nitrogen (pressurized)	Drives pitch system during power failure	Hub	90 kg per WTG	To be included at time of WTG installation	Expected annually	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Sulfur hexafluoride (SF_6)	Insulates switchgear	Tower Base (within switchgear)	19 kg per WTG	To be included at time of WTG installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel fuel	Fuel for generator (if used)	Tower Base (within diesel generator/diesel storage tank)	7,000 L per WTG	To be included at time of WTG installation or potentially transferred via hose from a vessel or container placed on the foundation	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Inert gases (e.g. NOVEC, nitrogen, carbon dioxide [CO_2], or similar)	Various locations	To be defined during detailed design	To be included at time of WTG installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Powder	Various locations	To be defined during detailed design	To be included at time of WTG installation	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Water/foam	Various locations	To be defined during detailed design	To be included at time of WTG installation	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Other types of extinguishers (if any)	Various locations	To be defined during detailed design	To be included at time of WTG installation	Not anticipated; Only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Paints & coatings	Corrosion protection of steel structure, paints (including anti-fouling paint), & varnishes	Steel structure, various locations	To be defined during detailed design	To be included at time of WTG installation; additional paint only needed for repairs	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines
Grout	For connection between foundation components	Foundation, various locations	Up to 159 m^3 per WTG	To be included at time of WTG installation	Not anticipated; Only changed if needed	To be brought back to port and disposed according to regulations and guidelines
ESP(s)						
Transformer oil	Mineral/naphthenic or ester oils	ESP topside (within power transformers, auxiliary/ earthing transformers, and reactors)	447,744 L per ESP	To be included at time of ESP installation During O&M, vessels will transfer the oil to the ESP(s), either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Lubrication oil	Lubricates machinery	Crane Emergency Generator	Crane: To be defined during detailed design Emergency generator: 53 L per ESP	During O&M, vessels will transfer the oil to the ESPs, either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
General oil	Hydraulic oil for crane	Various locations	1,267 L per ESP	To be included at time of ESP installation During O&M, vessels will transfer the oil to the ESP(s), either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel fuel	Fuel for generator	Diesel generator/diesel day tank/diesel storage tank	20,698 L per ESP	To be included at time of ESP installation or potentially transferred via hose from a vessel or container placed on the ESP	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Inert gases (e.g. NOVEC, nitrogen, CO_2, or similar)	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Fire extinguishing Agents	Powder	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents	Foam/water	Various locations	11,000 L foam per ESP	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing Agents	Other types of extinguishers (if any)	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Portable fire extinguisher	Various types	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
SF_6	Insulates switchgear	ESP topside (within switchgear)	4,120 kg	To be included at time of ESP installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Water/glycol	Cooling liquid for HVAC unit, Air Handling Unit	HVAC unit, Air Handling Unit	8,000 L per ESP	To be included at time of ESP installation	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines

Table 3.3-6 List of Potential Chemical Products Used on Phase 1 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 1 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Paints & Coatings	Corrosion protection of steel structure, paints (including anti-fouling paint), & varnishes	Steel structure, various locations	To be defined during detailed design	To be included at time of ESP installation; additional paint only needed for repairs	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines
Grout	For connections between foundation components	Foundation, various locations	Up to 362 m^3 per ESP	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel Exhaust Fluid (urea)	Injected in to exhaust to scrub nitrogen oxide (NOx), if necessary	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Only changed when needed; diesel genset only used during commissioning, servicing and grid faults	To be brought to designated O&M port and disposed according to regulations and guidelines
Lead-acid	Batteries	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Expected every 5-8 years	To be brought to designated to O&M port and disposed according to regulations and guidelines
Refrigerant gas R134a or R407C	Auxiliary cooling systems	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines

3.3.4.5 Grout Spill Management

As described in Sections 3.3.1.4 and 3.3.1.5, grout may be used during foundation installation for the connection between the monopile and TP, to secure the boat landing, to secure foundation piles into the pile sleeves, and/or to fill the interior of the monopiles. Grout material will be contained by a high strength rubber grout seal that ensures any grout overflow is directed to the inside of the foundation. When grout is used, the following grout spill management procedures will be used to mitigate the potential for any grout release:

- The grout level will be monitored visually using underwater cameras and when grout reaches the top of the sleeve, grouting will be halted.
- Special couplings will be attached to the grout hoses to mitigate grout spill when grout hoses are removed after grouting, where feasible. For monopiles, hoses will be disconnected on the upper TP platform to avoid losses of grout into the water column.
- Water and grout from cleaning of hoses and other equipment will be collected on the vessel and disposed of properly on shore.
- The risk for accidental grout spill in the sea due to grout seal failure will be mitigated by pressure testing grout seals.

Section 4.0

New England Wind Phase 2

4.0 NEW ENGLAND WIND PHASE 2

4.1 Overview of Phase 2

4.1.1 Phase 2 Construction and Operation Concept

4.1.1.1 Objective

The objective for Phase 2 is to design, permit, construct, operate, and decommission offshore renewable wind energy facilities in the remaining portion of Lease Area OCS-A 0534 that is not developed as part of Phase 1. Phase 2, also known as Commonwealth Wind, will deliver power to one or more Northeastern states and/or to other offtake users, including but not limited to 1,232 MW of power to the ISO-NE electric grid to meet the Proponent's obligations under long-term contracts with Massachusetts electric distribution companies (see Section 1.2). The Proponent is bidding into competitive power procurement processes to obtain one or more long-term contracts/power purchase agreements (PPAs) for the electricity generated by Phase 2.[59] Phase 2 may include one or more projects, depending on market conditions and the long-term contracts/PPAs ultimately awarded.

Phase 2's wind turbine generators (WTGs) will be among the most efficient renewable energy generators commercially available for offshore use within the anticipated timeframe of Phase 2 construction. Power from Phase 2 will make a substantial contribution to the region's electrical reliability and will enable individual states to meet their renewable energy requirements. Phase 2 will also provide a range of environmental and economic benefits (see Section 4.1 of COP Volume III).

4.1.1.2 Phase 2 Project Design Envelope and Proposed Activities

The key elements of Phase 2, as bounded by the Envelope (see Table 4.1-1), are as follows:

- **Layout:** Depending on the final footprint of Phase 1, the total number of WTG/electrical service platform (ESP) positions expected to be available for Phase 2 ranges from 64 to 88. Consistent with Phase 1, the WTGs and ESP(s) will be oriented in an east-west, north-south grid pattern with one nautical mile (NM) (1.85 kilometer [km]) spacing between positions.

- **Wind Turbine Generators:** Phase 2 will include up to 88 WTGs.

- **Electrical Service Platform(s):** Phase 2 may include up to three ESPs. The ESP(s) will likely include step-up transformers and other electrical gear.

59 Power from Phase 2 may be sold in response to a state-issued offshore wind solicitation or to a private entity.

- **Monopile, Jacket, and Bottom-frame Foundations:** The WTGs will be supported by monopile, jacket, and/or bottom-frame foundations. The ESP(s) will be supported by monopile or jacket foundations. The monopiles may be topped by transition pieces (TPs) or extended monopiles may be used. The jacket foundations and bottom-frame foundations may be secured to the seafloor using piles or suction buckets.

- **Scour Protection:** WTG and ESP foundations may have scour protection. The scour protection is expected to consist of one or more layers of rock laid around each foundation.

- **Inter-Array and Inter-Link Cables:** 66–132 kilovolt (kV) inter-array cables will connect "strings" of WTGs to an ESP. To provide additional reliability, the Phase 2 ESPs may be connected to each other or to a Phase 1 ESP with 66–345 kV inter-link cables. The inter-array and inter-link cables will be buried beneath the seafloor. The maximum anticipated total length of the Phase 2 inter-array cables is approximately 325 km (175 NM) and the maximum anticipated total length of the inter-link cables is approximately 60 km (32 NM).

- **Offshore Export Cables:** Two or three 220–345 kV high voltage alternating current (HVAC) Phase 2 offshore export cables will transmit power from the offshore ESP(s) to shore. Unless technical, logistical, grid interconnection, or other unforeseen issues arise,[60] all Phase 2 offshore export cables will be installed beneath the seafloor within the Offshore Export Cable Corridor (OECC) from the Southern Wind Development Area (SWDA) to the Dowses Beach Landfall Site and/or the Wianno Avenue Landfall Site. The maximum total length of the Phase 2 offshore export cables (assuming three cables) is approximately 356 km (192 NM).

- **Cable Protection (if required):** Where it is difficult to achieve a sufficient burial depth or where cables must cross existing infrastructure, inter-array, inter-link, and offshore export cables may be protected by rocks, gabion rock bags, prefabricated flexible concrete coverings (referred to as concrete mattresses), or half-shell pipes (or similar products).

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60 As described further in Section 4.1.3, the Proponent has identified two variations of the Phase 2 OECC in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC.

- **Onshore Export Cables:** Underground onshore export cables will transmit power from the Phase 2 landfall site(s) at Dowses Beach and/or Wianno Avenue to the new Phase 2 onshore substation(s).[61] The 220–500 kV onshore export cables will be installed underground along one or two Onshore Export Cable Routes.

- **Onshore Substations and Grid Interconnection Point:** Phase 2 will include one or two new onshore substations in the Town of Barnstable. The onshore substation(s) would house transformers, switchgear, and other necessary equipment. Using 345 kV underground onshore cables installed along one or two Grid Interconnection Routes, the onshore substation(s) will connect to the electric grid at Eversource's existing 345 kV West Barnstable Substation.[62]

- **Installation:** The Envelope also describes potential construction and installation approaches. As a general matter, it is expected that foundation, ESP, and WTG installation would be performed using jack-up vessels, anchored vessels, or dynamic positioning (DP) vessels along with necessary support vessels and barges. Cable laying is expected to be accomplished primarily by jet plowing, jet trenching, or mechanical plowing. Vessel types under consideration for cable installation include DP, anchored, self-propelled, or barge.

The design of Phase 2 may be further refined within the Envelope during the permitting process. The Envelope for Phase 2 of New England Wind is summarized in Table 4.1-1 below. The locations of the Phase 2 offshore facilities are illustrated in Figure 4.1-1. The Phase 2 onshore facilities will be located within the Phase 2 Onshore Development Area illustrated in Figure 4.1-2.

[61] One or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise. Under this scenario, Phase 2 could include one onshore transmission system in Barnstable (using either the Dowses Beach Landfall Site or Wianno Avenue Landfall Site) and/or an onshore transmission system(s) in proximity to the second grid interconnection point (see Section 4.1.4).

[62] As described in Section 4.1.3.3, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise.

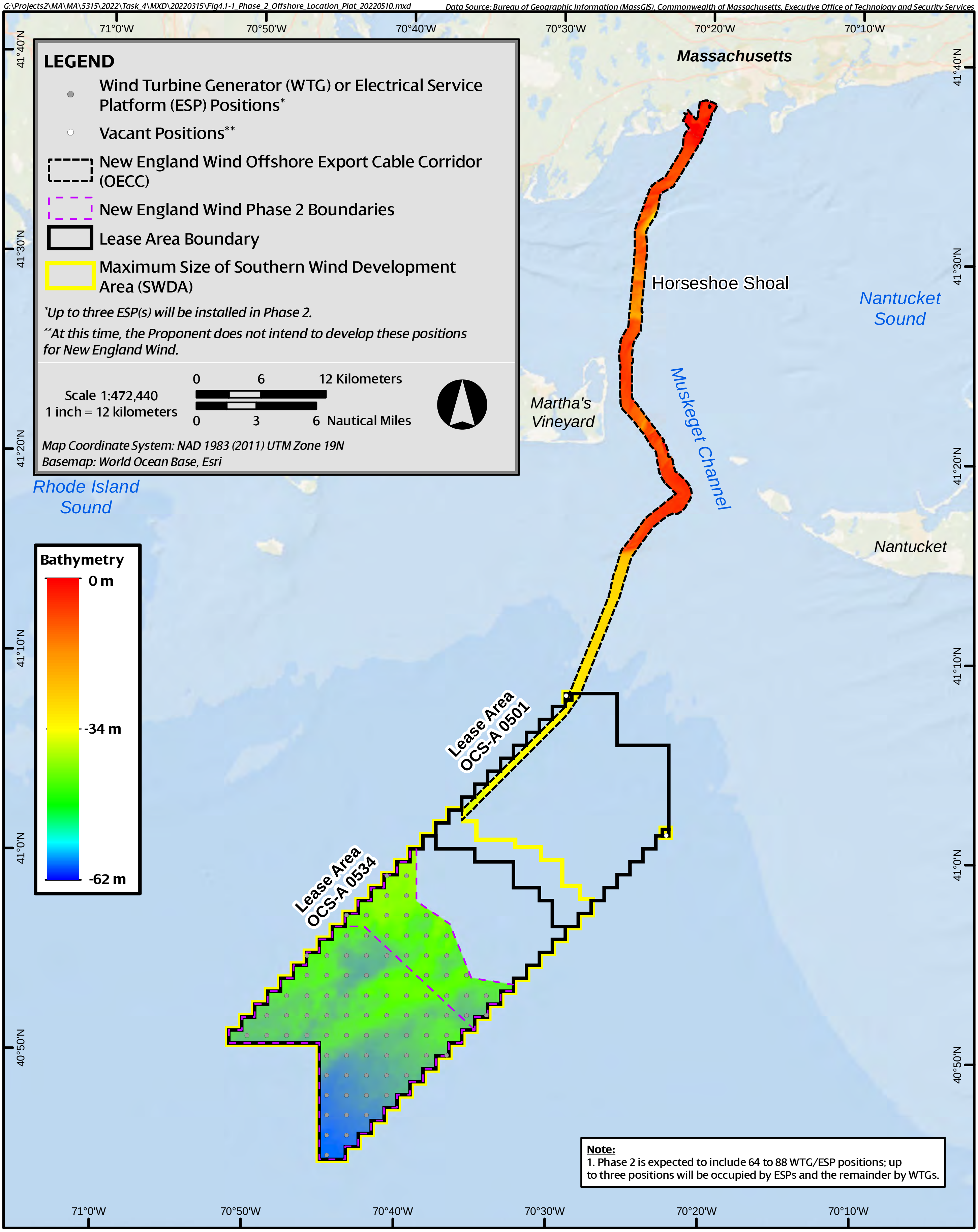
Table 4.1-1 Phase 2 of New England Wind Design Envelope Summary

Layout and Size of Phase 2	WTGs	WTG Foundations

• 64–88 total wind turbine generator (WTG) and electrical service platform (ESP) positions expected to be available
  ○ Up to 79 WTGs installed
  ○ Up to 3 ESPs installed
• Windfarm layout in E-W & N-S grid pattern with 1 NM (1.85 km) spacing between positions
• Area of Phase 2 SWDA: 222–303 km^2 (54,857–74,873 acres)
	• Up to 88 WTGs
	• Maximum rotor diameter of 285 m (935 ft)
	• Maximum tip height of 357 m (1,171 ft)
	• Minimum tip clearance of 27 m (89 ft)
	• Installation likely with a jack-up vessel, anchored vessel, or dynamic positioning (DP) vessel and components potentially supplied by feeder vessels
		• Each WTG installed on a monopile, jacket, or bottom-frame foundation
		• Scour protection may be used around all foundations
		• Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets and bottom-frames
		• Installation likely with a jack-up vessel, anchored vessel, or DP vessel and components potentially supplied by feeder vessels

ESP(s) (Topside and Foundation)	**Inter-Array & Inter-Link Cables**	**Offshore Export Cables**
• Up to 3 ESPs • Each ESP installed on a monopile or jacket foundation (ESPs installed on monopiles may be co-located) • Maximum pile driving energy of 6,000 kJ for monopiles and 3,500 kJ for jackets • Scour protection may be installed around the foundations • Installation likely with a jack-up vessel, anchored vessel, or DP vessel	• 66–132 kV inter-array cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-array cable length of ~325 km (~175 NM) • 66–345 kV inter-link cables buried at a target depth of 1.5–2.5 m (5–8 ft) • Maximum total inter-link cable length of ~60 km (~32 NM) • Example layout identified, not finalized • Pre-lay grapnel run and pre-lay survey • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial	• Two or three 220–345 kV high voltage alternating current (HVAC) cables buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) • Cables installed in an Offshore Export Cable Corridor (OECC) with potential variations • Maximum total offshore export cable length of ~356 km (~192 NM) • Pre-lay grapnel run, pre-lay survey, and possibly boulder clearance • Typical installation techniques include jetting (e.g. jet plow or jet trenching) and mechanical plow, possibly with dredging in some locations to achieve burial depth • Use of cable protection (rock, gabion rock bags, concrete mattresses, half-shell pipes [or similar]) on areas of minimal cable burial

Note: Elevations are relative to Mean Lower Low Water (MLLW).



New England Wind
AVANGRID RENEWABLES

Figure 4.1-1
Phase 2 Offshore Location Plat

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Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services

New England Wind
AVANGRID RENEWABLES

Figure 4.1-2
Phase 2 Onshore Location Plat

4.1.1.3 Tentative Draft Schedule for Phase 2

The full build-out of Phase 2 development is largely dependent upon market conditions and the advancement of WTG technology. It is likely that a portion of Phase 2 construction could begin immediately following Phase 1[63] with the remainder following by a number of years. Phase 2 may include one or more projects, depending on market conditions. It is expected that Phase 2 would follow a similar order of construction and timing of activities as Phase 1; a high-level representation of potential Phase 2 construction schedules (assuming Phase 2 is developed as one project) is provided as Figure 4.1-3. Once Phase 2 is ready to proceed, an updated schedule for Phase 2 will be provided.

4.1.2 Phase 2 Portion of the SWDA

Phase 2 will occupy the remaining portion of the Southern Wind Development Area (SWDA) that is not developed for Phase 1. The potential footprint of Phase 2 within the SWDA overlaps with the potential footprint of Phase 1 to account for the range in the number of WTGs that may be developed for Phase 1 (see Figure 4.1-4). Depending on the final layout of Phase 1, the total number of remaining WTG/ESP positions expected to be available for Phase 2 ranges from 64 to 88. The Phase 2 portion of the SWDA also includes two vacant positions (located in the separate aliquots along the northeastern boundary of Lease Area OCS-A 0501) that the Proponent does not intend to develop as part of New England Wind at this time.

The footprint of Phase 2 within the SWDA ranges in size between 222–303 square kilometers (km^2) (54,857–74,873 acres). Figure 4.1-4 illustrates the Phase 2 portions of the SWDA, including the two vacant positions. Figure 4.1-5 shows a representative Phase 2 layout if Park City Wind were to use 61 WTG/ESP positions and Vineyard Wind 1 only used three of its spare positions.

Consistent with Phase 1, the WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (1.85 km) spacing between WTG/ESP positions.[64] Water depths within the portion of the SWDA that may be developed for Phase 2 (excluding the two separate aliquots that are closer to shore) range from 47 to 62 meters (m) (154 to 203 feet [ft]). Water depths in the separate aliquots range from 38–40 m (125–131 ft).

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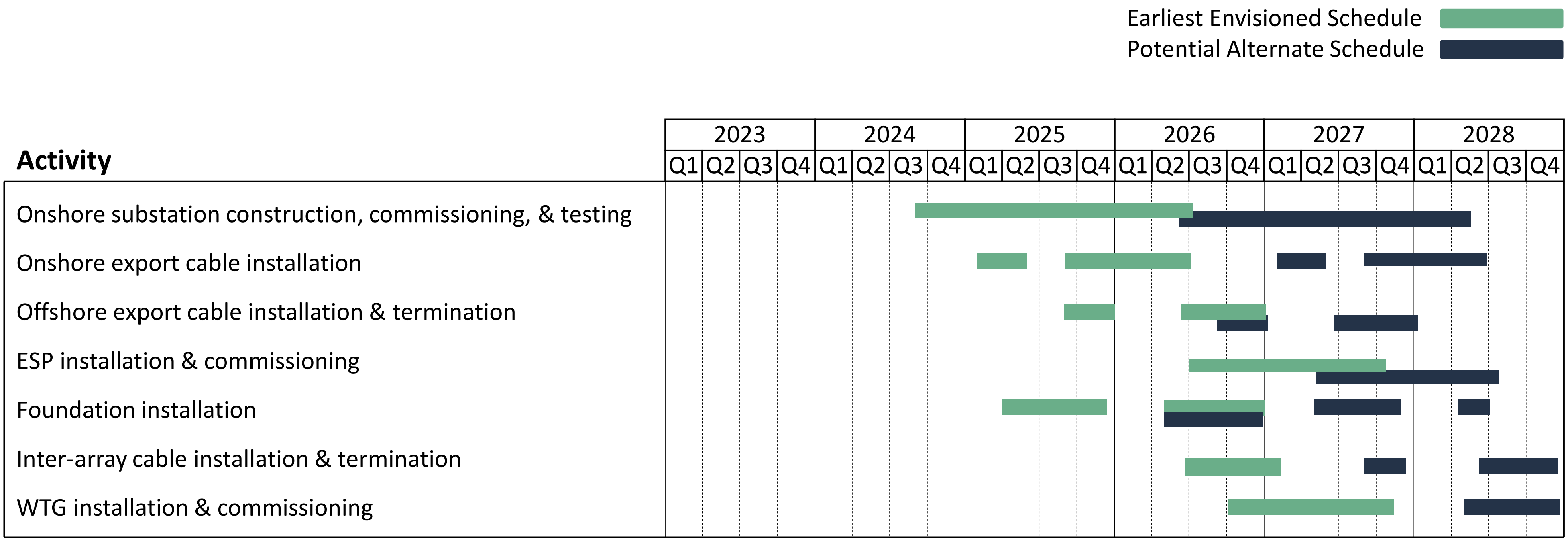
63 In this scenario, each major construction activity would be sequential for the two Phases (e.g. Phase 2 foundation installation would immediately follow Phase 1 foundation installation). However, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g. Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). There will be no concurrent/simultaneous pile driving of foundations.

64 Where necessary, WTGs and ESPs may be micro-sited by a maximum of 152 m (500 ft) to avoid unfavorable seabed conditions, maintain facilities within lease area boundaries, and/or for other unexpected circumstances.



Note: Although the earliest envisioned schedule for Phase 2 foundation installation shows some potential overlap with the Phase 1 foundation installation schedule (see Figure 3.1-3), there will be no concurrent/simultaneous piling of Phase 1 and Phase 2 foundations.

Figure 4.1-3

Draft Phase 2 High-Level Construction Schedule Variations

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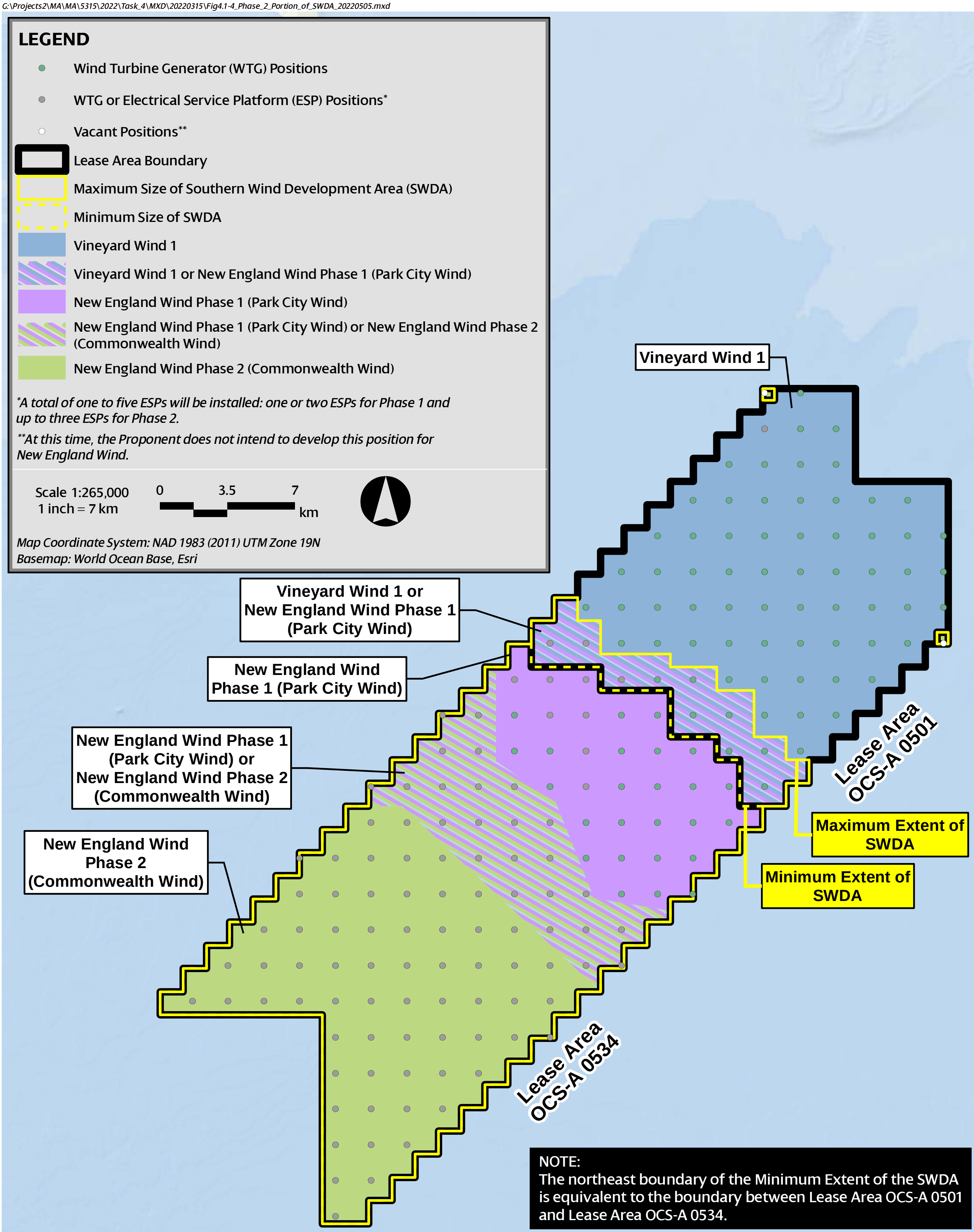
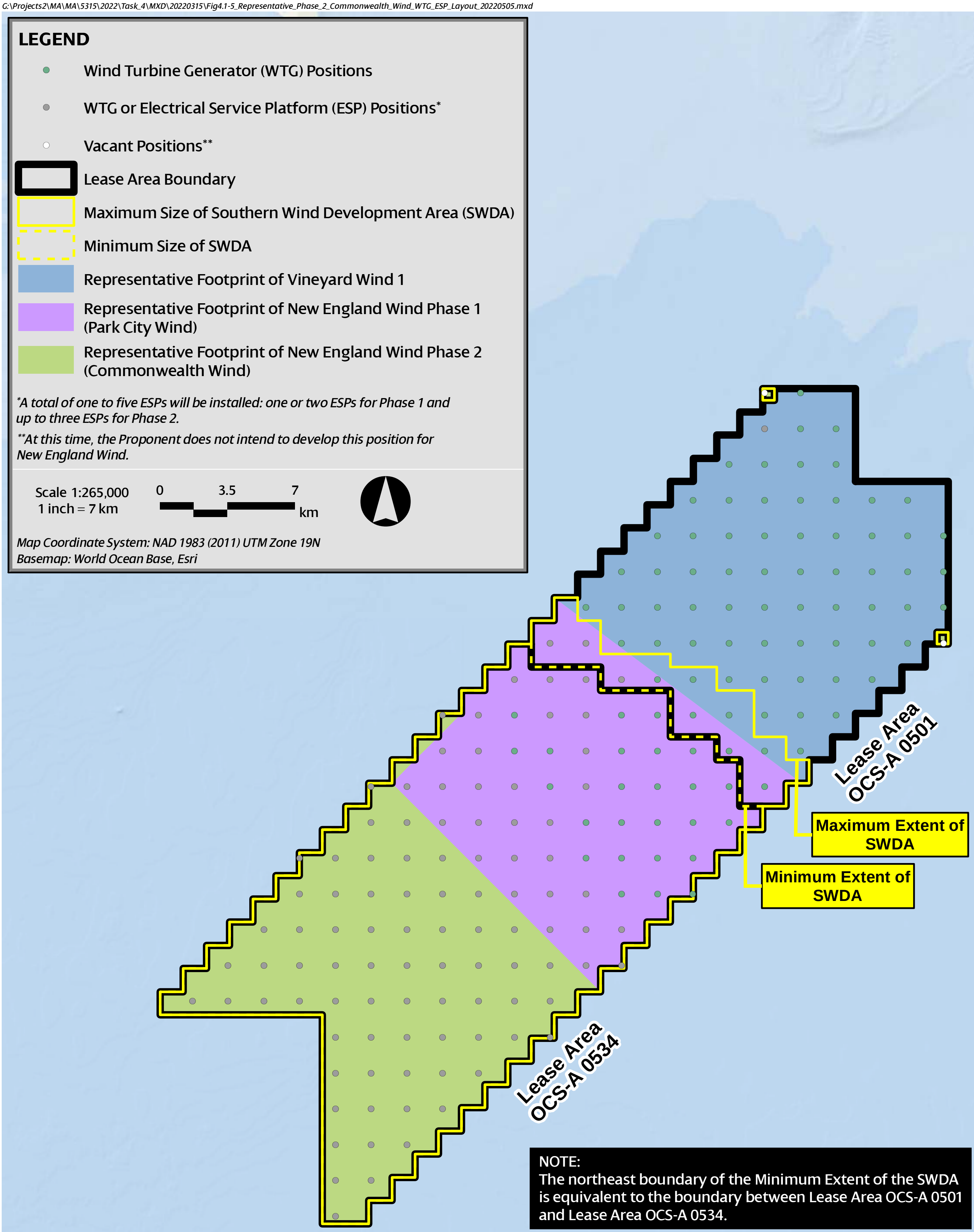


Figure 4.1-4
Phase 2 Portion of SWDA


LEGEND
Wind Turbine Generator (WTG) Positions
WTG or Electrical Service Platform (ESP) Positions*
Vacant Positions**
Lease Area Boundary
Maximum Size of Southern Wind Development Area (SWDA)
Minimum Size of SWDA
Representative Footprint of Vineyard Wind 1
Representative Footprint of New England Wind Phase 1 (Park City Wind)
Representative Footprint of New England Wind Phase 2 (Commonwealth Wind)
*A total of one to five ESPs will be installed: one or two ESPs for Phase 1 and up to three ESPs for Phase 2.
**At this time, the Proponent does not intend to develop this position for New England Wind.
Scale 1:265,000
1 inch = 7 km
0
3.5
7
km
Map Coordinate System: NAD 1983 (2011) UTM Zone 19N
Basemap: World Ocean Base, Esri
Lease Area OCS-A 0501
Maximum Extent of SWDA
Minimum Extent of SWDA
Lease Area OCS-A 0534
NOTE:
The northeast boundary of the Minimum Extent of the SWDA is equivalent to the boundary between Lease Area OCS-A 0501 and Lease Area OCS-A 0534.

4.1.3 Phase 2 OECC

4.1.3.1 Overview of the Phase 2 OECC

As described in Section 2.3, unless technical, logistical, grid interconnection, or other unforeseen issues arise, all Phase 2 offshore export cables will be installed within the Offshore Export Cable Corridor (OECC) to reach landfall site(s) in the Town of Barnstable. The OECC will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel towards the southern shore of Cape Cod. The OECC for Phase 2 will then continue toward landfall site(s) in Barnstable (see Figure 4.1-6).

From the Phase 2 landfall site(s)[65] to the SWDA boundary (excluding the two separate aliquots that are closer to shore), the OECC is approximately 77 km (41 NM). With allowances for turns and micro-siting, the maximum length of each Phase 2 cable within the OECC is ~82 km (~44 NM).[66] An additional length of offshore export cable within the SWDA (up to ~34–42 km [~18–23 NM] per cable) will be needed to reach the Phase 2 ESP(s). The maximum length of each Phase 2 offshore export cable between the landfall site(s) and the ESP(s) is approximately 116–124 km (63–67 NM). The maximum total length of the Phase 2 offshore export cables (assuming three cables) is ~356 km (~192 NM).

Outside the SWDA, the two or three Phase 2 offshore export cables would be installed within a portion of the approximately 950–1,700 m (3,100–5,500 ft) wide OECC.[67] As noted in Section 2.3, it is expected that four offshore export cables (two for Phase 1 and two for Vineyard Wind 1) will be installed within the OECC prior to the installation of the Phase 2 offshore export cables. The Phase 2 offshore export cables are expected to be located west of the Phase 1 and Vineyard Wind 1 cables in order to avoid cable crossings with those cables. To provide appropriate flexibility for routing and installation and to allow room for maintenance or repairs, the Phase 2 cables will typically be separated from each other and the Phase 1 cables by a distance of 50–100 m (164–328 ft), although this distance could be further adjusted pending ongoing routing evaluation.

While the Proponent intends to install all Phase 2 offshore export cables within the OECC shown on Figure 4.1-6, the Proponent has also identified two variations of the Phase 2 OECC. These variations are necessary to provide the Proponent with commercial flexibility should technical, logistical, grid interconnection, or other unforeseen issues arise during the Construction and

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65 The length of the OECC for Phase 2 (~77 km) is conservatively measured from the offshore edge of the corridor at the potential Phase 2 landfall sites.

66 The offshore export cable length includes a 15% allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5% allowance for micro-siting within the OECC outside the lease areas.

67 Where the OECC travels through Lease Area OCS-A 0501, the width of the corridor may be narrower than 950 m (3,100 ft) to avoid possible interference with Vineyard Wind 1's offshore facilities.

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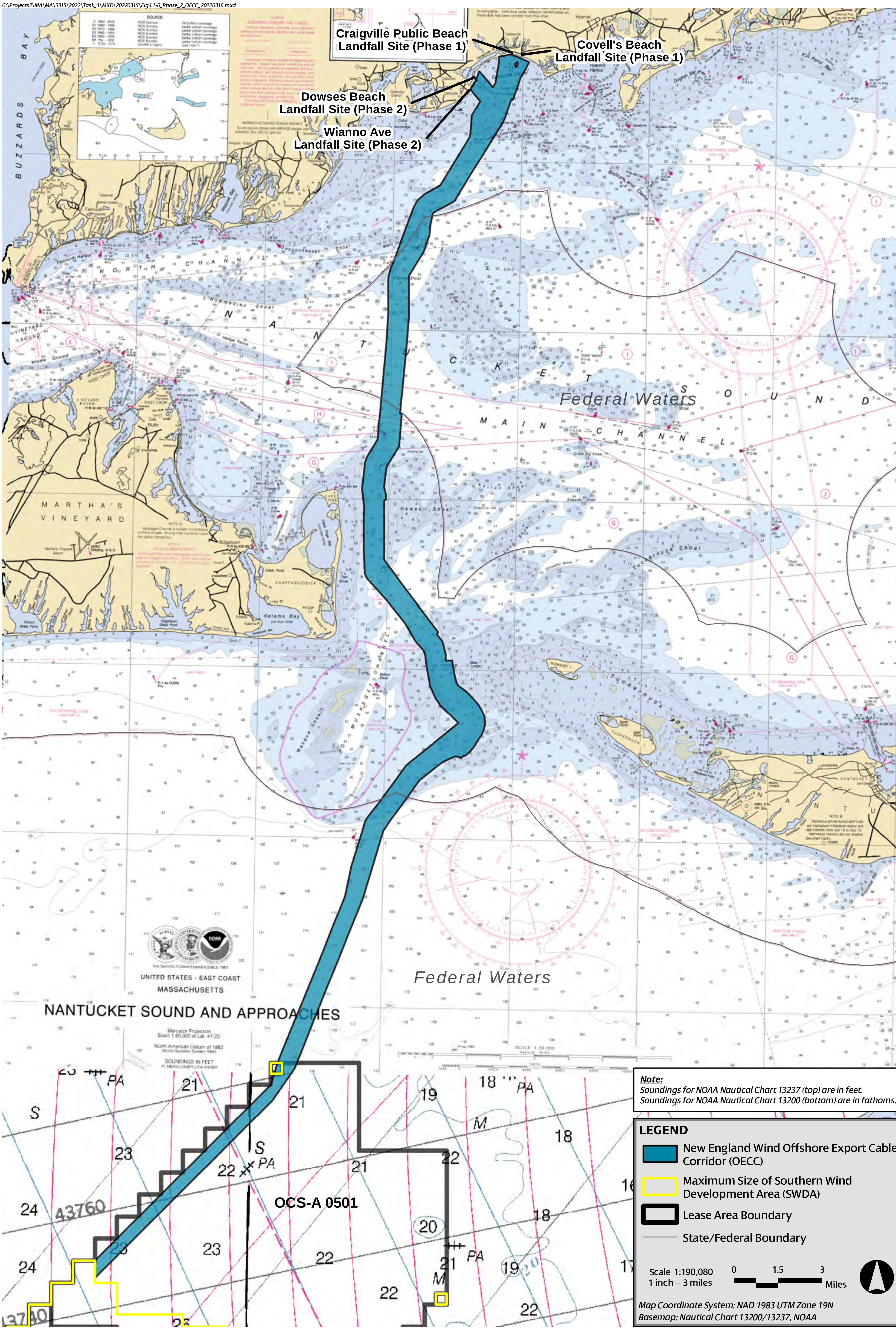

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Figure 4.1-6
Phase 2 Offshore Export Cable Corridor

Operations Plan (COP) review and engineering processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC. The variations of the Phase 2 OECC are described in Sections 4.1.3.2 and 4.1.3.3.

4.1.3.2 Phase 2 OECC Western Muskeget Variant

As described in Section 2.3.1, the preliminary engineering studies for New England Wind indicate that it is technically feasible to install New England Wind's four or five offshore export cables within the OECC. However, if detailed engineering or other technical issues arise demonstrating that installation of all Phase 2 cables within a portion of the OECC in the Muskeget Channel area is not feasible, the Proponent would exercise the option to install one or two Phase 2 offshore export cables within the Western Muskeget Variant that was included as part of the Vineyard Wind 1 OECC (see Section 2.3.1 and Appendix I-G). The Western Muskeget Variant, which is shown on Figure 4.1-7, is the same exact corridor as the western Muskeget option included in the Vineyard Wind 1 COP and has already been thoroughly reviewed and approved by the Bureau of Ocean Energy Management (BOEM) as part of that COP.

Using the slightly shorter Western Muskeget Variant, the OECC is approximately 74 km (40 NM) between the Phase 2 landfall site(s) and the SWDA boundary (excluding the two separate aliquots that are closer to shore). To allow additional cable length for turns and micro-siting of the cable within the corridor, the maximum length of each cable within this variation of the OECC is ~79 km (~43 NM).[68] An additional length of offshore export cable within the SWDA (up to ~34–42 km [~18–23 NM] per cable) will be needed to reach the Phase 2 ESP(s). Thus, the maximum length of each Phase 2 offshore export cable that employs the Western Muskeget Variant is 113–121 km (61–65 NM) between the landfall site(s) and the ESP(s). If one Phase 2 offshore export cable uses the Western Muskeget Variant, the maximum total length of the Phase 2 offshore export cables (assuming three cables) is ~353 km (~191 NM). The maximum total area of seafloor disturbance during construction associated with the use of the Western Muskeget Variant is presented in Table 4.3-4.

4.1.3.3 Phase 2 OECC South Coast Variant

The Proponent has identified a variation of the Phase 2 OECC that connects to a potential second grid interconnection point, which is referred to as the "South Coast Variant." This variant is included in the COP to provide the Proponent with the commercial flexibility required should technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes that preclude one or more Phase 2 export cables from interconnecting at the West Barnstable Substation.

[68] The offshore export cable length includes a 15% allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5% allowance for micro-siting within the OECC outside the lease areas.

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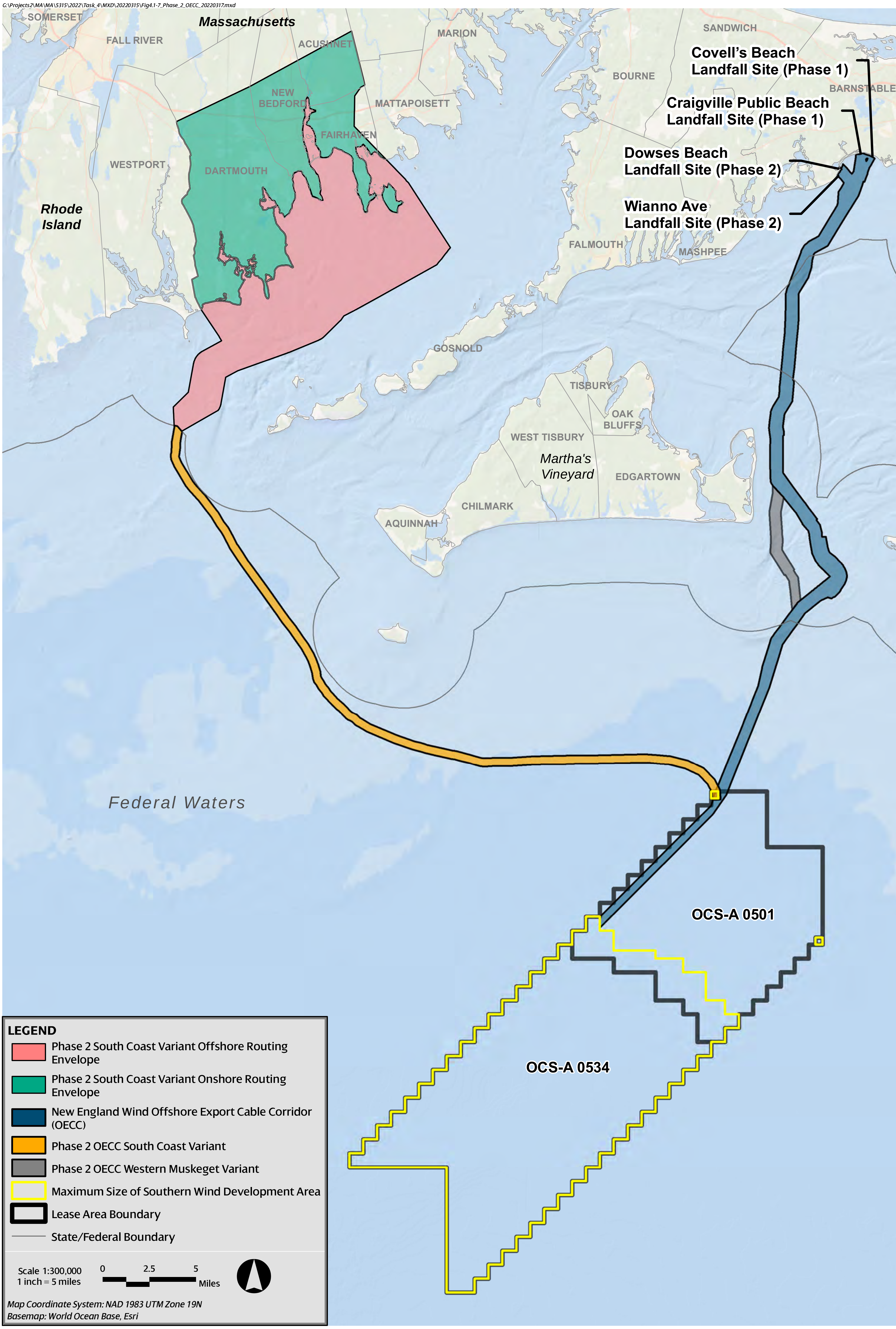

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Figure 4.1-7

Phase 2 Offshore Export Cable Corridor Variants

As shown in Figure 4.1-7, the South Coast Variant diverges from the OECC at the northern boundary of Lease Area OCS-A 0501 and travels west-northwest to the state waters boundary near Buzzards Bay. From the SWDA boundary (excluding the two separate aliquots that are closer to shore) through federal waters to the state waters boundary, the South Coast Variant is approximately 79 km (42 NM) in length and approximately 720 m (2,360 ft) in width. At the state waters boundary, the South Coast Variant broadens to a "Phase 2 South Coast Variant Offshore Routing Envelope" that indicates a region within Buzzards Bay where the Phase 2 offshore export cable(s) may be installed before making landfall along the southwest coast of Massachusetts within the Offshore Routing Envelope.

The South Coast Variant would only be employed if one or more Phase 2 offshore export cables need to interconnect at a second grid interconnection point. Unexpected scenarios that could potentially necessitate the use of the South Coast Variant include, but are not limited to:

- further detailed engineering identifies technical issues with landing one or more Phase 2 offshore export cables at potential landfall sites in Barnstable;
- additional detailed engineering identifies technical issues with installing one or more Phase 2 cables within roadway layouts and utility rights-of-way (ROWs) to reach the West Barnstable Substation; and/or
- grid interconnection issues at the West Barnstable Substation arise that are beyond the Proponent's control.

The Proponent intends to provide the data and analysis supporting the South Coast Variant in federal waters in its April 2022 COP Addendum. If it becomes necessary to employ the South Coast Variant and a second grid interconnection point is secured, the Proponent understands that BOEM would conduct a supplemental review of those portions of the South Coast Variant not otherwise considered in the Final Environmental Impact Statement.

4.1.3.4 Summary of Phase 2 OECC Scenarios

As described in the preceding sections, the Proponent has identified two variations of the Phase 2 OECC, such that multiple configurations are possible for the Phase 2 offshore export cables. Table 4.1-2 provides a summary of the Phase 2 offshore export cable scenarios in approximate order of likelihood. The scenarios presented in Table 4.1-2 and illustrated in Figures 4.1-8a through 4.1-8f are based on currently available information and are subject to further refinement as the export cable engineering process progresses.

Table 4.1-2 Phase 2 Offshore Export Cable Scenarios in Descending Order of Likelihood

Export Cable Scenario	Phase 2 OECC (Eastern Muskeget)	Phase 2 OECC Western Muskeget Variant	Phase 2 OECC South Coast Variant	Total # of Phase 2 Cables	Max. Total Length of Phase 2 Cables[1,2]	Figure
Scenario 1	3 cables			3	~356 km (~192 NM)	Figure 4.1-8a
Scenario 2	2 cables	1 cable		3	~353 km (~191 NM)	Figure 4.1-8b
Scenario 3	2 cables		1 cable	3	~358 km (~193 NM)	Figure 4.1-8c
Scenario 4	2 cables			2	~240 km (~130 NM)	Figure 4.1-8d
Scenario 5	1 cable	2 cables		3	~350 km (~189 NM)	Figure 4.1-8e
Scenario 6[3]			3 cables	3	~362 km (~196 NM)	Figure 4.1-8f

Notes:

1. The total length of the Phase 2 offshore export cables includes the length of the cables within the SWDA.
2. For Phase 2 offshore export cables within the South Coast Variant, the cable length only includes the portion of the cables within federal waters. At the state waters boundary, the South Coast Variant broadens to a "Phase 2 South Coast Variant Offshore Routing Envelope" that indicates a region within Buzzards Bay where the Phase 2 offshore export cable(s) may be installed before making landfall along the southwest coast of Massachusetts. Therefore, the length of the South Coast Variant within state waters has not yet been determined.
3. Scenario 6 is extremely unlikely. Installing all three Phase 2 offshore export cables within the South Coast Variant to a grid interconnection point capable of receiving the entire electrical capacity of Phase 2 is not feasible within the construction timelines contemplated in this COP. Significant capacity upgrades to the electric grid would need to be made by ISO-NE to receive the entire Phase 2 capacity. This scenario is only included as a potential option in the event that Phase 2 is significantly delayed beyond the contemplated construction timelines.

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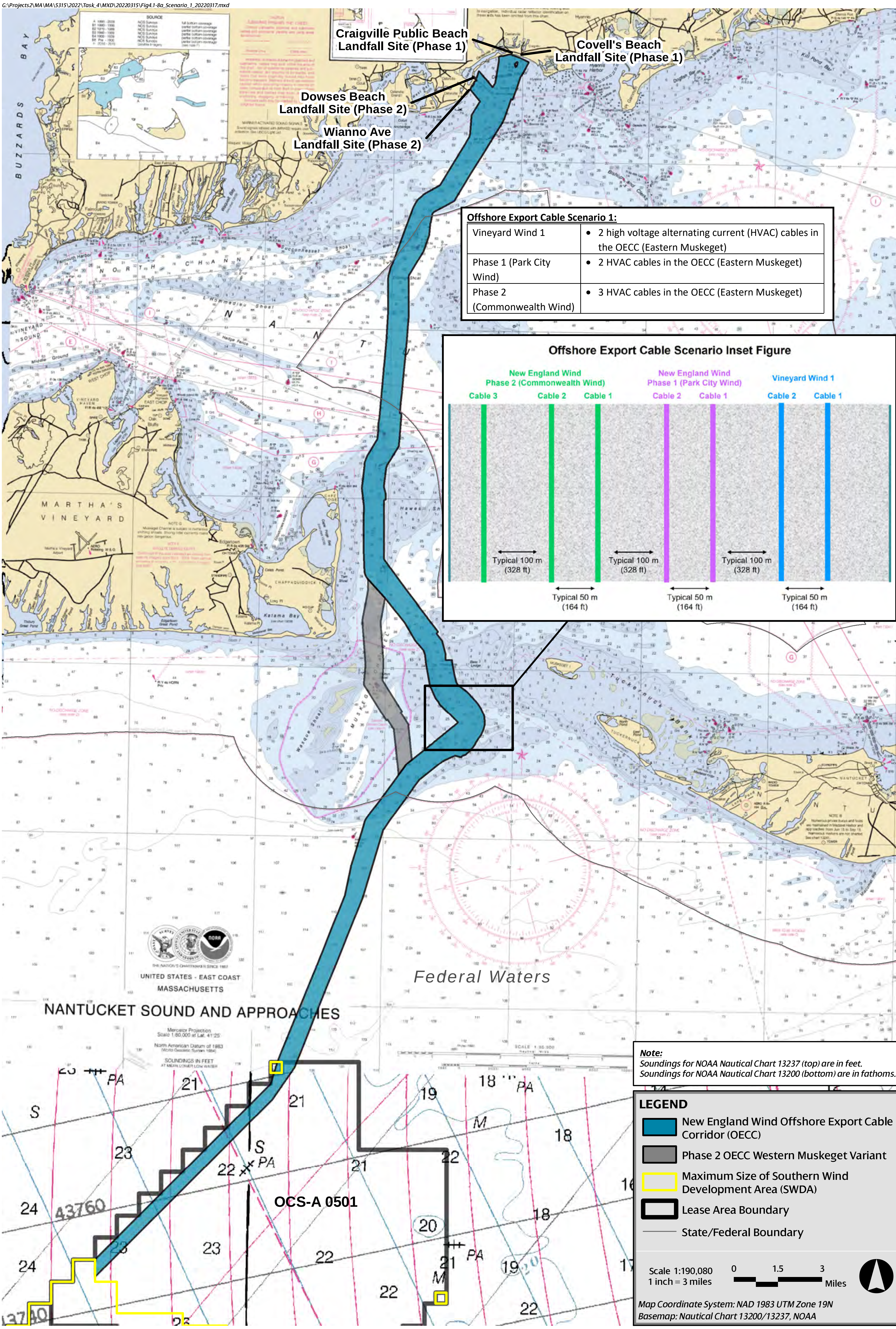

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Figure 4.1-8a
Offshore Export Cable Scenario 1

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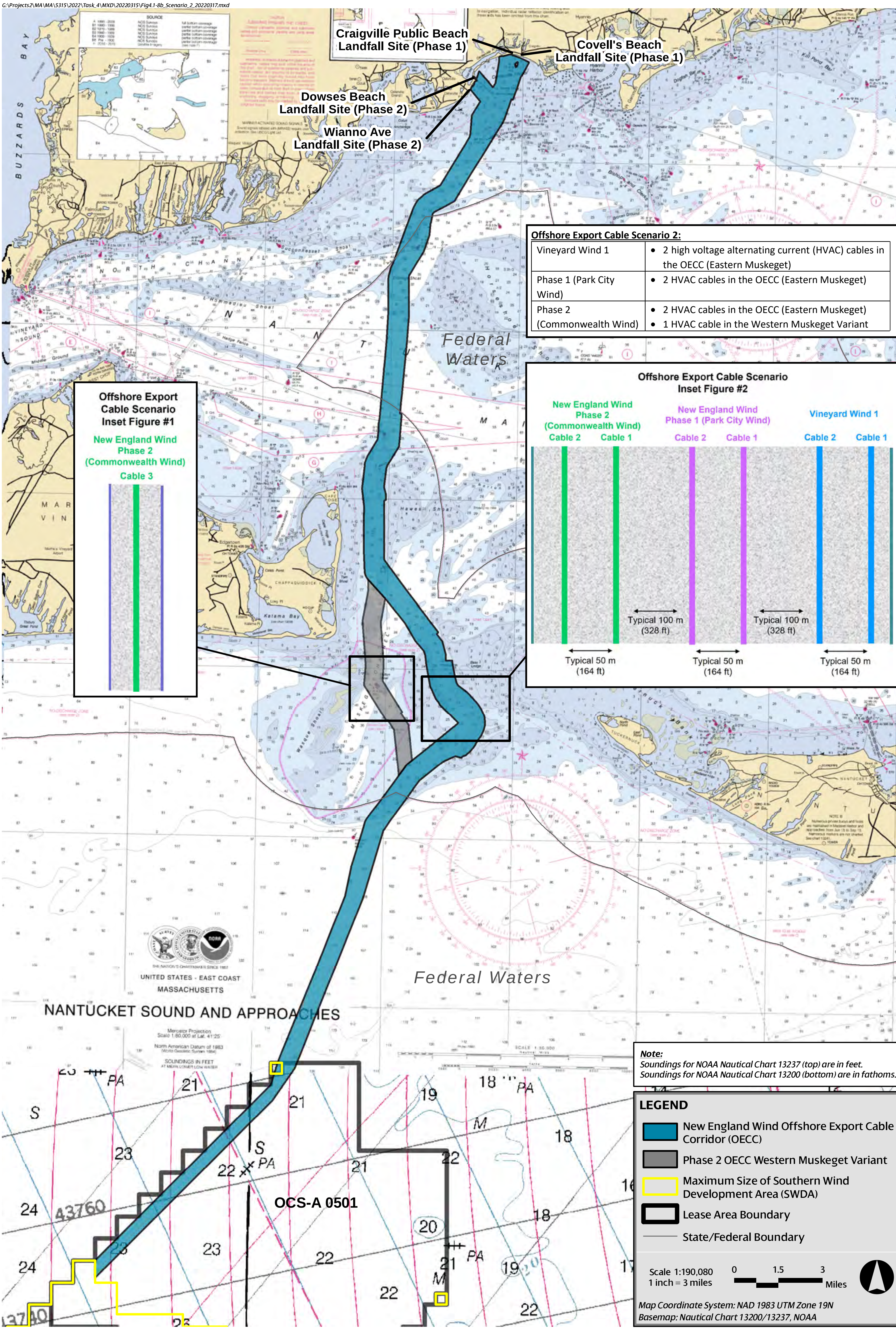

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Figure 4.1-8b
Offshore Export Cable Scenario 2

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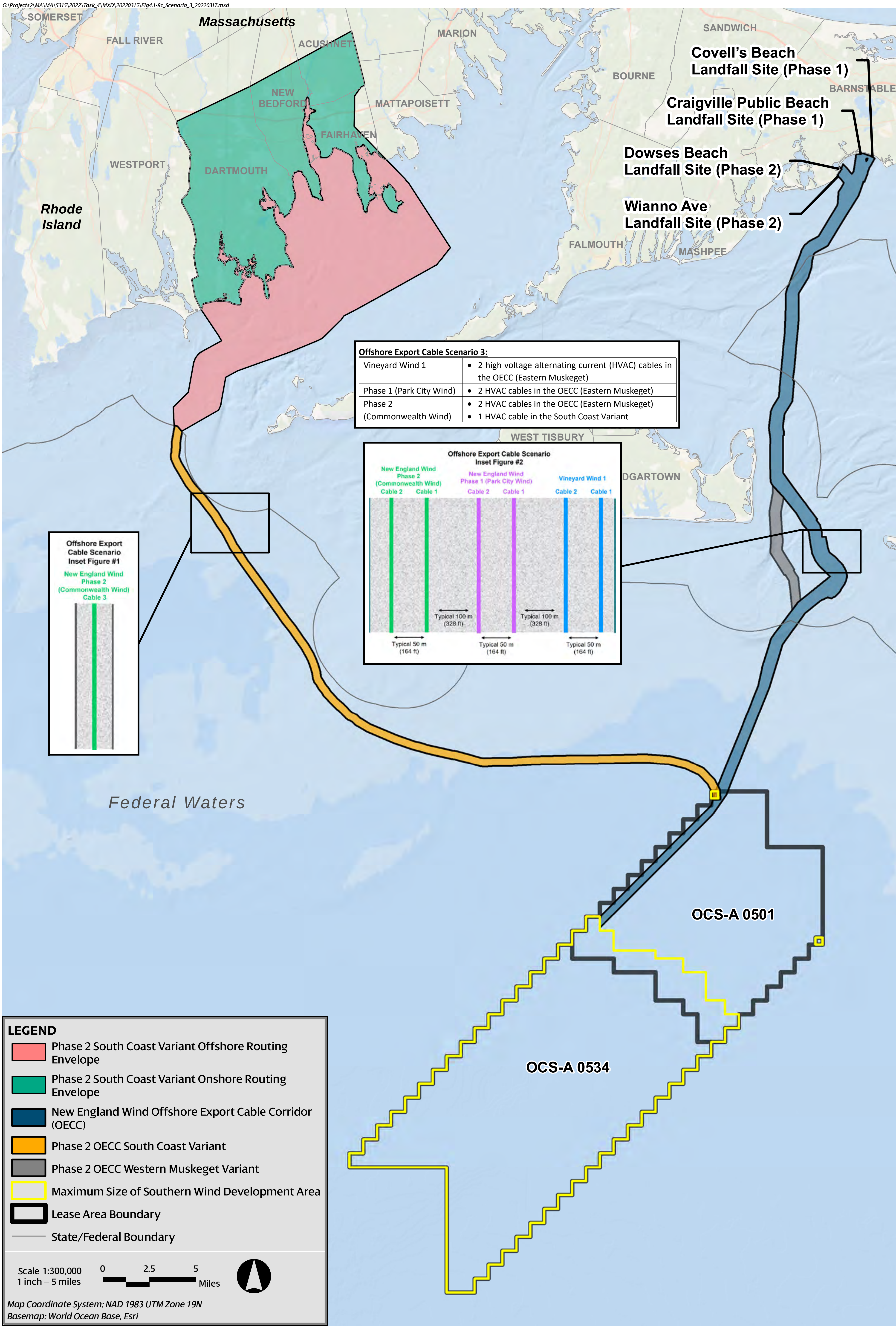

Offshore Export Cable Scenario 3:

Vineyard Wind 1	• 2 high voltage alternating current (HVAC) cables in the OECC (Eastern Muskeget)
Phase 1 (Park City Wind)	• 2 HVAC cables in the OECC (Eastern Muskeget)
Phase 2 (Commonwealth Wind)	• 2 HVAC cables in the OECC (Eastern Muskeget) • 1 HVAC cable in the South Coast Variant

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Figure 4.1-8c
Offshore Export Cable Scenario 3

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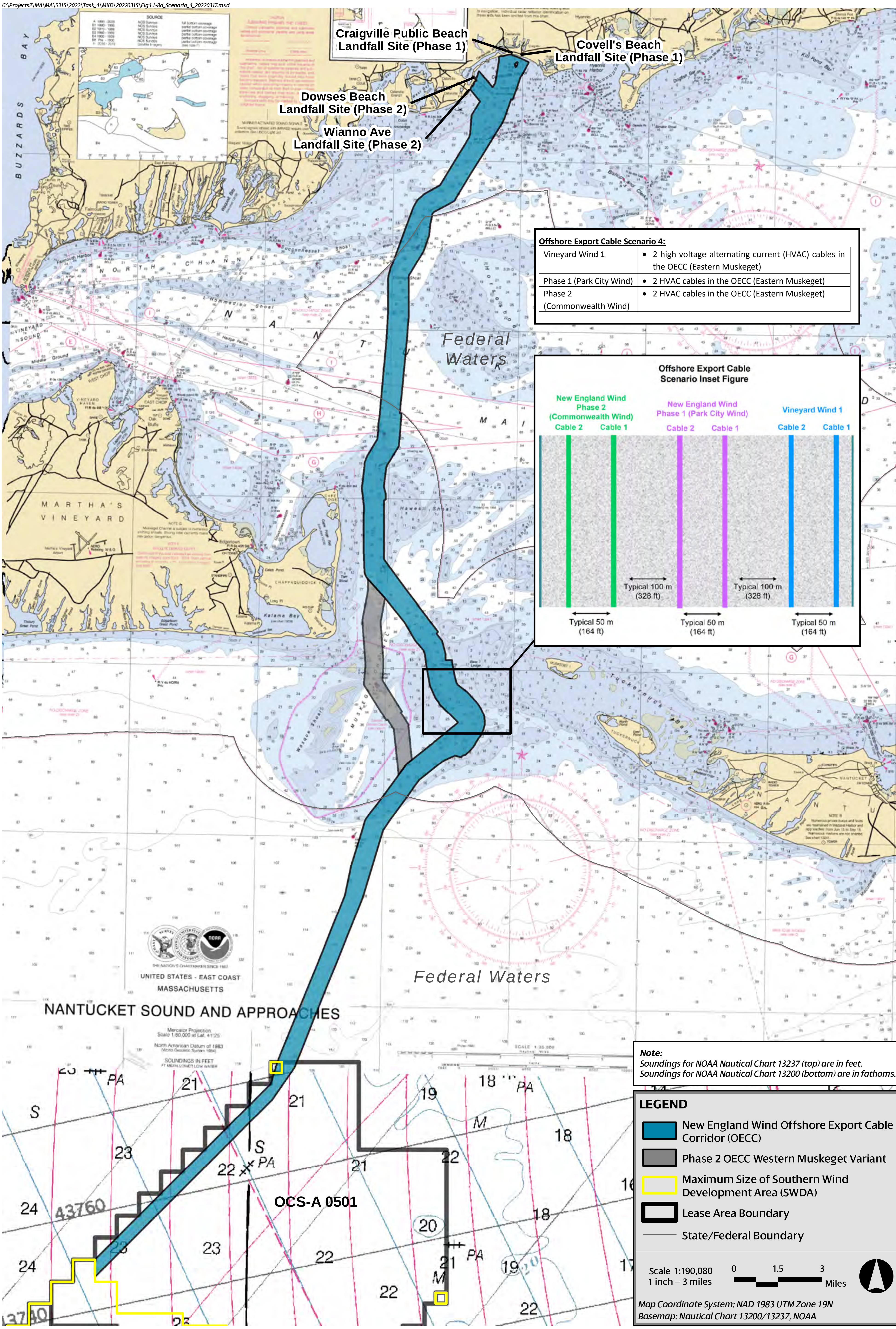

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Figure 4.1-8d
Offshore Export Cable Scenario 4

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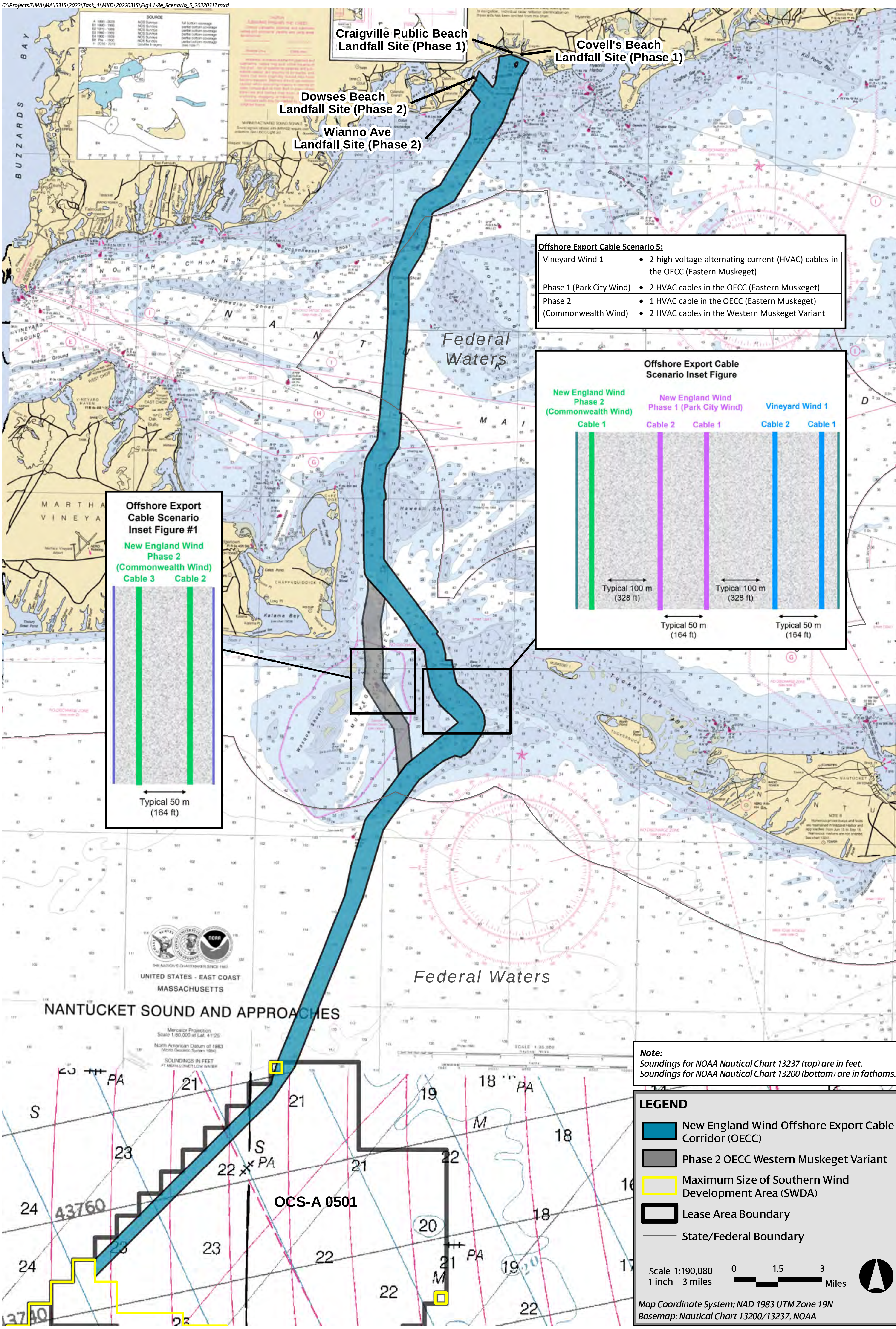

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Figure 4.1-8e
Offshore Export Cable Scenario 5

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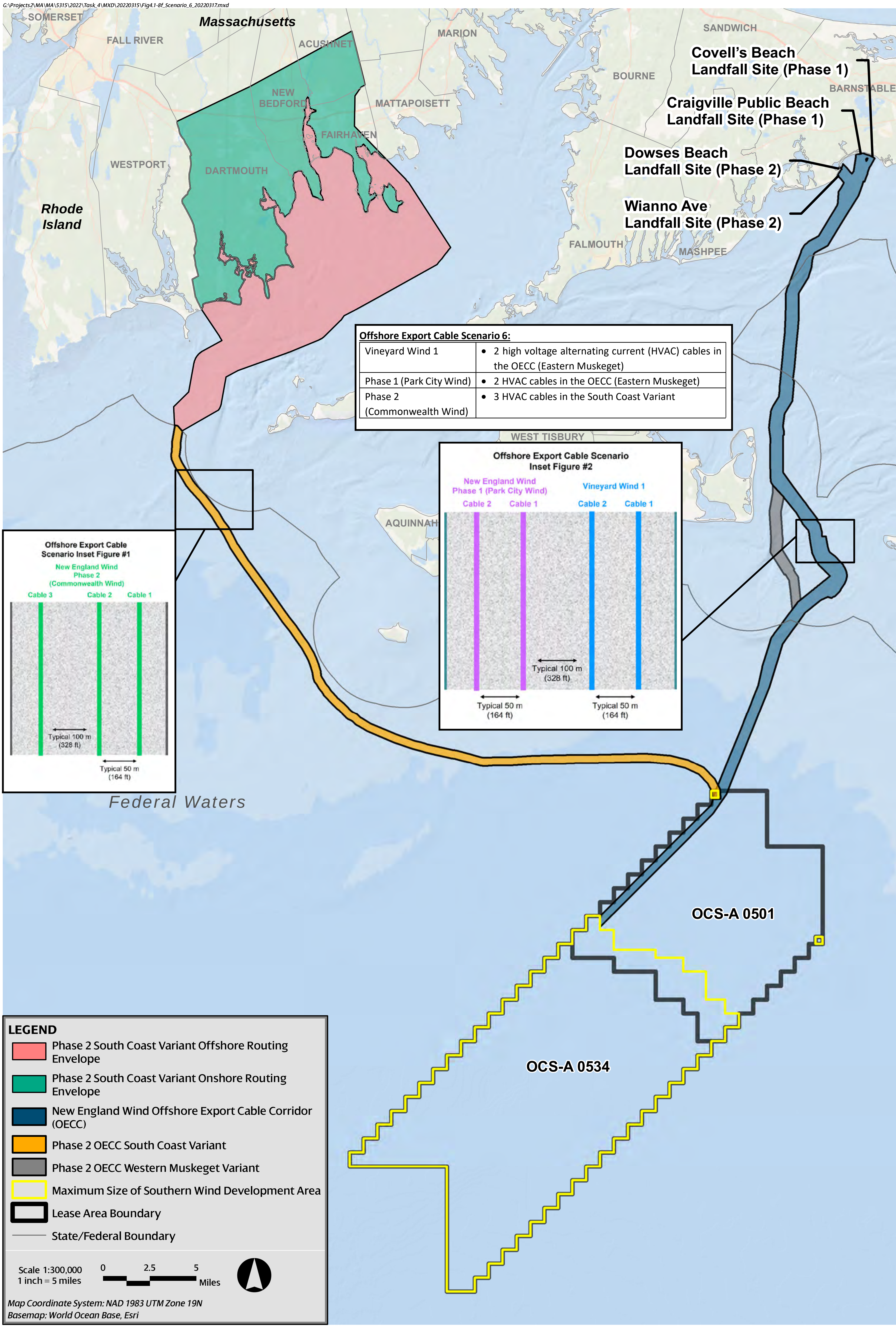

Offshore Export Cable Scenario 6:

Vineyard Wind 1	• 2 high voltage alternating current (HVAC) cables in the OECC (Eastern Muskeget)
Phase 1 (Park City Wind)	• 2 HVAC cables in the OECC (Eastern Muskeget)
Phase 2 (Commonwealth Wind)	• 3 HVAC cables in the South Coast Variant

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Figure 4.1-8f
Offshore Export Cable Scenario 6

4.1.4 Phase 2 Onshore Development Area

Depending on the number and size of the WTGs selected for Phase 2 and the corresponding total power production capacity of Phase 2, Phase 2 may require one or two onshore transmission systems. Therefore, the Phase 2 onshore facilities will ultimately include one or two landfall sites, one or two Onshore Export Cable Routes, one or two new onshore substations, and one or two Grid Interconnection Routes to transmit power to the grid interconnection point(s).

The Proponent intends to interconnect the entire electrical capacity of Phase 2 into the electrical grid at the West Barnstable Substation. The potential Phase 2 landfall sites, Onshore Export Cable Routes, and Grid Interconnection Routes associated with the West Barnstable Substation grid interconnection point are shown on Figure 4.1-2. The properties needed for the Phase 2 onshore substation site(s) have not yet been secured, but the site(s) will be located generally along the onshore routes illustrated on Figure 4.1-2. See Section 4.2.2 for additional description of the Phase 2 onshore facilities associated with the West Barnstable Substation grid interconnection point.

If the Phase 2 OECC South Coast Variant is employed and electricity generated by Phase 2 is delivered to a second grid interconnection point (see Section 4.1.3.3), Phase 2 could include one onshore transmission system in Barnstable and/or an onshore transmission system(s) in proximity to the second grid interconnection point. Figure 4.1-7 identifies a “Phase 2 South Coast Variant Onshore Routing Envelope” that indicates potential locations in southwest Massachusetts where landfall site(s), Onshore Export Cable Route(s), onshore substation(s), and Grid Interconnection Route(s) may be located if the South Coast Variant is employed.

4.2 Phase 2 Structures and Facilities – General Structural Design and Fabrication

4.2.1 Phase 2 Offshore Facilities

The Phase 2 offshore facilities include wind turbine generators (WTGs), electrical service platforms (ESP[s]), WTG and ESP foundations, inter-array cables, and offshore export cables. Phase 2 may also include scour protection for foundations and inter-link cables. The WTGs, ESP(s), inter-array cables, inter-link cables, and portions of the offshore export cables are in federal waters. The remaining portions of the offshore export cables are in Massachusetts waters.

4.2.1.1 Wind Turbine Generators

As described in Section 4.1.2, 64 to 88 WTG/ESP positions are expected to be available for Phase 2 depending on the final footprint of Phase 1. Thus, Phase 2 could have a maximum of 88 WTGs if all available positions are used for WTGs.

The WTGs consist of two main components: the Rotor Nacelle Assembly (RNA) and the tower. The RNA consists of a three-bladed rotor connected at the hub and a nacelle. The RNA is mounted on the tower. The tower is typically constructed in two or more sections and is mounted on a foundation via a bolted and/or grouted connection (see Section 4.2.1.2 for further description of WTG foundations). Both the nacelle and the tower are steel structures coated to protect against corrosion in harsh marine environments.

The nacelle contains a driveshaft and gearbox or direct-drive system (depending on WTG type), the electrical generator, motors to yaw and pitch the WTG, and workspaces for maintenance of the WTG. Wind sensors mounted on the top of the nacelle are used to control the yaw and pitch systems, which turn the RNA and adjust the angle of the blades to optimize power production and maintain the WTG's safety in high winds. The brake, pitch, and yaw systems may be operated using electric or hydraulic control systems. The nacelle also contains a full array of instrumentation, cables, controls, fire protection systems, other safety equipment, ventilation and cooling, and ancillary equipment. A helihoist platform may be located on top of the nacelle.

For service purposes, the WTGs will likely be equipped with auxiliary cranes in the nacelle and on the external working platform (which is mounted on the foundation and/or transition piece [TP]) capable of lifting spare parts to their proper location in accordance with operations and maintenance procedures. The WTGs will also likely include access ways for personnel inside the tower, including an elevator that will serve as the main access route. Ladders would serve as a secondary access route. All access routes will be designed to promote safety and will comply with all relevant standards and regulations in effect at the time Phase 2 proceeds toward construction. In addition, generators and/or batteries could be installed in the WTGs or on their foundations to provide standby/emergency power. Lightning protection would be installed on the WTGs to protect the WTGs' electrical systems.

The WTG parameters for Phase 2 are provided in the table below and illustrated in Figure 4.2-1.

Table 4.2-1 Phase 2 WTG Parameters

WTG Parameter	Dimension
Maximum Tip Height	357 m (1,171 ft) MLLW[1]
Maximum Top of The Nacelle Height[2]	221 m (725 ft) MLLW
Maximum Hub Height	214 m (702 ft) MLLW
Maximum Rotor Diameter	285 m (935 ft)
Minimum Tip Clearance	27 m (89 ft) MLLW
Maximum Blade Chord	9 m (30 ft)
Maximum Tower Diameter	10 m (33 ft)

Notes: WTG tip height, hub height, tip clearance, and rotor diameter dimensions may not align perfectly due to rounding and unit conversions.

1 Mean Lower Low Water (MLLW) is the average height of the lowest tide recorded at a tide station each day during the recording period. Elevations relative to Mean Higher High Water (MHHW) are approximately 1 m (3 ft) lower than those relative to MLLW.

2 Height includes Federal Aviation Administration (FAA) lights and other appurtenances.

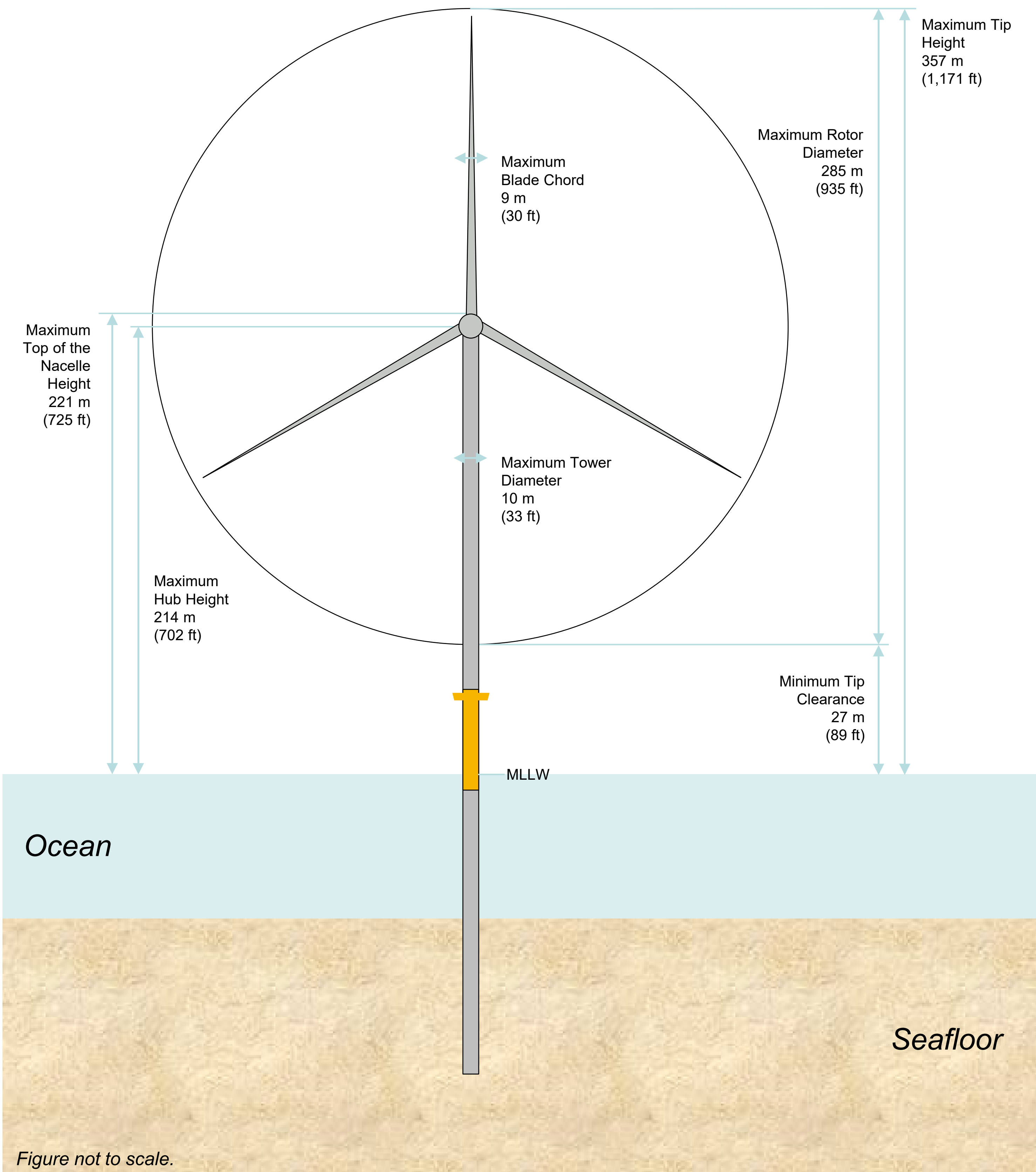


Figure 4.2-1

Phase 2 Wind Turbine Generator

The WTG design will be verified for the specific site conditions during the Certified Verification Agent (CVA) review process (see Section 4.2.3.2), where the design will be able to withstand wind speeds and gusts anticipated at the SWDA (see Appendix I-E). The WTGs will be designed to automatically stop power production when wind speeds exceed a maximum value, after which the rotor will normally idle. The exact speed at which power production will cease depends on the manufacturer's specifications. The structures will be designed for the extreme environmental conditions (including wind speed and wave height) verified by the CVA.

The WTGs will include an aviation obstruction lighting system in compliance with Federal Aviation Administration (FAA) and/or BOEM requirements in effect at the time Phase 2 proceeds. Unless current guidance is modified by the FAA and BOEM, the aviation obstruction lighting system will likely consist of two synchronized FAA L-864 red flashing aviation obstruction lights placed on the nacelle of each WTG. If the WTGs' total tip height is 213.36 m (699 ft) or higher, there will be at least three additional low intensity L-810 flashing red lights on the tower at a point approximately midway between the top of the nacelle and sea level. The frequency of flashes per minute will be established in consultation with BOEM when Phase 2 proceeds. Other temporary lighting (e.g. helicopter hoist status lights) may be utilized for safety purposes when necessary.

During Phase 2, efforts will continue to reduce lighting to lessen the potential impacts of nighttime light on migratory birds and to address potential visual impacts. The Proponent expects to use the same or similar approaches used for Vineyard Wind 1 and/or Phase 1, including the use of an Aircraft Detection Lighting System (ADLS) that is activated automatically by approaching aircraft. A report on how often the ADLS would be activated is included in Appendix III-N for informational purposes. If the use of ADLS is not approved or feasible, reduced lighting schemes would be reviewed and discussed with BOEM. Unless BOEM and FAA guidance is modified before Phase 2 proceeds, the WTGs will be no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey in color; the Proponent anticipates that the WTGs will be painted off-white/light grey to reduce their visibility against the horizon.

Marine navigation lighting and marking of the WTGs will follow US Coast Guard (USCG) and BOEM regulations and guidance in effect at the time Phase 2 proceeds. The Proponent plans to maintain each WTG as a Private Aid to Navigation (PATON). Based on USCG's current *ME, NH, MA, RI, CT, NY, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance* contained in District 1 Local Notice to Mariner (LNM) 44/20, the Proponent expects to implement a uniform system of marine navigation lighting and marking that includes yellow flashing lights on every WTG foundation and alphanumeric identifiers (as close to 3 m [10 ft] high as possible) on each WTG tower and/or foundation. The lights and alphanumeric identifiers would be visible from all directions. The Proponent also expects to indicate the WTG's air draft restriction on the foundation and/or tower. Mariner Radio Activated Sound Signals (MRASS) and Automatic Identification System (AIS) transponders are included in the offshore facilities' design to enhance marine navigation safety. The number, location, and type of MRASS and AIS transponders will be determined in consultation with USCG. Additional information on marine navigation marking and lighting can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

4.2.1.2 WTG Foundations

The types and combinations of foundations used for Phase 2 will depend on market conditions, supply chain availability, and technological advancements in foundation design and installation methods at the time Phase 2 proceeds to construction. For the purposes of the COP, it is reasonable to assume the consideration of the following three WTG foundation concepts in the Phase 2 Envelope:

- Monopiles (with or without TPs)
- Jackets (with piles or suction buckets)
- Bottom-frame foundations (with piles or suction buckets)

Of these options, monopiles and piled jacket foundations are proven concepts that are more foreseeable options for Phase 2 than the other foundation concepts. Jackets with suction buckets and bottom-frame foundations (with piles or suction buckets) are relatively immature technologies. At present, the use of suction buckets in offshore wind is limited, with two small demonstration projects using suction bucket jackets in Europe: Ørsted's Borkum Riffgrund II and Vattenfall's Aberdeen Offshore Wind Farm. Although both demonstration projects were ultimately successfully installed, both were beset by challenges, resulting in the cancellation of a planned deployment by Ørsted at the Hornsea One offshore wind farm. Further, the supply chain outlook for suction bucket jackets and bottom-frame foundations is uncertain.

However, an initial screening analysis indicated that suction bucket jackets and bottom-frame foundations may be feasible for Phase 2. Accordingly, these foundation types are included in the Phase 2 Envelope in anticipation that further development and refinement of these foundation types could enable them to be technically and economically viable for Phase 2. Detailed engineering would be required to confirm that they are technically feasible and commercially viable for Phase 2.

4.2.1.2.1 Monopiles (With or Without Transition Pieces)

The Phase 2 WTGs may be supported by monopiles (see Figure 4.2-2). A separate TP may be installed between the monopile and WTG tower or an extended monopile concept may be used. The base of the monopile will have j-shaped steel tubes (J-tubes) or an opening to allow the inter-array cables to enter and exit the foundation safely. The foundation is expected to contain secondary structures such as boat landing(s), internal and external platforms, and various electrical equipment needed during installation and operation (e.g. cranes).

The monopile foundations will be equipped with a corrosion protection system designed in accordance with relevant standards in effect at the time Phase 2 proceeds. The monopiles will likely require the use of an anode cage (a steel structure that has anodes attached to it) to ensure sufficient corrosion protection closer to the seabed. It is anticipated that the monopiles will be surrounded by scour protection (see Section 4.2.1.4).

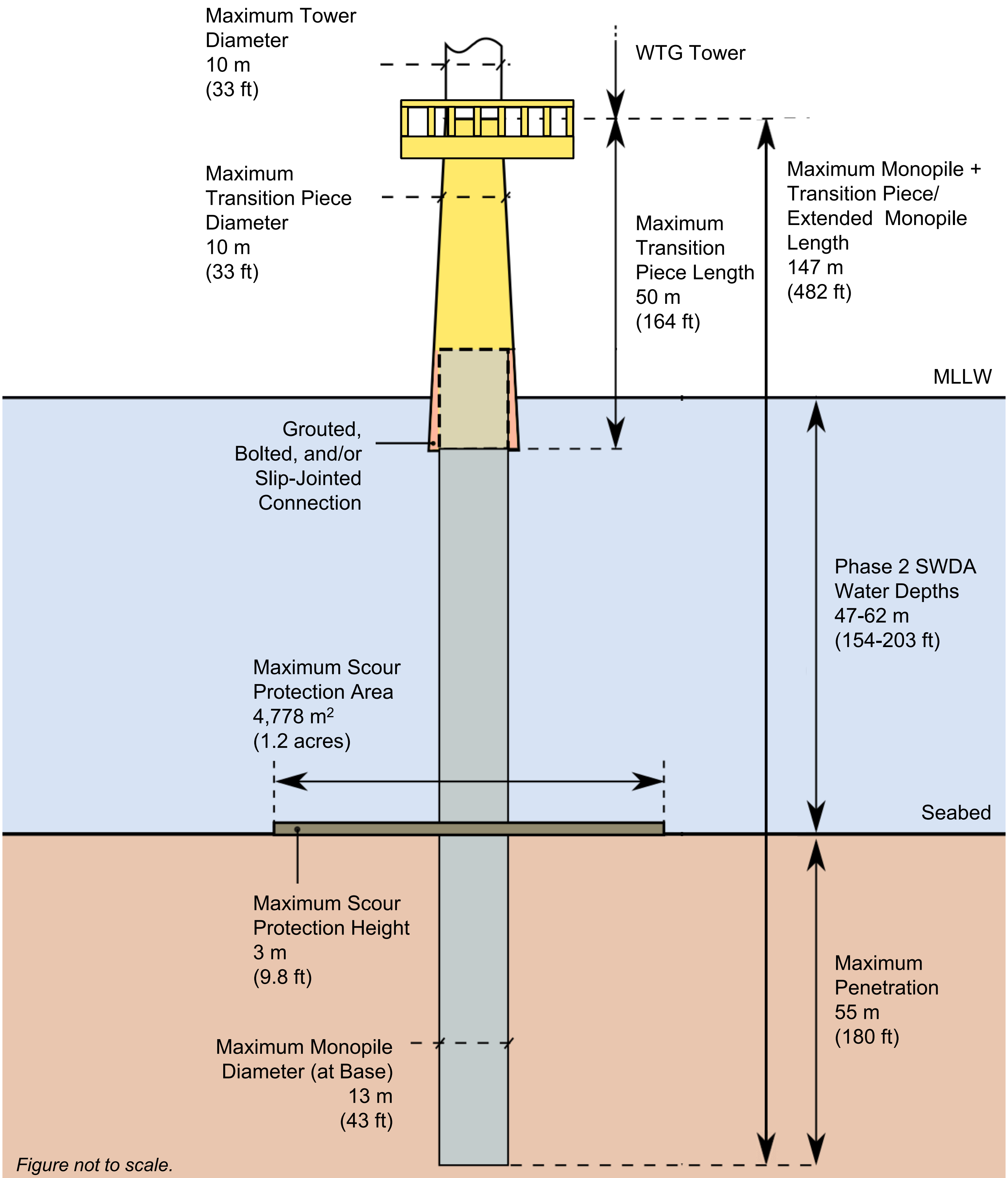


Figure 4.2-2

Phase 2 WTG Foundation - Monopile

4.2.1.2.2 Jackets (Piled or Suction Bucket)

The Phase 2 WTGs may be supported by jacket foundations that are secured to the seafloor using either pin piles or suction buckets.

If piled jackets are used, three or four piles would secure the foundation to the seafloor (see Figure 4.2-3). The piles may be driven through pile "sleeves" or guides mounted to the base of each leg. Alternatively, the piles may be pre-installed prior to the installation of the jacket structure. Piled jackets may include mudmats at the base of each leg to transfer and distribute the load of the jacket to the seafloor sediments and provide temporary support prior to pile driving.

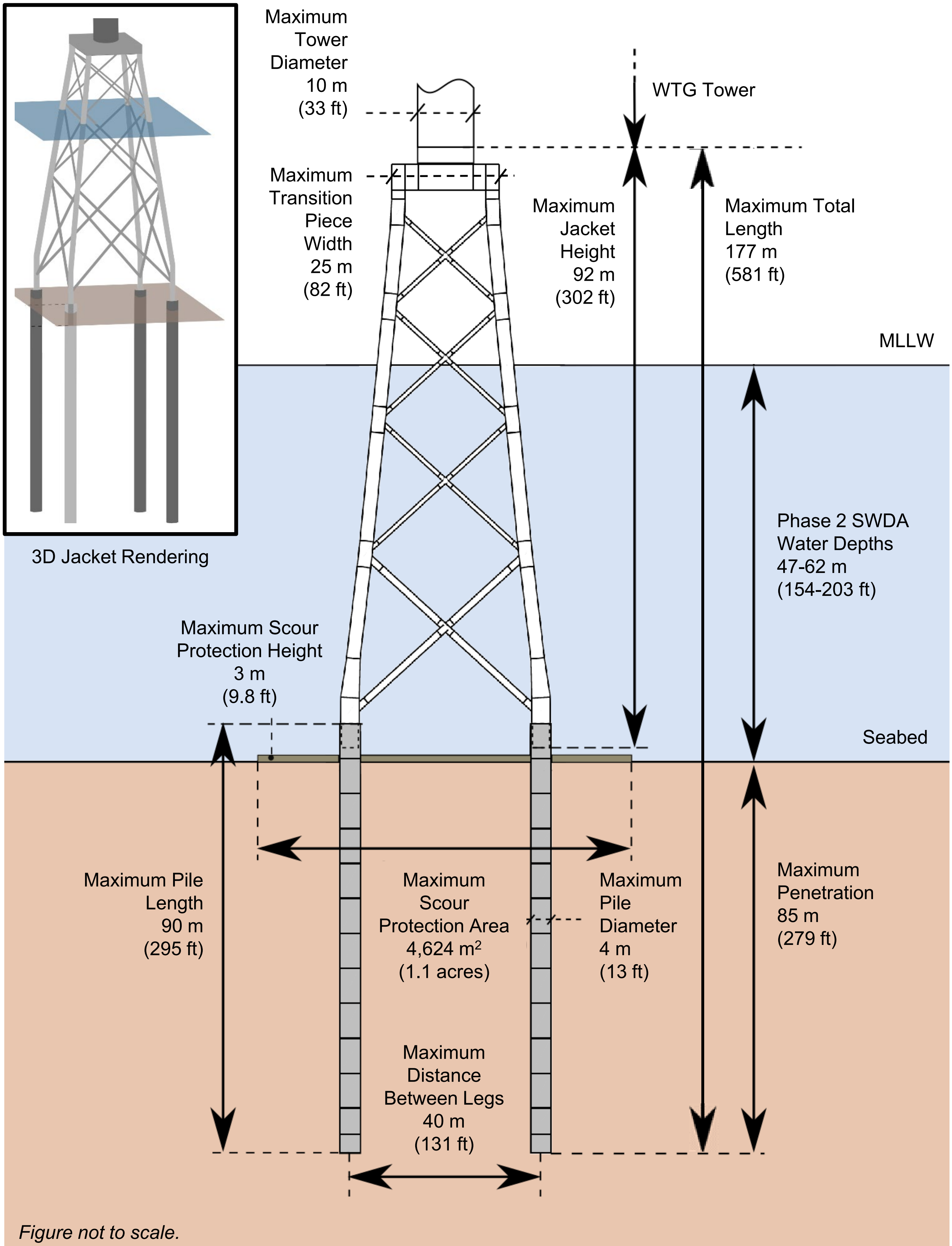
If used, suction bucket[69] jackets would contain a suction bucket (i.e. an inverted steel bucket) at the base of each leg (see Figure 4.2-4). A suction pump attached at the top of the bucket would reduce water pressure inside the bucket by pumping water out, which would create a driving force to push the bucket down into the seafloor. When the pushing force is large enough to overcome the soil resistance, the bucket penetrates the seafloor. Penetration of the bucket would stop when the pushing force is equal to the soil resistance.

The jackets would likely include an integrated TP and contain secondary structures such as boat landing(s), cable tubes, a tower flange for mounting the WTG, internal and external platforms, and various types of electrical equipment needed during installation and operation. The jackets would also contain J-tubes or a similar alternative to allow the inter-array cables to enter and exit the foundation safely. Further, as described for the monopiles (see Section 4.2.1.2.1, above), the jackets would be equipped with a corrosion protection system (e.g. anode cage) designed in accordance with relevant standards applicable at the time Phase 2 proceeds. The jackets may or may not be surrounded by scour protection (see Section 4.2.1.4).

4.2.1.2.3 Bottom-Frame Foundations (Piled or Suction Bucket)

A bottom-frame foundation is a triangular space-frame type structure. It consists of a central vertical column, which supports the WTG tower, connected to three members that radiate outwards from the base of the vertical column horizontally along the seabed towards the feet of the foundation. Three inclined diagonal elements connect the mid-point of the vertical column to the foundation feet and three lateral elements may be used to connect the feet to each other. At each foot, the structure would be secured to the seafloor using driven piles, which are long slender piles similar to those used by piled jacket foundations (see Figure 4.2-5), or suction buckets similar to those used for suction bucket jackets (see Figure 4.2-6).

[69] Although suction buckets are not included in the Phase 1 Envelope, they are included in the Phase 2 Envelope in case further development and refinement of suction buckets enable the foundation concept to become technically and economically viable for Phase 2 (see Section 4.2.3.3.3).



New England Wind
AVANGRID RENEWABLES

Figure 4.2-3

Phase 2 WTG Foundation – Piled Jacket

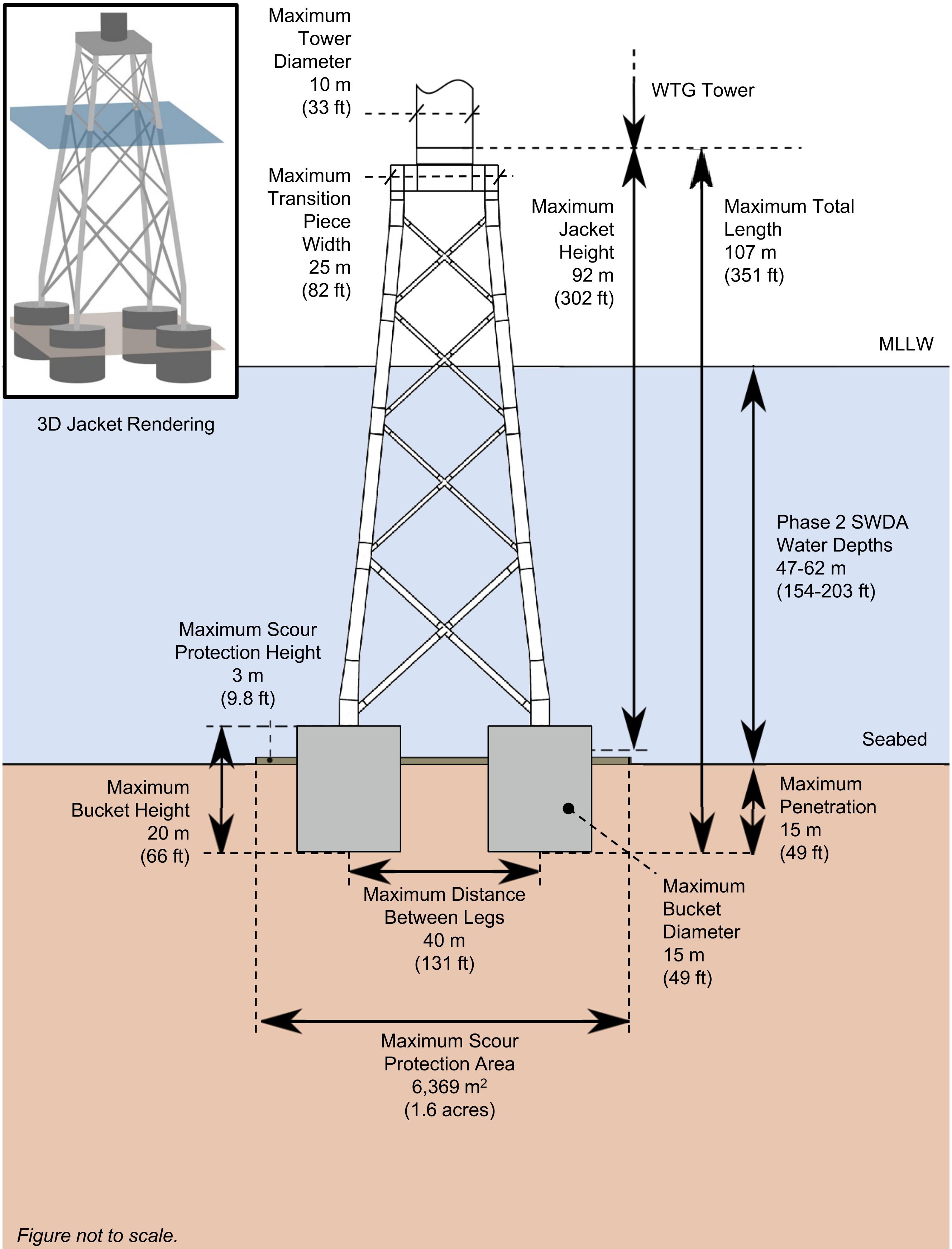
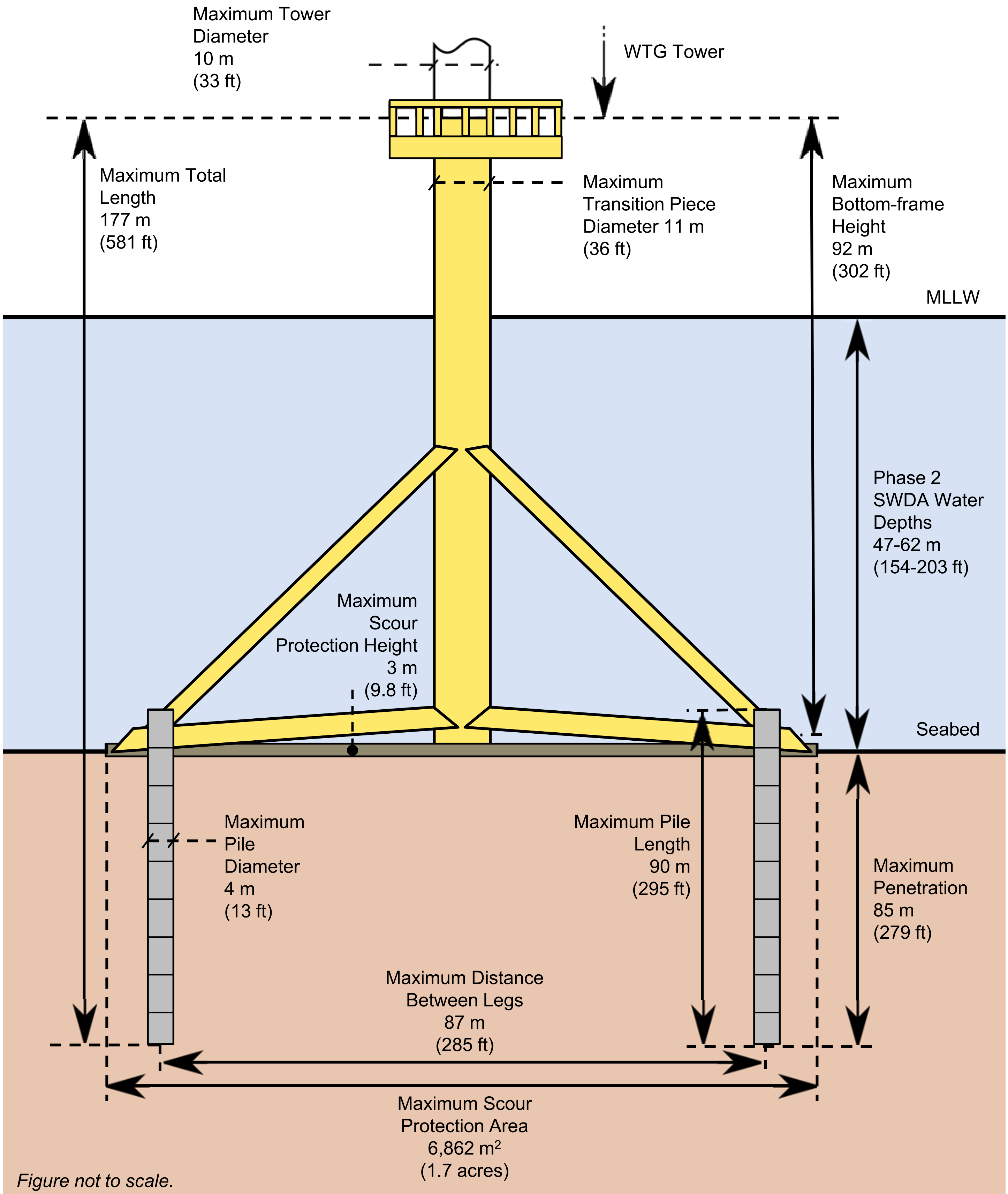


Figure 4.2-4

Phase 2 WTG Foundation – Suction Bucket Jacket



New England Wind

AVANGRID RENEWABLES

Figure 4.2-5

Phase 2 WTG Foundation – Piled Bottom-Frame

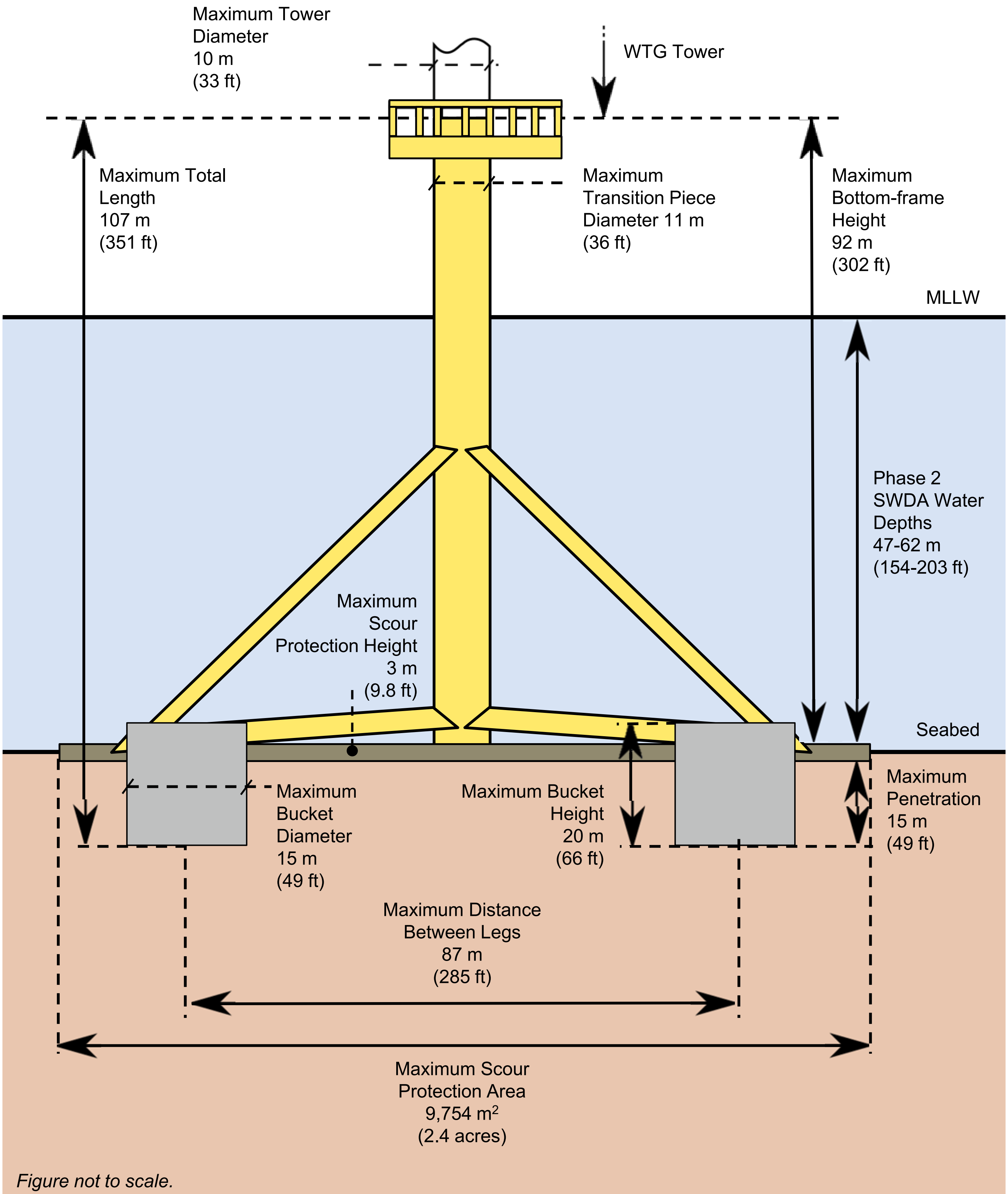


Figure 4.2-6

Phase 2 WTG Foundation – Suction Bucket Bottom-Frame

The bottom-frame foundation is similar to a conventional jacket foundation (see Section 4.2.1.2.2), but generally has fewer, larger structural tubular members, no small-diameter lattice cross-bracing, and a single central vertical tubular column. The reduced number of structural elements means that bottom-frame foundations will be less expensive and faster to assemble (which typically occurs at the quayside) than other foundation options. Typically, a bottom-frame foundation has a larger footprint than a conventional jacket, which reduces the loads generated by the WTG and allows the use of smaller driven piles.

If used, the bottom-frame foundations could be connected to the WTG tower directly or through a TP. Similar to jackets, bottom-frame foundations are expected to include secondary structures (e.g. boat landing(s), internal and external platforms, etc.). The foundations would also contain J-tubes or a similar alternative to allow cables to enter and exit the foundation safely. Like the monopiles and jackets described above (see Sections 4.2.1.2.1 and 4.2.1.2.2, above), the bottom-frame foundation would be equipped with a corrosion protection system (e.g. anode cage) designed in accordance with relevant standards in effect at the time Phase 2 proceeds. The bottom-frame foundations may or may not be surrounded by scour protection (see Section 4.2.1.4).

4.2.1.2.4 Phase 2 Maximum WTG Foundation Parameters

As noted above, commercial and technical considerations at the time Phase 2 is ready to proceed will determine the types of WTG foundations used for Phase 2. Monopiles, jackets, bottom-frame foundations, or a combination of those foundation types may be used for Phase 2 pending the outcome of a foundation feasibility analysis.

The WTG foundation parameters for Phase 2 are provided in the table below and illustrated in Figures 4.2-2 through 4.2-6. Representative photographs of various foundation concepts can be found in Figure 4.2-7.

Figure 4.2-7
Representative Photographs of WTG Foundations

Table 4.2-2 Phase 2 WTG Foundation Dimensions

Concept	Monopiles	Jackets		Bottom-Frame Foundations	
	With or Without TP	Piles (3-4 Piles)	Suction Bucket (3 Buckets)	Piled (3 Piles)	Suction Bucket (3 Buckets)
Maximum Total Length (from interface with WTG to deepest point beneath the seafloor)	147 m (482 ft)	177 m (581 ft)	107 m (351 ft)	177 m (581 ft)	107 m (351 ft)
Maximum Pile Length/ Bucket Height	147 m (482 ft)[1]	90 m (295 ft)	20 m (66 ft)	90 m (295 ft)	20 m (66 ft)
Maximum Pile/Bucket Diameter at Base	13 m (43 ft)	4 m (13 ft)	15 m (49 ft)	4 m (13 ft)	15 m (49 ft)
Maximum Penetration	55 m (180 ft)	85 m (279 ft)	15 m (49 ft)	85 m (279 ft)	15 m (49 ft)
Maximum TP Length for Monopiles/Height above Mudline for Jackets and Bottom-Frames	50 m (164 ft)	92 m (302 ft)	92 m (302 ft)	92 m (302 ft)	92 m (302 ft)
Maximum TP Diameter/Width[2]	10 m (33 ft)	25 m (82 ft)	25 m (82 ft)	11 m (36 ft)	11 m (36 ft)
Maximum Distance Between Adjacent Legs	N/A	40 m (131 ft)	40 m (131 ft)	87 m (285 ft)	87 m (285 ft)

Notes: Dimensions may not sum perfectly due to rounding and unit conversions.

1. Indicates the maximum monopile length using an extended monopile concept.
2. Transition piece diameter/width does not include any secondary structures such as boat landing(s) and external platforms.

For each foundation type, marine navigation lighting and marking will follow USCG and BOEM regulations and guidance in effect at the time Phase 2 proceeds. As described in Section 4.2.1.1 above, the Proponent plans to maintain each WTG as a PATON. The Proponent currently expects the uniform lighting and marking system to include yellow flashing lights on every WTG foundation, alphanumeric identifiers (as close to 3 m [10 ft] high as possible) on each WTG tower and/or foundation, and high-visibility yellow paint on each foundation (above sea level). Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

4.2.1.3 Electrical Service Platforms (Topsides and Foundations)

Phase 2 will include up to three ESPs. Alternatively, the ESPs could potentially be integrated onto a WTG foundation. This concept entails placing ESP equipment on one or more expanded WTG foundation platforms rather than having a separate ESP situated on its own foundation.[70] The potential ESP locations are shown on Figure 4.1-4. Photographs of ESPs can be found in Figure 4.2-8. A schematic of an ESP integrated onto a WTG foundation is provided as Figure 4.2-9.

Power generated by the WTGs will be transmitted to the ESP(s) via 66 to 132 kV inter-array cables. From the ESP(s), the offshore export cables will transmit electricity to shore. Additional information about the offshore cable systems is included in Sections 4.2.1.5 and 4.2.1.6.

Each ESP would be installed on a monopile, a piled jacket, or a suction bucket jacket. ESP monopile and jacket foundations are similar in concept to the WTG foundations described in Sections 4.2.1.2.1 and 4.2.1.2.2, but have different maximum dimensions. The ESP topside and foundation parameters for Phase 2 are provided in the tables below and illustrated in Figures 4.2-10 through 4.2-12. The ESP foundation(s) may or may not be surrounded by scour protection (see Section 4.2.1.4). If two or three ESPs are used, they may be located at separate positions or two of the ESPs may be co-located at one of the potential ESP positions shown on Figure 4.1-4 (co-located ESPs would be smaller structures installed on monopile foundations). If co-located ESPs are used, each ESP's monopile foundation would be located within 76 m (250 ft) of one of the potential ESP locations (i.e. the monopiles would be separated by up to 152 m [500 ft]).

Additional equipment on each ESP is subject to final design but could include: switchgear, transformer oil spill tanks, shunt reactors, auxiliary systems, cooling systems, fire pumps, an oil/water separator, fire detection and firefighting equipment, cranes, rescue and evacuation facilities and equipment, supervisory control and data acquisition (SCADA) equipment, a heating, ventilation, and air conditioning system, generators, batteries, and communications and navigation systems. Lightning protection would also be installed to protect each ESP's electrical system. The ESP(s) may also include a helipad for maintenance work and is anticipated to include at least one boat landing.

The ESP(s) will include an aviation obstruction lighting system in compliance with FAA and/or BOEM requirements in effect at the time Phase 2 proceeds, if necessary. The aviation obstruction lights would be activated by ADLS (or similar), subject to BOEM approval. Other temporary lighting (e.g. helipad lights) may be utilized for safety purposes when necessary.

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70 The concept of a WTG and ESP sharing a single foundation is further explained in Offshore Wind Programme Board's (2016) Lightweight Offshore Substation Designs – Final Summary Report found at: https://ore.catapult.org.uk/app/uploads/2018/02/Lightweight-Offshore-Substation-Designs.pdf

Figure 4.2-8

Representative Photographs of Electrical Service Platforms

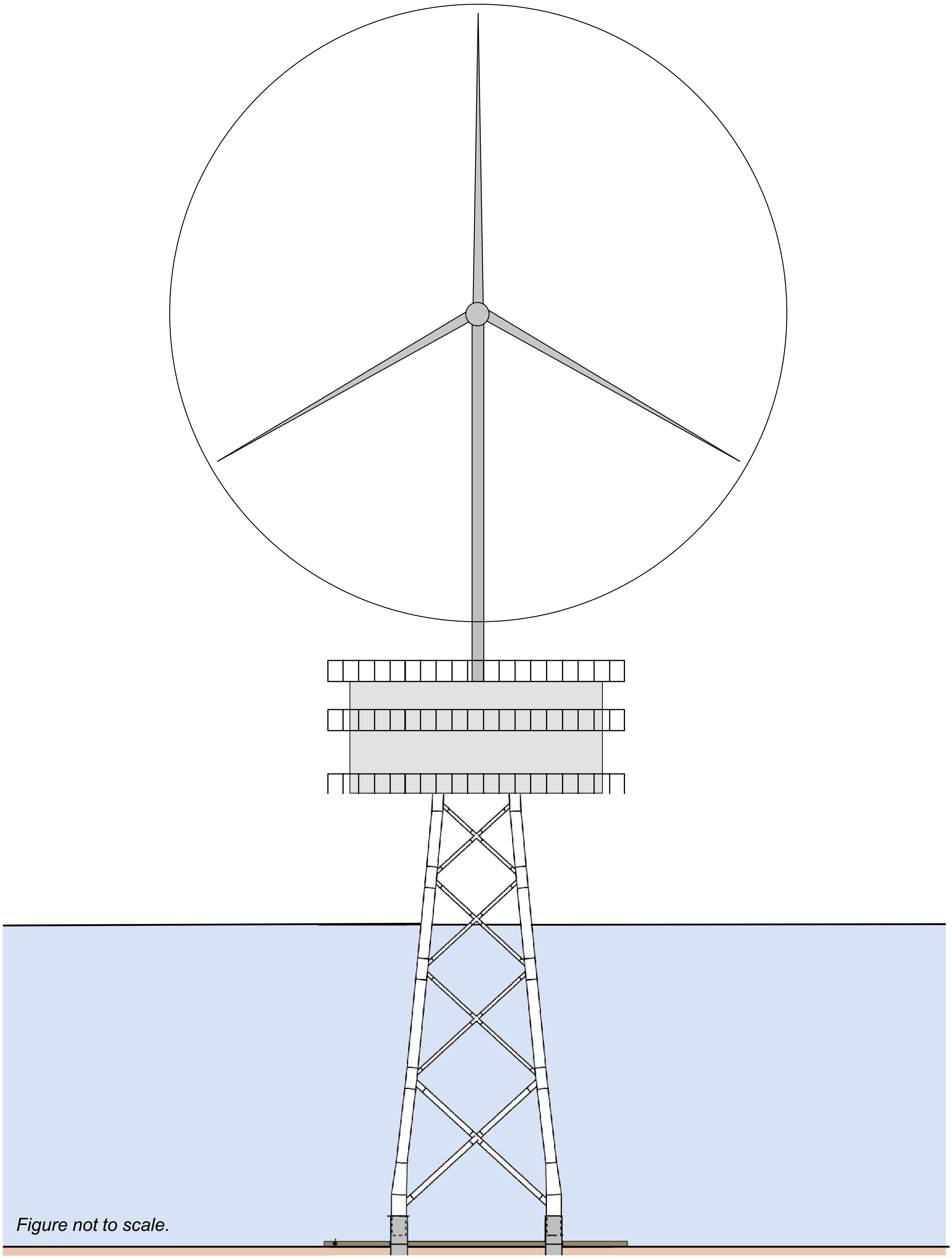


Figure 4.2-9

Schematic of an Integrated WTG and ESP Concept

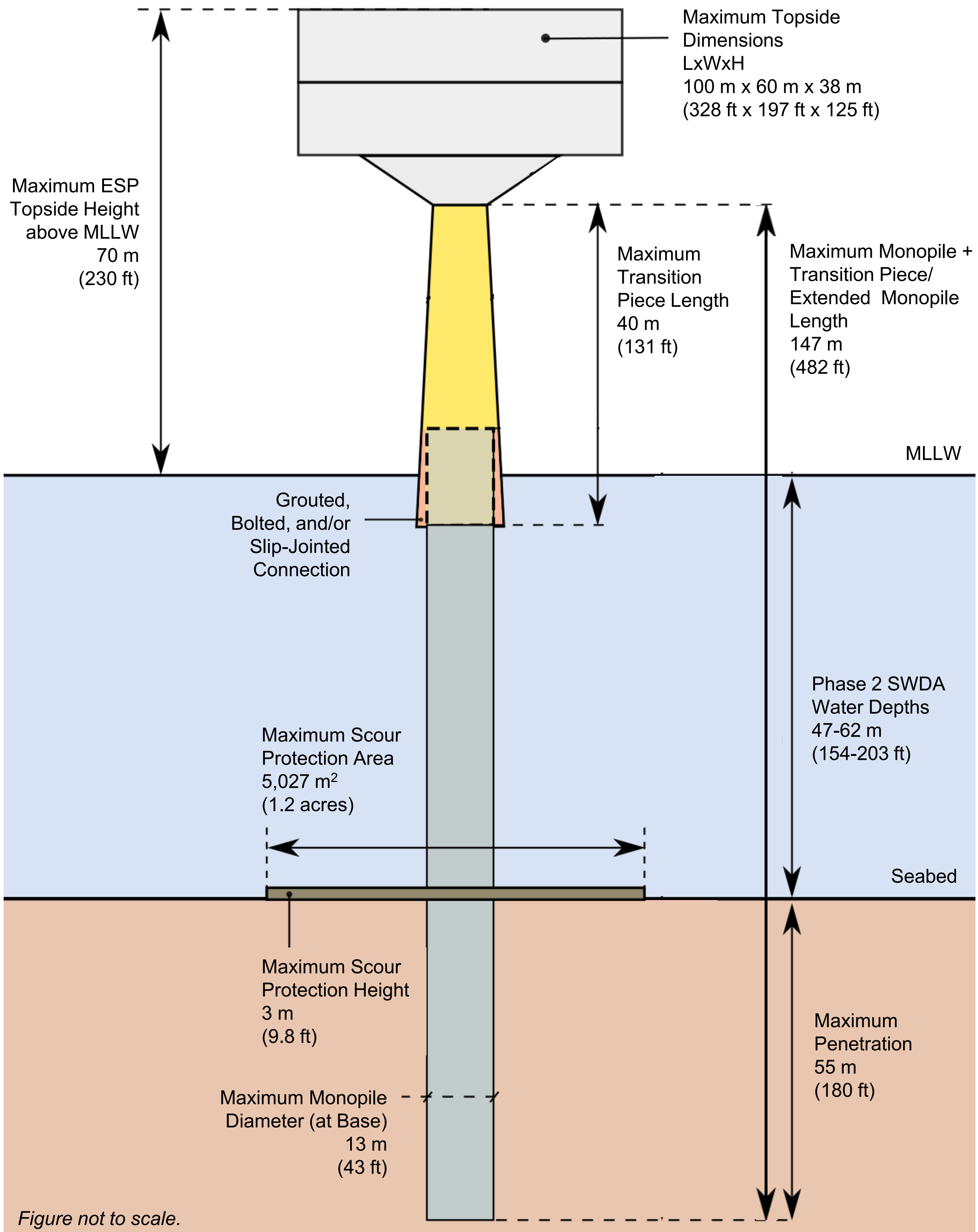


Figure 4.2-10

Phase 2 ESP Topside and Foundation - Monopile

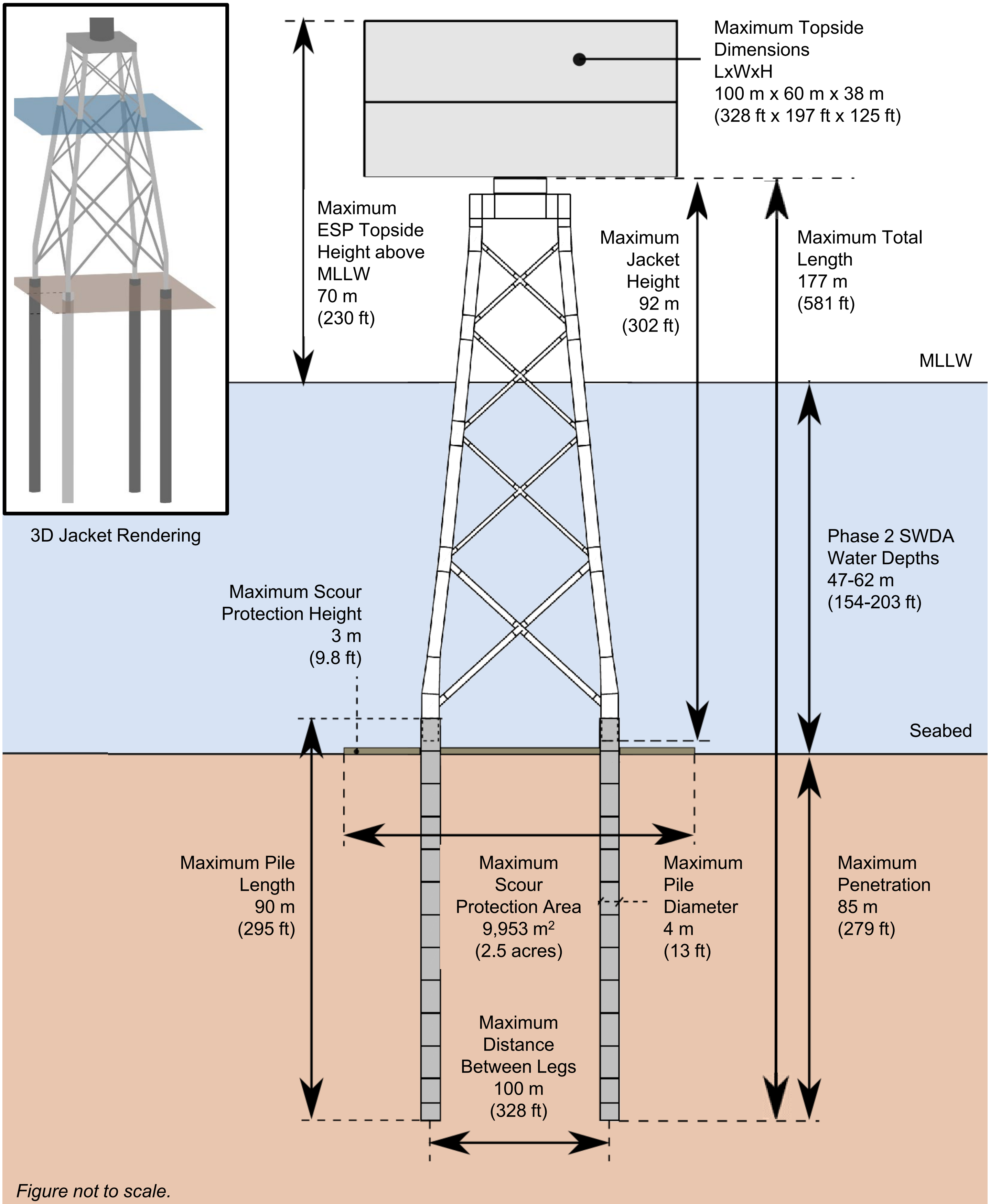


Figure 4.2-11

Phase 2 ESP Topside and Foundation - Piled Jacket

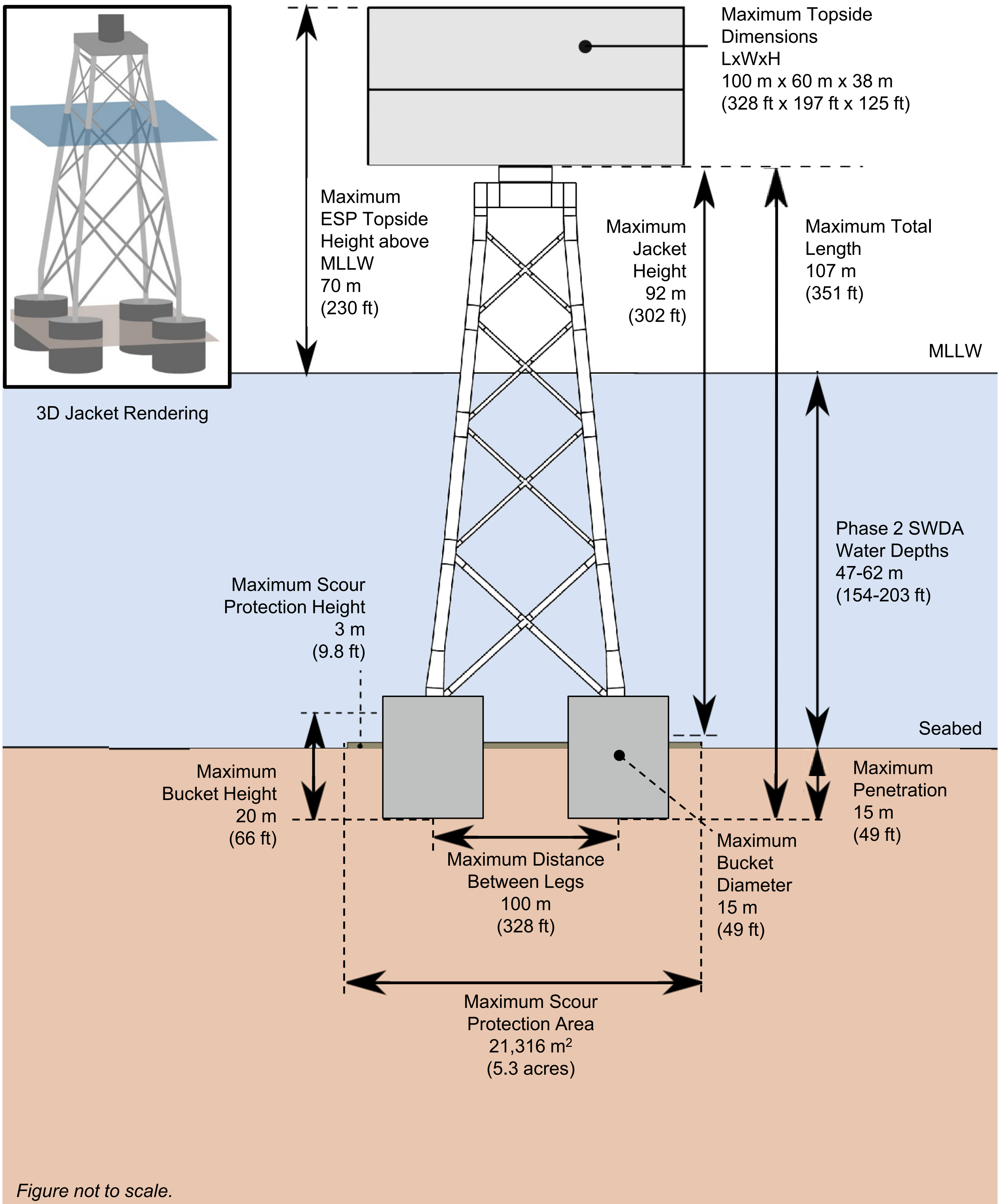


Figure 4.2-12

Phase 2 ESP Topside and Foundation - Suction Bucket Jacket

Marine navigation lighting and marking on each ESP will follow USCG and BOEM regulations and guidance in effect at the time Phase 2 proceeds. Like the WTGs, the Proponent plans to maintain each ESP as a PATON in accordance with USCG's PATON marking guidance for offshore wind facilities in First District-area waters (see Section 4.2.1.1). The Proponent currently expects each ESP to include yellow flashing lights, alphanumeric identifiers, and high-visibility yellow paint on each foundation. Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (see Appendix III-I).

Table 4.2-3 Phase 2 ESP Topside Dimensions

ESP Topside Parameter	Dimension
Maximum Width	60 m (197 ft)
Maximum Length	100 m (328 ft)
Maximum Height	38 m (125 ft)
Maximum Height of Topside above MLLW	70 m MLLW (230 ft MLLW)

Note: Dimensions include possible helipad but do not include antennae.

Table 4.2-4 Phase 2 ESP Foundation Dimensions

Foundation Concept	Monopiles	Piled Jackets	Suction Bucket Jackets
Number of Legs per Foundation	1	3–6	3-6
Number of Piles Driven per Foundation	1	3–12	0
Maximum Total Length (from interface with ESP to deepest point beneath the seafloor)	147 m (482 ft)	177 m (581 ft)	107 m (351 ft)
Maximum Pile/Bucket Length	147 m (482 ft)[1]	90 m (295 ft)	20 m (66 ft)
Maximum Pile/Bucket Diameter at Base	13 m (43 ft)	4 m (13 ft)	15 m (49 ft)
Maximum Penetration	55 m (180 ft)	85 m (279 ft)	15 m (49 ft)
Maximum TP Length for Monopiles/Jacket Height above Mudline	40 m (131 ft)	92 m (302 ft)	92 m (302 ft)
Maximum Distance Between Adjacent Legs	N/A	100 m (328 ft)	100 m (328 ft)

Notes: Dimensions may not sum perfectly due to rounding and unit conversions.

1. Indicates the maximum monopile length using an extended monopile concept.

4.2.1.4 Scour Protection

Scour protection may be installed around each WTG and ESP foundation to protect the foundations from scour development. If used, scour protection would consist of rock material placed around the foundation in one or two layers; if installed in two layers, the lower first layer (i.e. the filter layer) would consist of smaller rock size followed by an upper armor layer consisting of larger rock.

An evaluation of the potential for scour at the SWDA (included as Appendix III-Q) found that, due to low currents within the SWDA, there is low sediment mobility and transport; therefore, significant scour is not expected. The need for scour protection is specific to the final design of the foundation concept(s) selected and will be further assessed upon detailed engineering of the foundations. It is anticipated that scour protection will be needed for the larger diameter monopiles and suction buckets, but may or may not be needed for the smaller diameter piles used for jacket and bottom-frame foundations.

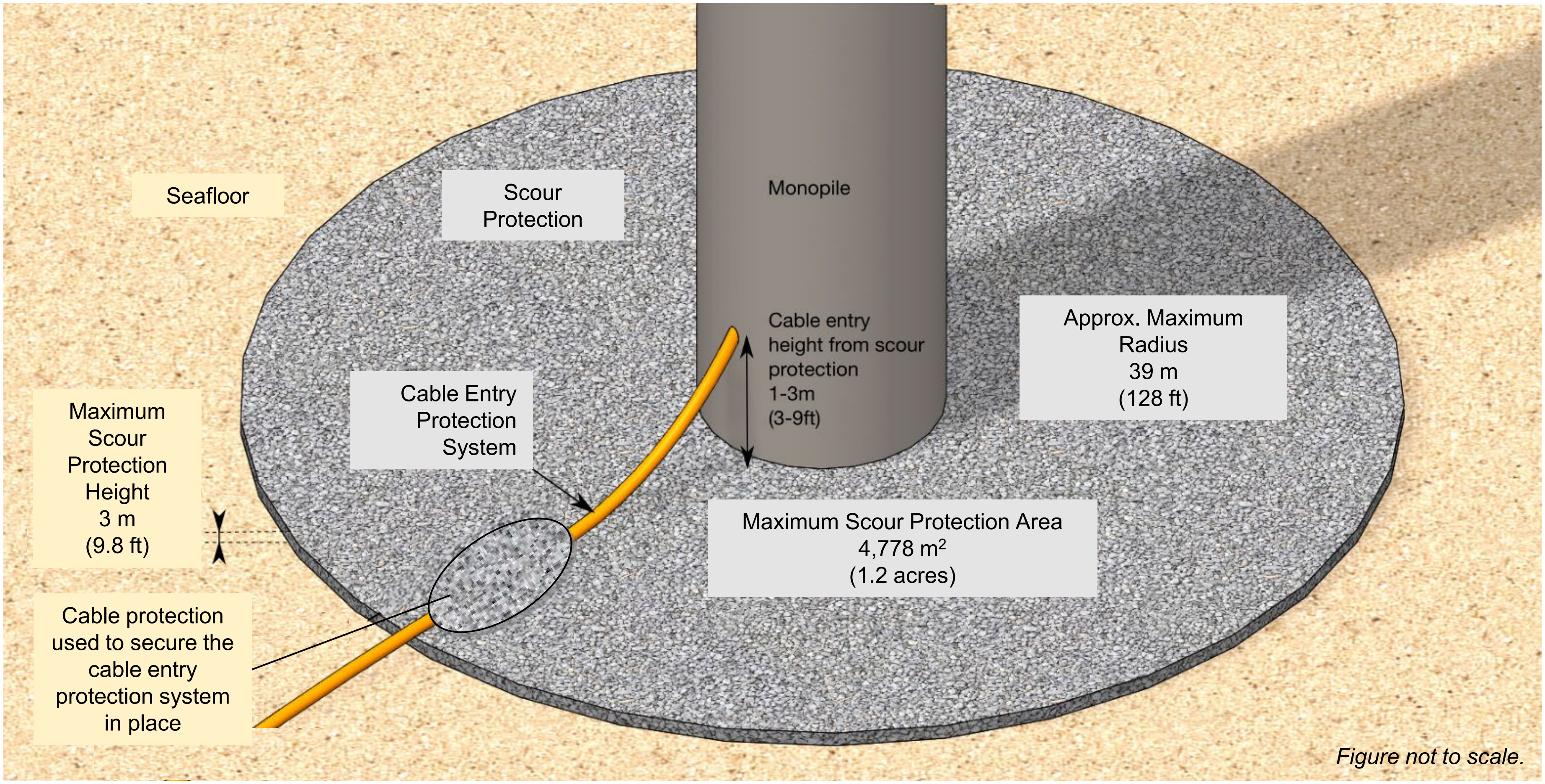
Table 4.2-5 and 4.2-6 below contain the maximum scour protection dimensions associated with each Phase 2 WTG and ESP foundation concept, respectively. The Proponent may install scour protection of any shape and size up to the maximum heights and areas provided below (including no scour protection). An example of scour protection for the monopile foundation concept is illustrated in Figure 4.2-13.

Table 4.2-5 Phase 2 WTG Scour Protection Dimensions

Concept	WTG Foundations				
	Monopile	Piled Jacket (3-4 Piles)	Suction Bucket Jacket (3 Buckets)	Piled Bottom-Frame (3 Piles)	Suction Bucket Bottom-Frame (3 Buckets)
Maximum Scour Protection Height	3 m (9.8 ft)	3 m (9.8 ft)	3 m (9.8 ft)	3 m (9.8 ft)	3 m (9.8 ft)
Approximate Maximum Dimensions[1]	Radius of 39 m (128 ft)	Square/rectangle with sides of 68 m (223 ft)	Triangle with sides of 121 m (397 ft)	Triangle with sides of 126 m (413 ft)	Triangle with sides of 150 m (492 ft)
Maximum Area of Scour Protection per Foundation[2]	4,778 m^2 (1.2 acres)	4,624 m^2 (1.1 acres)	6,369 m^2 (1.6 acres)	6,862 m^2 (1.7 acres)	9,754 m^2 (2.4 acres)

Notes: Dimensions may not sum/multiply perfectly due to rounding and unit conversions.

1. The approximate dimensions of scour protection are provided for informational purposes; however, the scour protection may not be the shape described (e.g. scour protection for a jacket may be a rounded triangle or donut-shaped). Regardless of the shape, the area of scour protection will fall within the maximum area of scour protection provided above.
2. The area of scour protection includes the physical footprint of the foundation.



Note: Conceptual drawing provided for Phase 2 monopile foundations only; scour protection dimensions for jacket and bottom-frame foundations are provided in Tables 4.2-5 and 4.2-6 and may not be circular.

Figure 4.2-13

Typical Scour Protection for Phase 2 Monopile Foundations

Table 4.2-6 Phase 2 ESP Scour Protection Dimensions

Concept	ESP Foundations		
	Monopile	**Piled Jackets (3-12 Piles)**	**Suction Bucket Jackets (3-6 Buckets)**
Maximum Scour Protection Height	3 m (9.8 ft)	3 m (9.8 ft)	3 m (9.8 ft)
Approximate Maximum Dimensions[1]	Radius of 40 m (131 ft)	Rectangle with sides of 129 m x 77 m (423 ft x 253 ft)	Rectangle with sides of 146 m (479 ft)
Maximum Area of Scour Protection per Foundation[2]	5,027 m^2 (1.2 acres)	9,953 m^2 (2.5 acres)	21,316 m^2 (5.3 acres)

Notes: Dimensions may not sum/multiply perfectly due to rounding and unit conversions.

1. The approximate dimensions of scour protection are provided for informational purposes; however, the scour protection may not be the shape described (e.g. scour protection for a jacket may be a rounded triangle or donut-shaped). Regardless of the shape, the area of scour protection will fall within the maximum area of scour protection provided above.
2. The area of scour protection includes the physical footprint of the foundation.

4.2.1.5 Offshore Export Cables

4.2.1.5.1 Offshore Export Cable Design

Two or three 220–345 kV high voltage alternating current (HVAC) offshore export cables will transmit electricity from the Phase 2 ESP(s) to the selected landfall site(s). Each offshore export cable is expected to be comprised of a three-core cable for power transmission and one or more fiber optic cables[71] (see Figure 4.2-14). The three cores of the cable are expected to consist of copper or aluminum conductors. Currently, offshore export cables are typically encapsulated by steel armoring, cross-linked polyethylene (XLPE) insulation, and waterproof sheathing; however, designs vary between cable suppliers and cable technology continues to evolve. The HVAC offshore export cables are expected to have an outer diameter of approximately 0.3 m (1 ft).

The cable design may include a Distributed Temperature System (DTS) or other system to monitor the temperature of the cable; significant changes in temperature recorded by this system may be used to indirectly indicate cable exposure. The offshore export cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) (see Section 4.3.1.3.6 for a description of cable installation techniques).

[71] Fiber optic cables are typically integrated into the offshore export cable, but may be bundled externally to the export cable. In either scenario, the fiber optic and export cables would be installed simultaneously.

Design:

1. Conductor (Al or Cu)
2. Inner semi-conducting layer
3. XLPE insulation
4. Outer semi-conducting layer
5. Swellable tape
6. Lead sheath
7. PE oversheath
8. Fibre optic cable
9. Filler profiles
10. Bedding (PP)
11. Armouring
12. Outer sheath (PP)

Figure 4.2-14

Typical Phase 2 Offshore Cable Cutaway

As described in Section 4.1.3, unless technical, logistical, grid interconnection, or other unforeseen issues arise, all Phase 2 offshore export cables will be installed within the OECC from the landfall site(s) to the northwestern corner of the SWDA (see Figure 4.1-6). Between the northwestern corner of the SWDA and the Phase 2 ESP(s), the offshore export cables may be installed in any area of the SWDA.[72] Accounting for additional cable length needed for turns and micro-siting, the maximum length of each offshore export cable within the OECC is ~82 km (~44 NM) and the maximum length per cable within the SWDA is ~34–42 km (~18–23 NM).[73] Altogether, the maximum length of each Phase 2 offshore export cable from the landfall site(s) to the ESP is approximately 116–124 km (63–67 NM), giving a total maximum length (assuming three cables) of ~356 km (~192 NM) for Phase 2.

4.2.1.5.2 Offshore Export Cable Separation and Alignment

Cable Separation

Unless technical, logistical, grid interconnection, or other unforeseen issues arise, all Phase 2 offshore export cables will be installed within the same OECC as both Phase 1's and Vineyard Wind 1's offshore export cables), resulting in three sets of cables within the OECC (see Section 4.1.3). The cables will typically be separated by a distance of 50–100 m (164–328 ft) to provide appropriate flexibility for routing and installation and to allow room for maintenance or repairs. This separation distance could be further adjusted, pending ongoing routing evaluation, to account for local conditions, such as deeper waters, micro-siting for sensitive habitat areas, or other environmental or technical reasons.

Offshore Export Cable Alignment Engineering

The Proponent has conducted preliminary route engineering to develop the first iteration of the Phase 1 and Phase 2 offshore export cable alignments within the SWDA and OECC (see Appendix III-P). These preliminary cable alignments are supported by a risk assessment that determines the minimum level of burial required to protect the cables and an assessment of the method of burial that is most suitable for specific site conditions. The preliminary alignments consider numerous seabed features and environmental constraints, including areas of coarse deposits, boulders, sand waves, seabed slopes, water depths, magnetic anomalies, and the location of other existing or planned cables.

The preliminary routing of the cables has avoided sensitive habitats including eelgrass, hard bottom, and complex bottom (i.e. sand waves) where feasible, but avoidance of all sensitive habitats is not always possible. Route engineers must develop routes for cables within the OECC that are technically viable and provide workable slopes, suitable water depths for available cable

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72 All areas where the offshore export cables may be located will have been surveyed in accordance with BOEM regulations and guidance.

73 The offshore export cable length includes a 15% allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5% allowance for micro-siting within the OECC outside the lease areas.

installation vessels, feasible turning radii for the cables, avoid high concentrations of boulders or very stiff sediments where cable burial would be challenging, maintain a sufficient distance from the planned Phase 1 and Vineyard Wind 1 cables, and avoid crossing the planned Phase 1 and Vineyard Wind 1 cables. It is expected that the identified eelgrass resources in proximity to the landfall sites will be avoided (see Figure 6.4-1 of COP Volume III). It is also expected that isolated areas of hard bottom may be avoided; however, in areas such as Muskeget Channel where hard bottom extends across the entire corridor, it will not be possible to avoid hard bottom.

Following the preliminary route engineering (as presented in Appendix III-P), detailed route engineering will be completed by the contractor retained by the Proponent to supply and install the submarine cables. When conducting the detailed route engineering, the contractor will review and refine the alignment(s) of the Phase 2 offshore export cables based on the as-built alignments of the Phase 1 and Vineyard Wind 1 cables and to optimize the installation activities and burial depth for its specific cable installation tool. Accordingly, the preliminary alignment(s) may shift as the route is optimized. The contractor's design process will be overseen by the Proponent, and any deviations from the preliminary route design will be subject to the Proponent's approval.

4.2.1.5.3 Cable Entry Protection System

The ends of the offshore export cables will likely be protected using protection conduits put in place at the approach to the ESP foundation(s) (see Figure 4.2-13). This cable entry protection system consists of different components of composite material and/or cast-iron half-shells with suitable corrosion protection. Although a large majority of the cable entry protection system will likely lie on top of the scour protection (if used), it may extend a short distance beyond the edge of the scour protection. Additional cable protection may be placed on top of the cable entry protection system (within the footprint of the scour protection) to secure the cable entry protection system in place and limit movement of the cable, which can damage the cable. Cable protection is described in Section 4.2.1.5.4 below.

4.2.1.5.4 Cable Protection

While the target burial depth of the offshore export cables will be at least 1.5 m (5 ft) along their entire length, cable protection will not automatically be applied if the target burial depth cannot be achieved. The Proponent plans to use cable protection if a minimum burial depth of 1.5 m (5 ft) is not achieved within areas of higher risk of damage from anchor strikes. These areas of higher risk are based on existing vessel traffic patterns and comprise the majority of the OECC. To minimize the use of cable protection, where the risk of anchor strike is negligible, the Proponent plans to use cable protection if a minimum burial depth of 1.0 m (3.3 ft) is not achieved. Section 9.0 of Appendix III-P describes the decision framework for when to apply cable protection if sufficient burial depths are not achieved in lower and higher risk areas along the OECC. Cable protection may also be used if the cables need to cross other infrastructure (e.g. existing cables, pipes, etc.), to secure the cable entry protection system in place, or where a cable joint requires protection.

Potential cable protection methods include:

- **Rock placement:** Rocks laid on top of the cable to provide protection. Rock will be installed in a controlled and accurate manner on the sea floor likely using a DP fall-pipe vessel (see Section 4.3.1.3.10). Rocks used for cable protection will be sized for site-specific conditions; where feasible, Phase 2 will use rocks sized 6.4 centimeters (cm) (2.5 inches [in]) in diameter or larger.[74]

- **Gabion rock bags:** Rock bags consisting of rock encased in a net material (e.g. a polyester net) that can be accurately deployed on top of the cable and recovered from a vessel for temporary or permanent cable protection. The bag is equipped with a single lifting point to enable its accurate and efficient deployment and recovery.

- **Concrete mattresses:** Prefabricated flexible concrete coverings consisting of high-strength concrete profiled blocks cast around a mesh (e.g. ultra-violet stabilized polypropylene rope) that holds the blocks together. The mattress construction provides flexibility allowing it to settle over the contours of the cable or pipeline. The mattress may also include aerated polyethylene fronds, which will float (resembling seaweed) and encourage sediments to be deposited on the mattress.

- **Half-shell pipes or similar (only for cable crossings or where the cable is laid on the seafloor):** Similar to the cable entry protection system described in Section 4.2.1.5.3 above, these products are made from composite materials and/or cast iron with suitable corrosion protection and are fixed around the cable to provide mechanical protection. Half-shell pipes (or similar solutions) are not used for remedial cable protection but could be used at cable crossings or where cable must be laid on the surface of the seabed. The half-shell pipes do not ensure full protection from damage due to fishing trawls or anchor drags (although they will offer some protection, they will not prevent damage).

The Proponent conservatively estimates that approximately 6% of the offshore export cables within the OECC could require one of these alternative cable protection methods.[75] The estimated length and area of offshore cables potentially requiring protection is presented in Section 4.3.1.13. Cable protection will be up to 9 m (30 ft) wide.

The Proponent intends to avoid or minimize the need for cable protection to the greatest extent feasible through careful site assessment and thoughtful selection of the most appropriate cable installation tool to achieve sufficient burial; therefore, the estimates of cable protection are expected to be conservative. Cable protection for the Phase 2 offshore export cables, if needed,

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[74] Some rocks may be fragmented into smaller pieces during handling, transport, and installation.

[75] The Proponent conservatively estimates that approximately 2% of the offshore export cables within the SWDA could require cable protection.

would likely occur in the same general location as cable protection for the Phase 1 offshore export cables. A detailed Burial Assessment Study will be developed for the Phase 2 offshore export cables during the contractor's engineering and design phase and made available for the CVA process.

4.2.1.6 Inter-Array and Inter-Link Cables

As already noted, 66–132 kV inter-array cables will connect "strings" of multiple WTGs to the ESP(s). The WTGs can be connected together in a variety of inter-array cable configurations, including linear strings, with or without redundancy links (i.e. redundant inter-array cables at end of strings to enhance reliability), and branched strings. The farthest WTG on each string will have one outgoing connection and each subsequent WTG will have both incoming and outgoing inter-array cables.

The expected cable type is conceptually similar to the three-core alternating current cable used for the HVAC offshore export cables (see Section 4.2.1.5.1). However, the design may differ due to the lower voltages and different performance specification requirements of the inter-array cables. For example, the inter-array cables may not include a water-impervious lead sheath and may have different armoring, including high-density polyethylene (HDPE) or other materials. Each section of inter-array cable string must transmit an increasing amount of power in the direction from the outermost WTG to the ESP. Therefore, multiple cross sections with different capacities are envisaged for the inter-array cables. These inter-array cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft) (see Section 4.3.1.6 for a description of inter-array cable installation). The maximum anticipated length of the Phase 2 inter-array cables is approximately 325 km (175 NM).

In addition to the inter-array cables, the ESPs may be connected to each other (if two or three ESPs are used) or to a Phase 1 ESP by 66–345 kV inter-link cables. The inter-link cables will be similar to either the offshore export cables or the inter-array cables. All inter-link cable designs would provide redundancy, thus improving reliability. The maximum total length of the inter-link cables for Phase 2 is ~60 km (~32 NM). Like the inter-array cables, the inter-link cables will be buried beneath the seafloor at a target depth of 1.5–2.5 m (5–8 ft).

The development of the inter-array and inter-link cable layout is highly dependent upon the final number of WTGs included in Phase 2 and the selected location and number of ESPs. The design and optimization of the inter-array and inter-link cable system will occur during the final design of Phase 2 and will consider cable design and capacity, ground conditions, operating conditions, installation conditions, and potential cultural resources. This means that the Proponent is permitting an Envelope for the inter-array and inter-link cables that includes any potential layout within the SWDA. All areas where inter-array and inter-link cables may be located will have been surveyed in accordance with BOEM regulations and guidance. A representative inter-array cable layout for Phase 2 is provided as Figure 4.2-15 for illustrative purposes.[76]

Like the offshore export cables, all inter-array cables and inter-link cables will likely be protected with cable entry protection systems at the approach to the WTG and ESP foundations (explained above in Section 4.2.1.5.3). The cable entry protection system may extend a short distance beyond the scour protection.

Based on initial survey data for the SWDA, the Proponent expects that cable protection is less likely to be needed for the inter-array cables and inter-link cables than the offshore export cables due to consistent geology and limited coarse materials. Where feasible, the inter-array and inter-link cable layout will be designed to avoid areas with increased risk of not achieving the target burial depth. In addition, the inter-array and inter-link cable layout will also be designed to avoid cable crossings; thus, no cable protection for cable crossings is expected.

Although not anticipated, the Proponent conservatively estimates that up to 2% of the total length of the inter-array and inter-link cables could require cable protection, with the majority of the cable protection likely located adjacent to the foundation's scour protection.[77] See Section 4.2.1.5.4 for a description of cable protection methods. Once additional survey data is collected for the SWDA and a cable layout is identified, the Proponent will likely perform a more detailed assessment of the need for cable protection over the inter-array and inter-link cables.

4.2.2 Phase 2 Onshore Facilities

The Phase 2 onshore facilities will ultimately include one or two landfall sites, one or two Onshore Export Cable Routes, one or two new onshore substations, and one or two Grid Interconnection Routes. The Proponent intends to interconnect the entire electrical capacity of Phase 2 into the electrical grid at the West Barnstable Substation. Potential Phase 2 landfall sites, Onshore Export Cable Routes, and Grid Interconnection Routes to reach the West Barnstable Substation have been identified (see Figure 4.1-2). As described in Section 4.2.2.3, the properties needed for the Phase 2 onshore substation site(s) have not yet been secured, but the site(s) will be located generally along the onshore routes illustrated on Figure 4.1-2.

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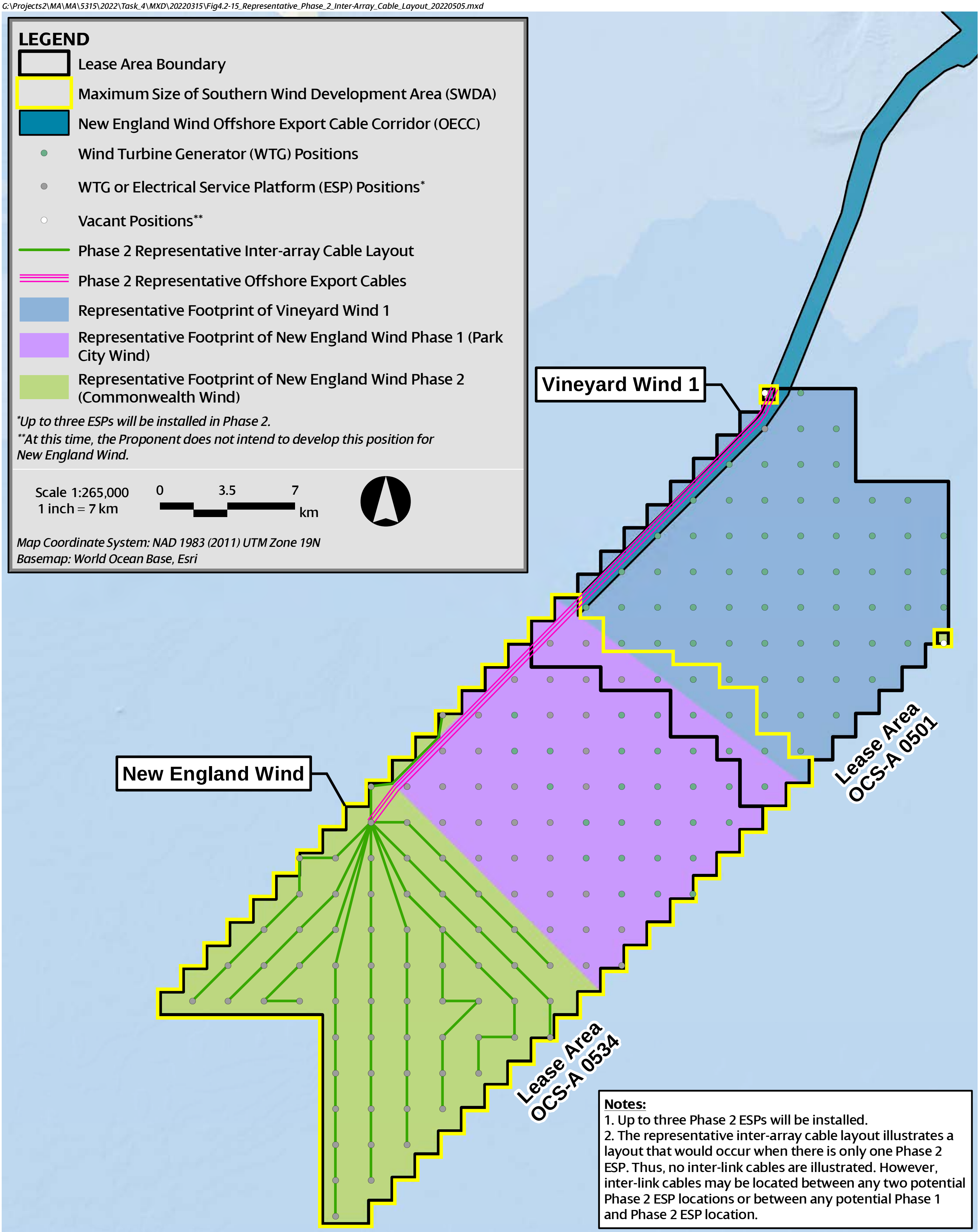
[76] Figure 4.2-15 is illustrative of an inter-array cable layout that would occur when there is only one Phase 2 ESP. Thus, no inter-link cables are illustrated. Inter-link cables may be located between any two potential Phase 2 ESP locations or between a Phase 1 and Phase 2 ESP location.

[77] The estimate of cable protection includes any length of the cable entry protection system beyond the scour protection.



New England Wind
AVANGRID RENEWABLES

Figure 4.2-15

Representative Phase 2 Inter-Array Cable Layout

The following discussion of the Phase 2 onshore facilities is specific to the grid interconnection at the West Barnstable Substation. However, as described in Sections 4.1.3 and 4.1.4, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise. Under this scenario, Phase 2 could include one onshore transmission system in Barnstable (using either the Dowses Beach Landfall Site or Wianno Avenue Landfall Site) and/or an onshore transmission system(s) in proximity to the second grid interconnection point.

4.2.2.1 Landfall Site(s)

Unless technical, logistical, grid interconnection, or other unforeseen issues arise, all Phase 2 offshore export cables will come ashore at one or both of the following landfall sites in the Town of Barnstable:[78]

- **Dowses Beach Landfall Site:** The Dowses Beach Landfall Site is located within a 0.01 km^2 (2.5 acre) mostly paved parking area at Dowses Beach, which is a residents-only beach that is owned and managed by the Town of Barnstable. Dowses Beach is situated on a peninsula between East Bay and the Centerville Harbor. Existing uses in and around the landfall site include recreational use of the beach area, seasonal residential use, and recreational boating in East Bay to the northwest of Dowses Beach. At Dowses Beach, the offshore export cables' ocean-to-land transition will be made using horizontal directional drilling (HDD). From Dowses Beach, the onshore export cables would either continue beneath public roadway layouts or, using a trenchless crossing, travel beneath East Bay to one of two potential locations on East Bay Road (see Figure 4.1-2). The Dowses Beach Landfall Site has adequate space for an HDD/trenchless crossing staging area and favorable route options to the onshore substation site(s).

- **Wianno Avenue Landfall Site:** The Phase 2 offshore export cables may make landfall at a 462 m^2 (4,970 ft^2) paved parking area where Wianno Avenue intersects with Sea View Avenue. The landfall site may extend into the adjacent roadway layouts. As described further in Section 4.3.1.8.2, the Wianno Avenue Landfall Site is less suited for HDD than open trenching due to the elevated onshore topography and slope of the parking lot. This landfall site is suitable for open trenching because the shoreline has already been altered by the installation of a riprap seawall, a portion of which would be temporarily removed and replaced following cable installation. The Proponent only expects to use the Wianno Avenue Landfall Site if unforeseen challenges arise that make it infeasible to use the Dowses Beach Landfall Site to accommodate all or some of the Phase 2 offshore export cables.

[78] As described in Section 4.1.4, if electricity generated by Phase 2 is delivered to a second grid interconnection point, Phase 2 could include one landfall site in Barnstable (at either Dowses Beach or Wianno Avenue) and/or a landfall site(s) in proximity to the second grid interconnection point.

Both potential landfall sites are considered good candidates for cable landing given their favorable egress and inland routing to Eversource's existing 345 kV West Barnstable Substation via public roads and existing utility rights-of-way (ROWs).

At the landfall site(s), the physical connection between the offshore export cables and the onshore export cables is expected to be made in underground transition vaults (one per offshore export cable). Each vault is anticipated to have dimensions of approximately 4 m (13 ft) wide by 19 m (62 ft) long by 1 m (3.5 ft) tall. Inside the vaults, each offshore export cable will be separated and spliced into three separate single-core onshore export cables, giving a total of up to nine onshore export cables for Phase 2. Immediately adjacent to the transition vaults, there may be smaller fiber optic cable vault(s) and/or link boxes.

After the onshore export cables and fiber optic cables leave the transition vaults and fiber optic cable vault(s), they will be housed inside a concrete duct bank. At the landfall site(s), the components of the onshore cable system are expected to be entirely underground except for any at-grade manhole covers.

Construction methods for the landfall sites are discussed in Section 4.3.1.8.

4.2.2.2 Onshore Export Cables and Grid Interconnection Cables

Onshore export cables will connect the Phase 2 landfall site(s) to one or two new onshore substations. Grid interconnection cables will then connect the Phase 2 onshore substation(s) to the grid interconnection point.[79] To reach the West Barnstable Substation, the Phase 2 onshore export cables and grid interconnection cables will be installed underground along any of the potential Onshore Export Cable Routes and Grid Interconnection Routes identified in Figure 4.1-2 and described in Section 4.2.2.2.1. The onshore cable design is described in Section 4.2.2.2.2.

4.2.2.2.1 Onshore Export Cable Routes and Grid Interconnection Routes

Between the landfall site(s) and the onshore substation site(s), the Phase 2 onshore export cables will be installed beneath public roadway layouts or within utility ROWs along one or two Onshore Export Cable Routes. From the onshore substation site(s) to the grid interconnection point, the Phase 2 grid interconnection cables will also be installed beneath public roadway layouts or within utility ROWs along one or two Grid Interconnection Routes. Potential Phase 2 Onshore Export Cable Routes and Grid Interconnection Routes are identified in Figure 4.1-2.[80] The onshore

[79] If electricity generated by Phase 2 is delivered to a second grid interconnection point, Phase 2 could include one onshore transmission system in Barnstable and/or an onshore transmission system(s) in proximity to the second grid interconnection point (see Section 4.1.4).

[80] Since the final location of the onshore substation(s) have not yet been determined, the Onshore Export Cable Routes cannot be distinguished from the Grid Interconnection Routes. Thus, Figure 4.2-1 illustrates both potential Onshore Export Cable Routes and potential Grid Interconnection Routes.

substation site(s) will be located generally along the routes illustrated on Figure 4.1-2, but the properties needed for the site(s) have not yet been secured. From each landfall site to the grid interconnection point, the maximum combined length of the Phase 2 Onshore Export Cable Route and Grid Interconnection Route is up to 17 km (10.6 mi).

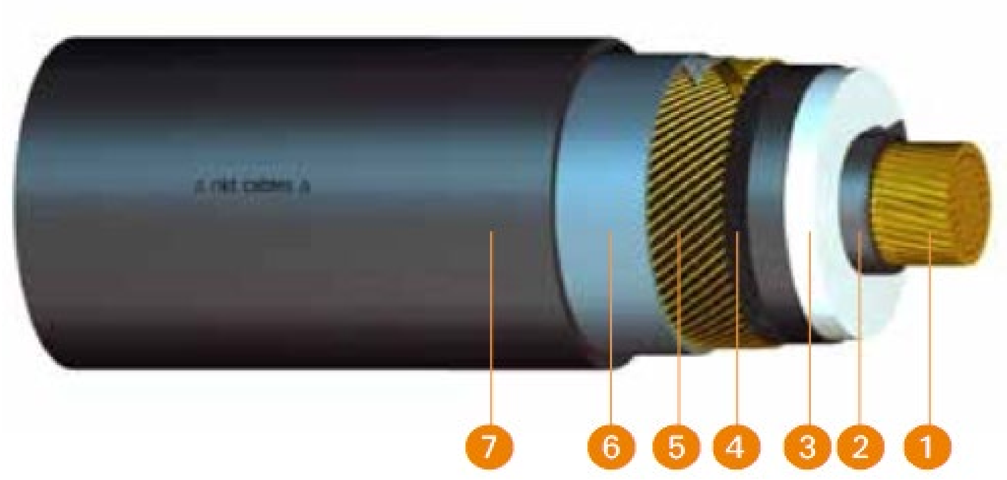
Generally, the onshore export cables and grid interconnection cables will travel from the landfall site(s) located just south of East Bay northward through the Town of Barnstable to reach the onshore substation site(s) and then the grid interconnection point. The Phase 2 Onshore Export Cable Routes and Grid Interconnection Routes will primarily follow town roads and portions of state highways, which could include East Bay Road, Wianno Avenue, Main Street/South County Road, Old Mill Road, Osterville West Barnstable Road, Route 28, Route 149, Lumbert Mill Road, Old Falmouth Road, Old Stage Road, Oak Street, Shootflying Hill Road, and Route 132, among others. The Phase 2 onshore routes may also be installed within ROW #345, ROW #343, ROW #381, and/or ROW #342. Depending on the route(s) ultimately selected, the onshore export cables and grid interconnection cables will pass through a mix of moderate-density residential and commercial areas.

The Phase 2 onshore cables may traverse wetlands, waterbodies, and/or busy roadways, depending on the final Onshore Export Cable Route(s) and Grid Interconnection Route(s) selected. All potential Phase 2 onshore routes will require a crossing of Route 28 and Route 6. If the Dowses Beach Landfall Site is used, the onshore export cables may be installed beneath East Bay to one of two potential locations on East Bay Road. These special crossings are discussed further in Section 4.3.1.10.

4.2.2.2.2 Onshore Cable and Duct Bank Design

Based on currently available onshore cable technologies, each 220–345 kV HVAC onshore export cable and each 345 kV HVAC grid interconnection cable is expected to be comprised of a single core (copper or aluminum conductor) encapsulated by XLPE solid insulation and wrapped in a metallic sheath and a non-metallic outer jacket. A manufacturer's cutaway of a typical HVAC onshore cable is provided as Figure 4.2-16; three of these cables would make up a single alternating current circuit. However, designs for HVAC onshore cables may vary as cable technology continues to evolve.

The onshore export cables and grid interconnection cables are expected to be installed underground within a duct bank. The duct bank will likely consist of plastic (e.g. HDPE or polyvinyl chloride [PVC]) conduits encased in concrete. Each onshore cable and fiber optic cable is expected to be installed within its own conduit. Spare conduits and grounding may also be accommodated within the duct bank. For a three-circuit HVAC configuration, the conduits may be arranged four conduits wide by three conduits deep, with the total duct bank measuring approximately 1.4 m (4.5 ft) wide and 1.0 m (3.3 ft) deep, or six conduits wide by two conduits deep, with the duct bank measuring approximately 2.0 m (6.5 ft) wide and 0.7 m (2.3 ft) deep. A more upright design arrayed three conduits wide and four conduits deep is also possible, which would measure



Design:

1 Conductor (Al or Cu)

2 Inner semi-conducting layer

3 XLPE insulation

4 Outer semi-conducting layer

5 Wire screen (Al or Cu)

6 Lead sheath

7 PE oversheath

Figure 4.2-16

Typical Phase 2 Onshore Cable Cutaway

approximately 1.0 m (3.3 ft) wide and 1.4 m (4.5 ft) deep. For a two-circuit HVAC configuration, the conduits will be arrayed four conduits wide by two conduits deep (1.5 m [5 ft] wide and 0.8 m [2.5 ft] deep) or two conduits wide by four conduits deep (0.8 m [2.5 ft] wide and 1.5 m [5 ft] deep). Depending on the configuration of existing subsurface utilities, the duct bank arrangement could be modified along short stretches to enable deeper burial depth to respect utility separation requirements.

The duct bank will be installed within public roadway layouts (either beneath the road or within 3 m [10 ft] of pavement) or within existing utility ROWs. The duct bank is expected to be installed in open trenches. Once the duct bank is in place, the cables are pulled into place via underground splice vaults and associated manholes, which are placed in groups every 457–914 m (1,500–3,000 ft) or more along the duct bank. The splice vaults are typically two-piece (top and bottom) pre-formed concrete chambers with openings at both ends to connect with the duct bank conduits and admit the cables. Each splice vault is typically 2.4 m (8 ft) wide by 10 m (34 ft) long and up to 2.7 m (9 ft) deep (interior dimensions), subject to further engineering.

See Section 4.3.1.10 for a discussion of onshore export cable and grid interconnection cable installation.

4.2.2.3 Phase 2 Onshore Substation(s)

The Phase 2 onshore export cables will connect to one or two new onshore substations in the Town of Barnstable.[81] Several onshore substation sites within the Town of Barnstable are being considered for Phase 2 but have not yet been secured; these sites are located generally along the onshore routes identified in Figure 4.1-2. The largest parcel, or combination of parcels, currently under consideration for each substation is 0.15 km^2 (38 acres) in size.

At the onshore substation(s), the onshore export cable voltage will step up or step down in preparation for interconnection at the grid interconnection point (see Section 4.2.2.4). The onshore substation(s) will likely house transformers, switchgear, and other necessary equipment. The onshore substations may use either an air-insulated switchgear design or a gas-insulated switchgear design pending the substations' final detailed design. The new onshore substation(s) may include a small control equipment enclosure. Depending on the site(s) selected and technologies available at the time Phase 2 is ready to proceed, battery storage may be a feasible option that could be included as part of a future COP revision.

81 If electricity generated by Phase 2 is delivered to a second grid interconnection point, Phase 2 could include one onshore substation in Barnstable and/or an onshore substation(s) in proximity to the second grid interconnection point (see Section 4.1.4).

Onshore substation construction may require initial grading and clearing (see Section 4.3.1.9), but revegetation would occur outside of the substation fence line. Depending on the onshore substation site(s) selected, the Proponent may plant vegetated screening to provide visual screening for existing residences. The onshore substation site(s) will have a perimeter access fence and may include sound attenuation walls, if necessary.

The Proponent expects to provide full-volume (110%) containment systems for any substation components using dielectric fluid located at the onshore substation site(s). The containment sumps will be designed to fully contain the dielectric fluid in the very unlikely event of a complete, catastrophic failure of the transformer or other equipment. To provide additional containment for an extreme rain event, if requested by the Town of Barnstable, the Proponent will increase the 110% containment volume to account for the simultaneous Probable Maximum Precipitation (PMP) event in a 24-hour period, which will be determined for the onshore substation site(s) in consultation with the Town. As additional mitigation, the onshore substation design will include a common drain system that routes each individual containment area, after passing through an oil-absorbing inhibition device, to an oil/water separator before draining to the infiltration basin.

A stormwater management system at the onshore substation site(s) will include low-impact development (LID) strategies (e.g. grass water quality swales to capture and convey site runoff, deep sump catch basin(s) to pretreat surface runoff, etc.), which are designed to capture, treat, and recharge stormwater runoff.

Outdoor lighting at the onshore substation site(s) will typically be equipped with light shields to prevent light from encroaching into adjacent areas. There are typically a few lights illuminated for security reasons on dusk–to-dawn sensors as well as a few on motion-sensing switches, depending on the application needed for the site(s). The majority of lights will be used for emergency situations only. The Proponent will work closely with the Town of Barnstable to ensure that the lighting scheme complies with Town requirements.

4.2.2.4 Grid Interconnection Point

Phase 2 will connect into the ISO New England (ISO-NE) electric grid via Eversource's existing 345 kV West Barnstable Substation.[82] New England Wind has ISO-NE interconnection queue positions for the 345 kV West Barnstable Substation (see Table 5.1-1). Some modifications to the 345 kV West Barnstable Substation will be necessary to accommodate the interconnection from Phase 2. The Proponent is consulting with Eversource on the specific design and location of these modifications. Based on a recent regional ISO-NE cluster study, additional system upgrades to be constructed by Eversource have been identified that will include added electric grid capacity for interconnection of Phase 2 and achieving adequate system stability.

[82] As described in Section 4.1.3.3, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise.

4.2.2.5 Port Facilities & Construction Staging Areas

The Proponent has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used for major Phase 2 construction staging activities. In addition, some components, materials, and vessels could come from Canadian and European ports. A complete list of the possible ports that may be used for major construction staging activities can be found in Table 4.2-7 and are shown on Figure 4.2-17.

Numerous entities have publicized plans to develop or upgrade port facilities to support offshore wind construction and the Proponent anticipates an increased demand for ports by other Northeast offshore wind developers in the coming years. Given these factors and the uncertainty concerning the timing of Phase 2 construction, the Proponent is identifying a wide range of ports that could be used for Phase 2. It is not expected that all the ports identified would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.

The Proponent expects to use one or more of these ports for frequent crew transfer and to offload shipments of components, store components, prepare them for installation, and then load components onto vessels for delivery to the SWDA.[83] Some component fabrication and assembly may occur at these ports as well. The greatest distance from a port used for major construction staging activities to the SWDA is approximately 619 km (334 NM).

Some activities such as refueling,[84] restocking supplies, sourcing parts for repairs, vessel repairs, vessel mobilization/demobilization, some crew transfer, and other construction staging activities may occur out of ports other than those listed in the table below. These activities would occur at industrial ports suitable for such uses and would be well within the realm of normal port activities.

See Table 4.2-8 in Section 4.2.2.6 for a discussion of ports used during Phase 2 operations and maintenance (O&M).

Table 4.2-7 Possible Ports Used During Phase 2 Construction

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Harbor
Brayton Point Commerce Center
Vineyard Haven
Fall River
Salem Harbor

[83] Monopiles may not be loaded onto vessels for transport but may instead be pulled by tugs while floating in the water.

[84] Some refueling could also occur offshore.

Table 4.2-7 Possible Ports Used During Phase 2 Construction (Continued)

Port
Rhode Island Ports
Port of Davisville
Port of Providence (ProvPort)
South Quay Terminal
Connecticut Ports
Bridgeport
New London State Pier
New York Ports
Capital Region Ports (Port of Albany, Coeymans, & NYS Offshore Wind Port)
Staten Island Ports (Arthur Kill & Homeport Pier)
South Brooklyn Marine Terminal
GMD Shipyard
Shoreham, Long Island
New Jersey Ports
Paulsboro
Canadian Ports[1]
Halifax
Sheet Harbor
Saint John
Miscellaneous European Ports

Note:

1. Analysis of potential Canadian ports that may be used is ongoing.

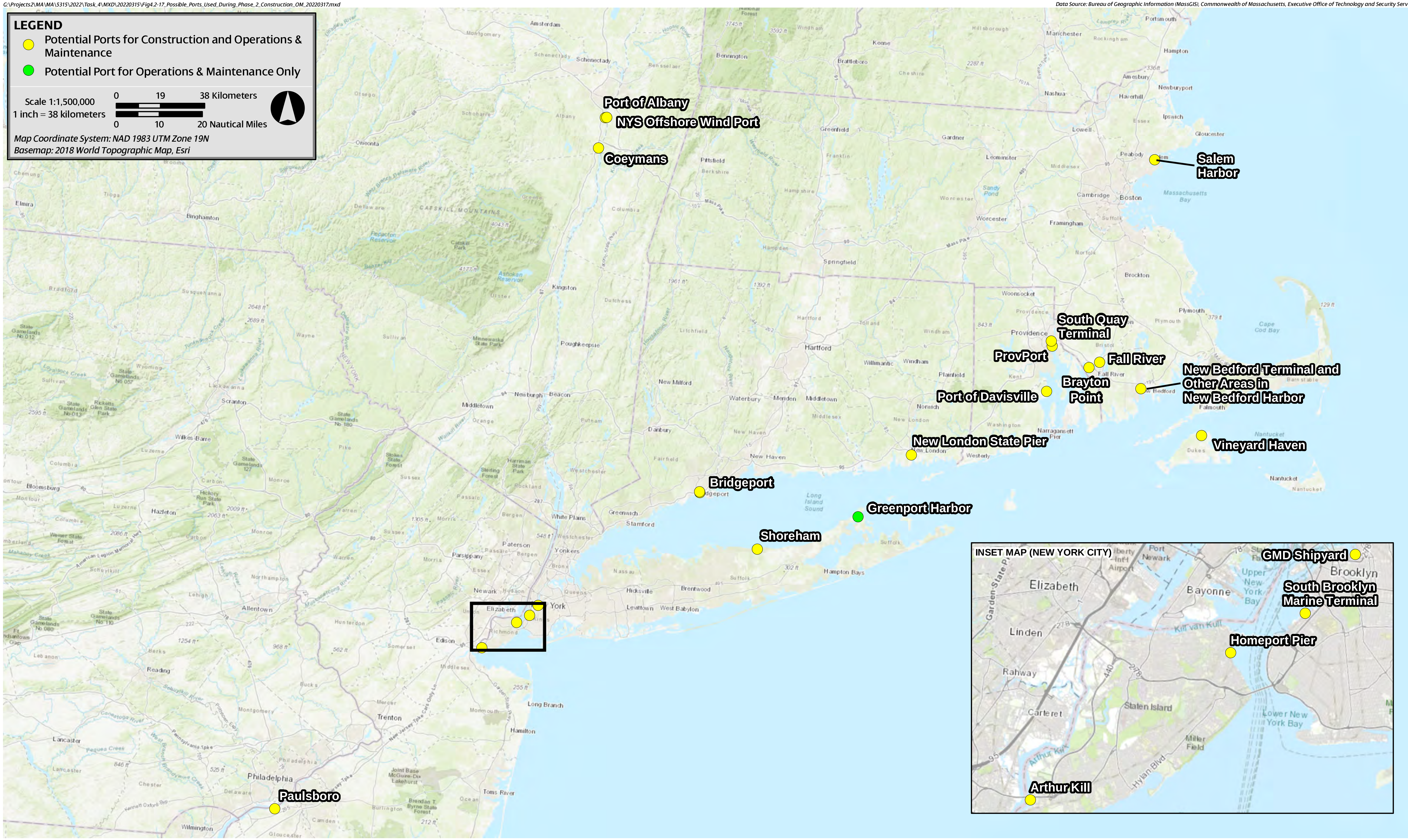
Each port facility under consideration for Phase 2 is either already located within an industrial waterfront area with sufficient existing infrastructure or is identified as an area where other entities intend to develop infrastructure with the capacity to host construction activities around the anticipated timeframe of Phase 2 construction. The activities conducted at each port and combination of ports used is highly dependent on the final Phase 2 construction logistics schedule, the infrastructure that is ultimately available at each port, other users of each port, supply chain availability, and the potential for synergies between the Proponent's projects.

The Proponent does not expect to implement any port improvements that may be made. Although the Proponent may financially support a port's redevelopment as part of an economic incentive package, any port would be developed independent of New England Wind (all permits and approvals will be obtained by the site owner/lessor) and the port could be used by multiple developers once any necessary upgrades are made by the owner/lessor.

Each US port that may be used for major Phase 2 construction staging activities is described in more detail below based on their status at the time of COP submission. It is expected that many of these ports will likely be further developed to accommodate offshore wind vessels and activities by the time Phase 2 proceeds to construction.

G:\Projects2\MA\MA\5315\2022\Task_4\MXD\20220315\Fig4.2-17_Possible_Ports_Used_During_Phase_2_Construction_OM_20220317.mxd

Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services



New England Wind

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Figure 4.2-17

Possible Ports Used During Phase 2 Construction and O&M

- **New Bedford Marine Commerce Terminal, New Bedford, MA:** The 0.12 km^2 (29 acre) New Bedford Marine Commerce Terminal ("New Bedford Terminal") is owned and operated by the Massachusetts Clean Energy Center (MassCEC). It is located on the City's extensive industrial waterfront and was purpose-built to support offshore wind energy projects.

- **Other areas in New Bedford Harbor, MA:** The Proponent may use other areas in the Port of New Bedford, including, but not limited to, those identified by MassCEC's (2017) *2017 Massachusetts Offshore Wind Ports and Infrastructure Assessment* as potentially viable offshore wind ports, if necessary upgrades are made by the owner/lessor. For example, the Eversource Energy/Sprague Oil Facility is a 0.12 km^2 (29 acre) site that could be used by the Proponent, subject to the facility's acquisition and redevelopment by a private and or public entity. Rehabilitation work for this site could include, but would not be limited to, removal of all existing structures (including oil tanks and buildings) to provide a finished, high bearing capacity graveled surface suitable for supporting offshore wind components; upgrades to the quayside; and dredging and filling operations to support mooring and berthing of specialized offshore wind component transport vessels. Use of other sites in the harbor may also require redevelopment efforts by the owner(s)/lessor(s) to make the respective facilities suitable for Phase 2 activities.

- **Brayton Point Commerce Center, Somerset, MA:** The Brayton Point Commerce Center is located on the site of the former coal-fired Brayton Point Power Plant. Brayton Point is a 1.2 km^2 (307 acre) property located in Mount Hope Bay less than 1.6 km (1 mi) from Interstate 195. Commercial Development Company, Inc. and its affiliate Brayton Point, LLC are in the process of transforming the former power plant site into a world-class logistics port, manufacturing hub, and support center for the offshore wind industry. Commercial Development Company, Inc. has signed an agreement with Patriot Stevedoring + Logistics LLC to manage operations of the marine commerce terminal (Froese 2019).

- **Vineyard Haven, Martha's Vineyard, MA:** Vineyard Haven already provides a number of services to vessels as large as 84 m (275 ft) in length and has onshore facilities that house multiple business entities. The owner of the marina is currently upgrading the facilities to accommodate additional marine industrial uses, as well as to increase the existing facility's protection from storms.

- **Fall River, MA:** The Proponent may use port facilities in Fall River if the necessary upgrades are made by the owner/lessor. Potential ports could include, but are not limited to, those identified by MassCEC's (2017) *2017 Massachusetts Offshore Wind Ports and Infrastructure Assessment* as potentially viable offshore wind ports.

- **Salem Harbor, MA:**[85] When the recently commissioned Salem Harbor Power Station natural gas power plant replaced a coal and oil plant in 2018 along the Salem waterfront, it opened 0.17 km^2 (42 acres) for development. The Salem Harbor Power Station mostly bisects the area available for development; the north side of the site is approximately 0.06 km^2 (13.7 acres) and the south side is approximately 0.12 km^2 (29 acres). The site includes shared access to a 244 m (800 ft) deep water wet berth that is periodically used for visiting cruise ships. The area also includes approximately 700 m (2,300 ft) of frontage on Salem Harbor, which hosts active commercial, recreational, and water transportation facilities. The site is located approximately 35 km (22 miles) northeast of Boston.

- **Port of Davisville, North Kingstown, RI:** The Port of Davisville offers five terminals, 1,372 linear meters (4,500 linear feet) of berthing space at two 366 m (1,200 ft) long piers, a bulkhead, on-dock rail, and 0.23 km^2 (58 acres) of laydown and terminal storage. The Port of Davisville also has heavy lift capacity, including a 150 metric ton mobile harbor crane. Located near the mouth of Narragansett Bay, vessels access the Port of Davisville through a shipping channel that is not maintained by the Army Corps of Engineers (QDC 2019). Ongoing renovations to the Port's Pier 2 include construction of a new steel bulkhead, dredging Narragansett Bay to accommodate larger ships, and extending Pier 2 by 71 m (232 ft), which will create a third berth to increase the port's overall capacity and provide necessary infrastructure for the offshore wind industry (King 2020).

- **ProvPort, Providence, RI:** The Port of Providence (ProvPort) is a privately-owned marine terminal located within the City of Providence that occupies approximately 0.47 km^2 (115 acres) along the Providence River. ProvPort provides 1,280 m (4,200 ft) of berthing space, 12,077 square meters (m^2) (130,000 square feet [ft^2]) of covered storage, and more than 0.08 km^2 (20 acres) of open lay down area. ProvPort also has on-dock rail service and is located 1.6 km (1 mi) from the interstate (ProvPort 2020). Marine transportation into ProvPort is facilitated by a federally maintained navigational channel, which was dredged in 2005 to -12.2 m (-40 ft) mean low water, allowing the port to accommodate deep-draft vessels (RICRMC 2010).

- **South Quay Terminal, East Providence, RI:** The South Quay Terminal is an over 0.12 km^2 (30 acre) greenfield site located on the Providence River in East Providence. Waterfront Enterprises, LLC has announced plans to develop a staging area for offshore wind construction at the site as well as other mixed uses (Faulkner 2020).

[85] During appropriate time periods, New England Wind-related vessels traveling to/from Salem Harbor will transit at 18.4 km per hour (10 knots) or less within National Oceanic and Atmospheric Administration (NOAA)-designated North Atlantic right whale critical habitat and outside critical habitat.

- **Bridgeport, CT:** The Barnum Landing site owned by the McAllister Towing and Transportation Company consists of approximately 0.06 km^2 (15 acres) of industrial waterfront property along Bridgeport Harbor. Other areas in Bridgeport, such as another port facility off of Seaview Avenue just north of Barnum Landing, may be used for Phase 2, if the necessary upgrades are made by the owner/lessor.

- **New London State Pier, New London, CT:** There are plans to redevelop the New London State Pier, located on the Thames River, for offshore wind as specified in the Harbor Development Agreement between the Connecticut Port Authority, Gateway New London LLC, and North East Offshore LLC. The ~0.12 km^2 (~30 acre) site has no air draft restrictions, direct access to a federally-maintained deep water channel, and access to rail and highway (Lamont 2020). The Proponent may use the state-owned New London State Pier for Phase 2 if the site is developed and available at the time it is needed.

- **Capital Region Ports, NY:** The Port of Coeymans is an existing 1.6 km^2 (400 acre) privately-owned marine terminal on the Hudson River south of Albany that is used for large-scale construction projects. The marine terminal has a 660 ton crawler crane that can be used to lift offshore wind farm components (Maritime Executive 2019). Just north of Coeymans, the Albany Port District Commission is proposing to expand the Port of Albany by developing ~0.33 km^2 (~81.5 acres) of riverfront property in Glenmont, NY that could be used as an assembly and staging area for offshore wind farm components (Cagara 2019). On the opposite side of the Hudson River, the New York Offshore Wind Port in East Greenbush, NY is being proposed for development to support the needs of the offshore wind industry. The site consists of ~0.45 km^2 (~112 acres) with over 1,188 m (3,900 ft) of riverfront (NYoffshorewind 2019). Phase 2 may use any of these ports, if the necessary upgrades are made by the owner/lessor.

- **Staten Island Ports, NY:** The proposed Arthur Kill Terminal is a greenfield site on Staten Island that would be developed into an over 0.13 km^2 (32 acre) port facility designed for the staging and assembly of offshore wind farm components. The proposed facility would have a 396 m (1,300 ft) quayside and a warehouse for equipment and spare part storage (Atlantic Offshore Terminals 2020). Homeport Pier is located on Staten Island just north of the Verrazano-Narrows Bridge and is the former site of a 0.14 km^2 (35 acre) Naval Base with a 430 m (1,410 ft) pier. New York City Economic Development Corporation has requested expressions of interest from parties interested in developing the facility for the offshore wind industry (Waterwire 2019).

- **South Brooklyn Marine Terminal, Brooklyn, NY:** The ~0.26 km^2 (~65 acre) South Brooklyn Marine Terminal has two piers with 1,950 m (6,400 ft) of water frontage on the Upper Bay of New York Harbor. The port is proposed to be upgraded to support staging, installation, and maintenance of offshore wind farms (Kassel R 2020).

- **GMD Shipyard, Brooklyn, NY: T**he GMD Shipyard is located within the Brooklyn Navy Yard on the East River. The shipyard has the largest dry dock facility in New York City, ~335 m (~1100 ft) of wet berth, and numerous cranes (GMD Shipyard Corp c2017).

- **Shoreham, Long Island, NY:** The 2.8 km^2 (700 acre) site of the decommissioned Shoreham Nuclear Power Plant has been identified by the New York State Energy Research and Development Authority (NYSERDA) as a potential site for offshore wind port facilities. The site, located adjacent to Long Island Sound on Long Island, would require significant investment and upgrades because the facility is not currently a functioning waterfront terminal. The site would only be used by Phase 2 if such improvements were made by the owner/lessor.

- **Paulsboro, NJ:** Paulsboro, located on the Delaware River, may become the site of a monopile foundation factory (Stromsta 2019). Thus, Phase 2 may use port facilities in the vicinity of the proposed factory if those facilities were developed by the owner/lessor in time for Phase 2.

4.2.2.6 Operations & Maintenance Facilities/Ports

In support of operations and maintenance (O&M) activities for Phase 2, the Proponent will likely use O&M facilities in Bridgeport, Vineyard Haven, and/or New Bedford Harbor. The O&M facilities may include management and administrative team offices, a control room, office and training space for technicians and engineers, and/or warehouse space for parts and tools. The O&M facilities are also expected to include pier space for crew transfer vessels (CTV) and/or other larger support vessels, such as service operation vessels (SOVs).[86] See Section 4.3.2.6 for further description of vessels, vehicles, and aircraft used during O&M.

The Proponent may use any of the ports listed in Table 4.2-8 below to support O&M activities. As with the construction ports, some activities such as refueling, restocking supplies, sourcing parts for repairs, vessel repairs, vessel mobilization/demobilization, and potentially some crew transfer (activities well within the realm of normal port activities) may occur out of ports other than those listed in Table 4.2-8. During O&M, there is no planned use of Canadian ports. While not anticipated, use of Canadian or other US ports could occur to support an unplanned significant maintenance event, if such maintenance activity could not be accomplished using one of the US ports identified in the COP.

[86] SOV, as the term is used in the COP, includes similar vessel types that can provide offshore accommodations such as floatels and service accommodation vessels (SATVs).

Table 4.2-8 Possible Ports Used During Phase 2 O&M

Port
Massachusetts Ports
New Bedford Marine Commerce Terminal
Other areas in New Bedford Harbor
Brayton Point Commerce Center
Vineyard Haven
Fall River
Salem Harbor
Rhode Island Ports
Port of Davisville
Port of Providence (ProvPort)
South Quay Terminal
Connecticut Ports
Bridgeport
New London State Pier
New York Ports
Capital Region Ports (Port of Albany, Coeymans, & NYS Offshore Wind Port)
Staten Island Ports (Arthur Kill & Homeport Pier)
South Brooklyn Marine Terminal
GMD Shipyard
Long Island Ports (Shoreham and Greenport Harbor)
New Jersey Ports
Paulsboro
Miscellaneous European Ports

With the exception of Greenport, all ports listed above may also be used for Phase 2 construction and are described in Section 4.2.2.5. Greenport Harbor, located on the tip of Long Island, is home to numerous commercial docks that could be rented to offshore wind developers and used for provisioning, crew changes, weather standby, repairs, equipment change, and possibly fuel and water delivery (Nalepinski 2019).

4.2.3 Design, Engineering, and Fabrication

The Phase 2 facilities will undergo an extensive and well-vetted structural design process based on site-specific conditions. The design process will also ensure that the Phase 2 facilities can be decommissioned in accordance with the Decommissioning and Site Clearance Procedures described in Section 4.3.3. As described in Section 4.2.3.1 below, the offshore facilities are designed to international and US standards, which are identified in the Hierarchy of Standards (see Appendix I-E).

Once the majority of the engineering and design has been finalized, the Proponent will develop a Facility Design Report (FDR) and Fabrication and Installation Report (FIR) for Phase 2. The FDR contains the specific details of the offshore facilities' design, including structural drawings, justification for referenced design standards, all design and load calculations, and summaries of the environmental, engineering, geotechnical data used as the basis for the designs. The FIR describes how the components of each structure will be manufactured and installed in accordance with the design criteria in the FDR.

Both the FDR and FIR will be reviewed by a third-party CVA that certifies the design conforms to all applicable standards (see Section 4.2.3.1).

4.2.3.1 Design Standards

BOEM's COP Guidelines recognize that "[t]he BOEM's renewable energy regulations are not prescriptive regarding the design standards that must be used for an offshore wind energy installation" (COP Guidelines Appendix C, Section I). Further, the guidelines state that "[f]or offshore wind turbines, BOEM will accept a "design-basis" approach whereby the applicant proposes which criteria and standards to apply, and then justifies why each particular criterion and standard is appropriate" (COP Guidelines Appendix C, Section I).

[redacted]

[redacted]

4.2.3.2 Certified Verification Agent

The third-party CVA certifies that the facilities' design conforms to all applicable standards identified in the Hierarchy of Standards and oversees the fabrication and installation of the facilities' components.

On December 22, 2020, the Proponent requested a departure from BOEM's regulations at 30 CFR § 585.626(b)(20), which require the Proponent to include a nomination for a CVA for Phase 2 in the COP; that departure request was approved by BOEM on April 28, 2021. The Proponent will thus nominate a CVA for the Phase 2 FDR and FIR as required by 30 CFR § 585.706(a) as an amendment to the COP for review and approval. At that time, the Proponent will provide the Statement of Qualifications for CVA Services, which will address:

- Previous experience of the nominated CVA in third-party verification and BOEM procedures

- Technical capabilities of the CVA and staff members
- Size and type of organization
- Availability of technology
- Ability to perform
- Conflict of interest
- Professional Engineer supervision

The Proponent will also provide the CVA Scope of Work and Verification Plan for Phase 2 as an amendment to the COP. The scope will specify the level of work to be performed by the CVA at all steps of the verification process and identify the high-level list of documents and subject matter that the CVA will review.

4.2.3.3 Technologies Considered Commercially or Technically Infeasible for Phase 2

4.2.3.3.1 Introduction

Phase 2 of New England Wind is intended to deliver commercially sustainable, clean, and renewable offshore wind power to the ISO-NE electric grid. In order to ensure that Phase 2 meets its objective (see Section 4.1.1.1), the Proponent evaluated numerous technologies and designs for their technical and commercial feasibility. The main elements driving the concept for the Phase 2 Envelope are the: (1) WTGs; (2) WTG foundations; and (3) ESP(s).

4.2.3.3.2 Wind Turbine Generators

Phase 2 is anticipated to use the latest generation offshore WTGs that are commercially available at the time of Phase 2 procurement in order to maximize Phase 2 power production given a fixed WTG layout (see Section 2.2). The Phase 2 WTG Envelope was selected based on an analysis of offshore wind industry trends and predicted Original Equipment Manufacturer (OEM) technology roadmaps for WTG development (with some added contingency for accelerated growth scenarios).

4.2.3.3.3 WTG Foundations

The types and combinations of foundations used for Phase 2 will depend on market conditions, supply chain availability, and technological advancements in foundation design and installation methods at the time Phase 2 proceeds to construction. The Proponent considered numerous foundation types based on their potential technical and commercial feasibility and potential for improvements in design by the time Phase 2 proceeds, including: (1) monopile foundations, (2) jacket foundations (with piles or suction buckets), (3) bottom-frame foundations (with piles, gravity pads, or suction buckets), (4) gravity-based foundations, and (5) floating foundations.

The Phase 2 Envelope includes three foundation concepts: monopile, jacket (piled or suction bucket), and bottom-frame (piled or suction bucket) foundations. While suction buckets jackets and bottom-frame foundations were not considered feasible for Phase 1, they are included in the Phase 2 Envelope in anticipation that further development and refinement of these foundation types would enable them to be technically and economically viable for Phase 2. The feasibility of suction bucket jackets and bottom-frame foundations for Phase 2 will be determined when Phase 2 construction is ready to proceed (see Section 4.2.1.2).

As discussed in more detail below, gravity-based foundations, gravity pad bottom-frame foundations, and floating foundations are not considered appropriate for Phase 2 based on the site-specific conditions of the Phase 2 portion of the SWDA.

Gravity-Based Foundations

Gravity-based foundations were used during the early years of the offshore wind energy industry at shallow sites located in benign wave climates, particularly in the Baltic Sea. Since then, their use has become less frequent as the economic and practical benefits of other foundation types (particularly monopiles) have become more widely appreciated. The Phase 2 portion of the SWDA (excluding the two separate aliquots that are closer to shore) is relatively deep, with water depths ranging from 47 to 62 m (154 to 203 ft), whereas gravity-based foundations have only been used in water depths of up to approximately 30 m (98 ft). In addition to being relatively deep, the Phase 2 portion of the SWDA is exposed to North Atlantic metocean conditions; these factors would increase the size of the gravity-base considerably. Since soft sediments are prevalent throughout the Phase 2 portion of the SWDA, installation of gravity-based foundations would require substantial dredging to remove the soft sediments, leveling, and the installation of a large gravel bed to provide a strong flat surface that can support and distribute the foundation's substantial weight. To date, the offshore wind industry has had no experience with gravity-based foundations at sites with conditions similar to the Phase 2 portion of the SWDA. As gravity-based foundations have had limited application and require large fabrication and staging facilities, supply chains are not readily available. There would be significant lead times and excessive costs required to establish suitable port facilities, establish a fabrication yard, and transport the gravity-based foundations to the SWDA.

Gravity Pad Bottom-Frame Foundations

Gravity pads are smaller gravity-based structures (similar in concept to gravity-based foundations) that could be used at the base of each leg of a bottom-frame foundation. Gravity pads include the same inherent limitations as gravity-based foundations, including that gravity-based foundations have only been used in shallow to medium water depths (up to 30 m [98 ft]), whereas the Phase 2 portion of the SWDA (excluding the two separate aliquots that are closer to shore) is relatively deep with water depths ranging from 47 to 62 m (154 to 203 ft). Similar to gravity-based foundations, gravity pad bottom-frame foundations are not considered suitable in soft sediments, which are prevalent across the SWDA. Significant seabed preparation in the form of dredging, leveling, and installation of a gravel base would be required. Like gravity-based foundations, gravity pad bottom-frame foundations would also require excessive costs to establish suitable port facilities, establish a fabrication yard, and transport the gravity pad foundations to the SWDA.

Floating Foundations

Due to the water depths across the Phase 2 portion of the SWDA and the relatively immature status of floating foundations, the Proponent did not perform a detailed analysis on their use for Phase 2. Although there are a number of floating wind demonstration projects successfully operating around the world, these are typically in deeper waters. Since costs are not yet competitive with fixed foundations, floating foundations are not considered viable for offshore wind projects participating in competitive power auctions.

4.2.3.3.4 Electrical Service Platforms

The number and potential locations of the ESPs consider reliability, cost, and future potential requirements under long-term contracts/PPAs for the power generated by Phase 2. The Phase 2 Envelope proposes up to three ESPs to enable the Proponent to maximize reliability and electrical design. Alternatively, the ESPs could potentially be integrated onto a WTG foundation. Given the fixed WTG/ESP layout, which limits number of WTG/ESP positions available in the SWDA (see Section 2.2), using one foundation to support both an ESP and WTG would maximize Phase 2 energy production.

Cost considerations are driven by the distance to shore, which determines the offshore export cable length and transmission technology, and optimizing the inter-array cable layout. For this reason, the ESP(s) or integrated WTG/ESPs may be located closer towards shore (to minimize offshore export cable length) or in the center of a Phase 2 project (to minimize inter-array cable length). However, because Phase 2 may be developed as one or more projects, the Proponent requires flexibility on the location of the Phase 2 ESP(s). Thus, all Phase 2 WTG positions are also potential Phase 2 ESP positions, as illustrated on Figure 4.1-4.

ESP foundation concepts were evaluated as described in Section 4.2.3.3.3 above. However, bottom-frame foundations are not considered a credible candidate for ESP foundations because of the relative technological immaturity of the concept for ESPs and the relatively small opportunity for cost reductions.

4.2.3.4 Fabrication

The Phase 2 components will be fabricated by skilled manufacturers in the US, Europe, or elsewhere. The manufacturers will be determined through a competitive procurement process in order to ensure most economic pricing, while continuing to look for opportunities for locating manufacturing in the Northeastern US. The Proponent has also used the knowledge and information gained during the development of Vineyard Wind 1 to identify cost-effective opportunities for locating component manufacturing/fabrication in the Northeastern US.

Potential fabrication methods and manufacturing locations for Phase 2 components are summarized in Table 4.2-9 below, but this list is not final or exhaustive. Table 4.2-9 is based on current manufacturing and fabrication capabilities in the US; over time, more components are expected to be procured from US suppliers.

Table 4.2-9 [redacted]

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Table 4.2-9 [redacted]

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4.3 Phase 2 Construction, Operation, and Decommissioning Activities

4.3.1 Construction Activities

4.3.1.1 Construction Approach Overview

The discussion of Phase 2 construction and installation is organized by offshore activities followed by onshore activities.

The discussion of offshore construction activities follows the anticipated construction sequence. As described in Section 4.1.1.3, Phase 2 is expected to follow a similar order of construction and timing of activities as Phase 1, beginning with scour protection and proceeding through installation of offshore export cables, foundations, electrical service platform(s) (ESP[s]), inter-array and inter-link cables, and wind turbine generators (WTGs). Potential high-level construction and commissioning schedules are provided in Section 4.1.1.3, specifically Figure 4.1-3. As shown on Figure 4.1-3, there may be considerable overlap in the installation periods for each component of Phase 2.

4.3.1.1.1 Onshore Construction Hours and Schedule

For the installation of the onshore duct bank and cables, construction is anticipated to occur during typical work hours (7:00 AM to 6:00 PM) on Monday through Friday, though in specific instances at some locations, or at the request of the Barnstable Department of Public Works (DPW), the Proponent may seek municipal approval to work at night or on weekends. Nighttime work will be minimized and performed only on an as-needed basis, such as when crossing a busy road, and will be coordinated with the Town of Barnstable.

For work at the landfall site(s), the proposed construction schedule is from 7:00 AM to 7:00 PM on Monday through Saturday. However, during horizontal direction drilling (HDD) conduit pull-in, the contractor will likely need to work around the clock since that process cannot be stopped once it has started. Should the Proponent need to extend construction work beyond those hours and/or days (i.e. on Sunday), with the exception of emergency circumstances on a given day that necessitate extended hours, the Proponent will seek prior permission from the Town of Barnstable.

The Proponent will adhere to the general summer limitations on construction activities on Cape Cod. Activities at the landfall site(s) are not expected to be performed during the months of June through September unless authorized by the Town of Barnstable. Activities along the Onshore Export Cable Route(s) and Grid Interconnection Route(s) (particularly where the route follows public roadway layouts) will also likely be subject to significant construction limitations from Memorial Day through Labor Day unless authorized by Barnstable, but could extend through June 15 subject to consent from the DPW. The Proponent will consult with the Town of Barnstable regarding the construction schedule.

4.3.1.2 Scour Protection Installation

As described in Section 4.2.1.4, one or two layers of rocks may be placed on the seabed at each foundation location. Rock is the most widely used scour protection in the offshore wind industry and it is expected to continue as the preferred scour protection into the future. Scour protection dimensions are presented above in Tables 4.2-5 and 4.2-6.

Scour protection may be installed up to several months prior to the start of foundation installation and/or after foundation installation. Scour protection installation is expected to follow the multi-step process outlined below:

1. A pre-construction survey of the bottom bathymetry is conducted.

2. Based on the results of the survey, seabed preparation may be required prior to scour protection or foundation installation. This could include the removal of large obstructions and/or leveling of the seabed.

3. The scour protection is loaded onto the scour protection installation vessels in a designated harbor or directly at the quarry's harbor and is transported to the SWDA.

4. The scour protection material is placed on the seafloor. If needed, a mud mat may be placed below the scour protection.

5. A post-lay seabed survey of bottom bathymetry is conducted; additional material is added, if needed, to provide the necessary coverage and thickness.

6. If a two-layer scour protection system is used, Steps 3 through 5 are repeated to install a second layer of scour protection around the foundation before or after the foundation is installed.

Several techniques for placing scour protection exist, including fall-pipes, side dumping, and placement using a crane/bucket. The fall-pipe method, in which a pipe extends from the vessel to the seafloor near the intended foundation location, is the most precise technique and is expected to be used wherever possible. A remotely operated vehicle (ROV) located at the bottom of the fall-pipe would likely be used to control the lateral movement of the fall-pipe and monitor the installation process. The installation vessel would move along a predetermined pattern to ensure even distribution of the rock material, likely using dynamic positioning (DP). Figure 4.3-1 provides illustrations of typical scour protection vessels.

4.3.1.3 Offshore Export Cable Installation

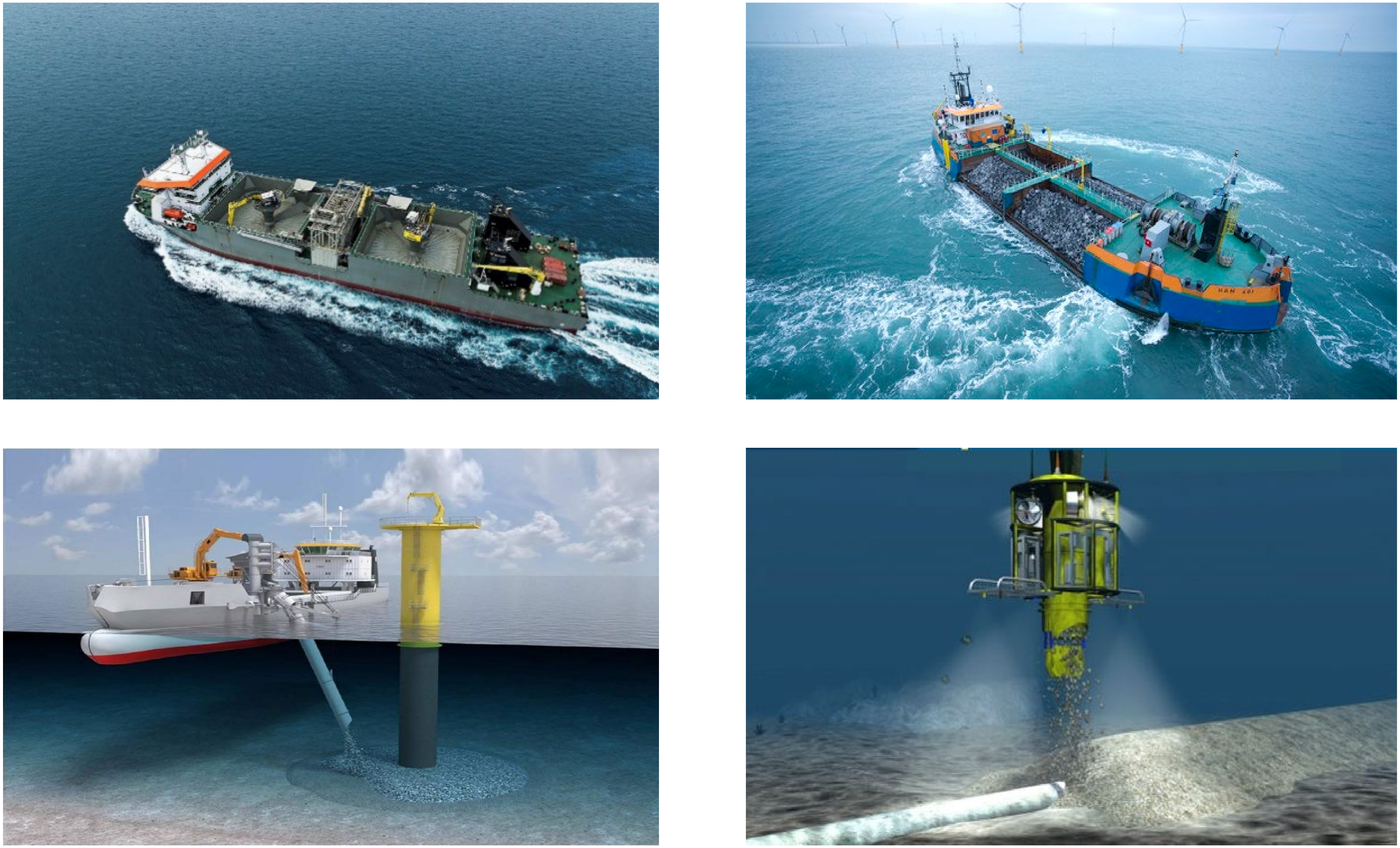
4.3.1.3.1 Overview

As described in Section 4.2.1.5, two or three offshore export cables will be installed for Phase 2. The offshore export cables will likely be transported directly to the Offshore Development Area in a cable laying vessel, on an ocean-going barge, or on a heavy transport vessel (which may also transport the cable laying vessel overseas) and installed by the cable laying vessel upon arrival. Vessel types under consideration for cable installation activities are presented in Table 4.3-1.

Prior to cable laying, a pre-lay grapnel run and pre-lay survey are expected to be performed to clear obstructions, such as abandoned fishing gear and other marine debris, and inspect the route. Large boulders along the route may need to be relocated prior to cable installation. Some dredging of the upper portions of sand waves may also be required prior to cable laying to achieve sufficient burial depth below the stable sea bottom. Following the route clearance activities and any required dredging, offshore export cable laying is expected to be performed primarily via simultaneous lay and bury using jetting techniques (e.g. jet plow or jet trenching) or mechanical plow. However, depending on bottom conditions, water depth, and contractor preferences, other specialty techniques may be used in certain areas to ensure sufficient burial depth (see Section 4.3.1.3.6). No blasting is proposed for cable installation.

The offshore export cables can either be installed from the shore towards the ESP(s) or in the opposite direction. The installation will likely require two or three joints (splices) per cable due to the overall length of each offshore export cable. At the ESP(s), the cable will be pulled in. A cable entry protection system will likely be installed at the interface between an ESP and the offshore export cables.

The specific steps to install the offshore export cables are described in more detail below.



Note: Figures of scour protection placement are for illustrative purposes only. As described in Section 4.3.1.2 of Volume I, scour protection may be placed prior to foundation installation.

Figure 4.3-1

Typical Scour Protection Installation Vessels

4.3.1.3.2 Boulder Relocation

Any large boulders along the final offshore export cable alignments (see Section 4.2.1.5.2) may need to be relocated prior to cable installation, facilitating installation without any obstructions to the burial tool and better ensuring sufficient burial. Boulder relocation is expected to be accomplished either by means of a grab tool suspended from a vessel's crane that lifts individual boulders clear of the route or by using a plow-like tool that is towed along the route to push boulders aside (this may occur during the cable installation process). Boulders will be shifted perpendicular to the cable route; no boulders will be removed from the site.

Avoidance of surficial coarse deposits with boulders will occur where feasible. It is currently anticipated that boulders larger than approximately 0.2–0.3 m (0.7–1 ft) will be avoided or relocated outside of the final installation corridor to create an installation corridor wide enough to allow the installation tool to proceed unobstructed along the seafloor. Tools for moving the boulders are available to accomplish this for boulders up to approximately 2 m (7 ft) in size. If there are boulders along the final route that cannot be moved, a reasonable buffer could be utilized. This buffer size would be defined based on the appointed installation contractor's operating procedures and burial tool(s) in addition to any further engineering analysis.

4.3.1.3.3 Pre-lay Grapnel Run

The pre-lay grapnel run would consist of a vessel towing equipment (i.e. a grapnel train) that hooks and recovers obstructions such as fishing gear, ropes, and wires from the seafloor. Depending on the size and type of debris, it will be either removed from the route or recovered to the vessel deck.

The pre-lay grapnel run may begin up to several months before cable installation commences. Prior to offshore export cable laying preparatory activities, the Proponent will communicate with the fishing industry following the protocols outlined in its Fisheries Communication Plan (the current version is provided in Appendix III-E).

4.3.1.3.4 Pre-lay Surveys

Shortly before offshore export cable installation, the Proponent will likely conduct pre-lay surveys along the planned cable alignments. These surveys would be used to confirm that the cable route is free of obstructions and verify seabed conditions.

4.3.1.3.5 Dredging

As described in Volume II, multiple seasons of marine surveys have confirmed that segments of the OECC contain sand waves. Portions of these sand waves may be mobile over time; therefore, the upper portions of the sand waves may need to be removed so the cable laying equipment can achieve sufficient burial depth below the sand waves into the stable sea bottom.

Dredging will be limited only to the extent required to achieve adequate cable burial depth during cable installation. Where dredging is necessary, it is conservatively assumed that the dredge corridor will typically be 15 m (50 ft) wide at the bottom (to allow for equipment maneuverability) with approximately 1:3 sideslopes for each cable. However, the depth of dredging will vary with the height of sand waves; hence the dimensions of the sideslopes will likewise vary with the depth of dredging and sediment conditions. This dredge corridor includes the up to 1 m (3.3 ft) wide cable installation trench and the up to 3 m (10 ft) wide temporary disturbance zone from the tracks or skids of the cable installation equipment. Based on the preliminary Phase 2 cable alignments (see Section 4.2.1.5.2), the average dredge depth is approximately 0.5 m (1.6 ft) and may range up to 5.25 m (17 ft) in localized areas. The total vertical disturbance within sand waves is up to 8 m (26 ft), which includes dredging and cable installation.

For three offshore export cables combined, dredging may impact approximately 0.27 km^2 (67 acres)[87] along ~19.4 km (~10.5 NM) and may include up to approximately 180,000 cubic meters (235,400 cubic yards) of dredged material. Actual dredge volumes will depend on the final cable alignments and cable installation method(s); a cable installation method that can achieve a deeper burial depth will require less dredging. Appendix III-P provides the maximum extent of dredging.

Dredging could be accomplished by several techniques, such as a trailing suction hopper dredge (TSHD) (see Figure 4.3-2). If used for Phase 2, a TSHD would be used to remove enough of the top of a sand wave to allow subsequent cable installation into the stable seabed using one of the techniques described in Section 4.3.1.3.6 below. Should a TSHD be used, it is anticipated that the TSHD would dredge along the cable alignment until the hopper was filled to an appropriate capacity; then, the TSHD would sail several hundred meters away and deposit the dredged material within the OECC. Bottom dumping of dredged material would only occur within sand waves (see Figure 4.3-3). [88]

A second dredging technique that could be used is jetting by controlled flow excavation. Controlled flow excavation uses a pressurized stream of water to push sediments to the side (see Figure 4.3-2). Controlled flow excavation can be used to simultaneously remove the top of the sand wave and bury the cable. Controlled flow excavation may require several passes to lower the cable to a sufficient burial depth.

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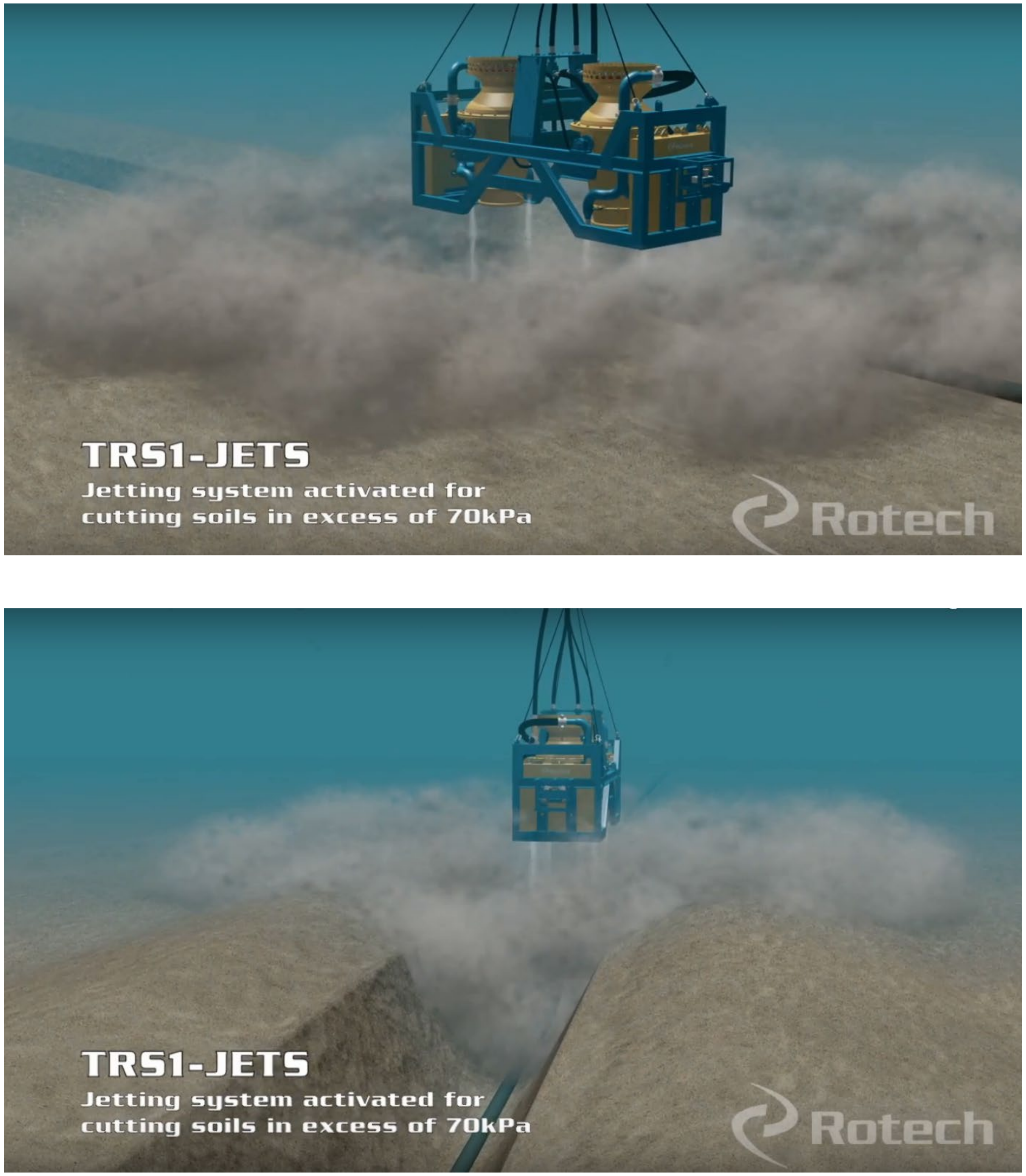
87 Since the dredging area will overlap with the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) wide temporary disturbance zone from the tracks or skids during cable installation (see Section 4.3.1.3.6), these areas have been subtracted from the dredging area to avoid double-counting impacts. The total dredging area including the cable installation trench is approximately 0.35 km^2 (86 acres).

88 Figure 4.3-3 shows the locations in the OECC where sand waves and sand bedforms greater than 0.3 m (1 ft) relief were present at the time of the survey. Sand wave and sand bedform locations are subject to change over time.



Source: http://www.rotech.co.uk/subsea-video-gallery.html

Jetting

Source: https://www.flickr.com/photos/jaxstrong/albums/72157637944233765

Trailing Suction Hopper Dredge

Figure 4.3-2

Types of Dredging Equipment

G:\Projects2\MA\MA\5315\2022\Task_4\MXD\20220315\Fig4.3-3_Potential_Sandwave_Locations_for_Dredged_Material_Deposition_20220317.mxd

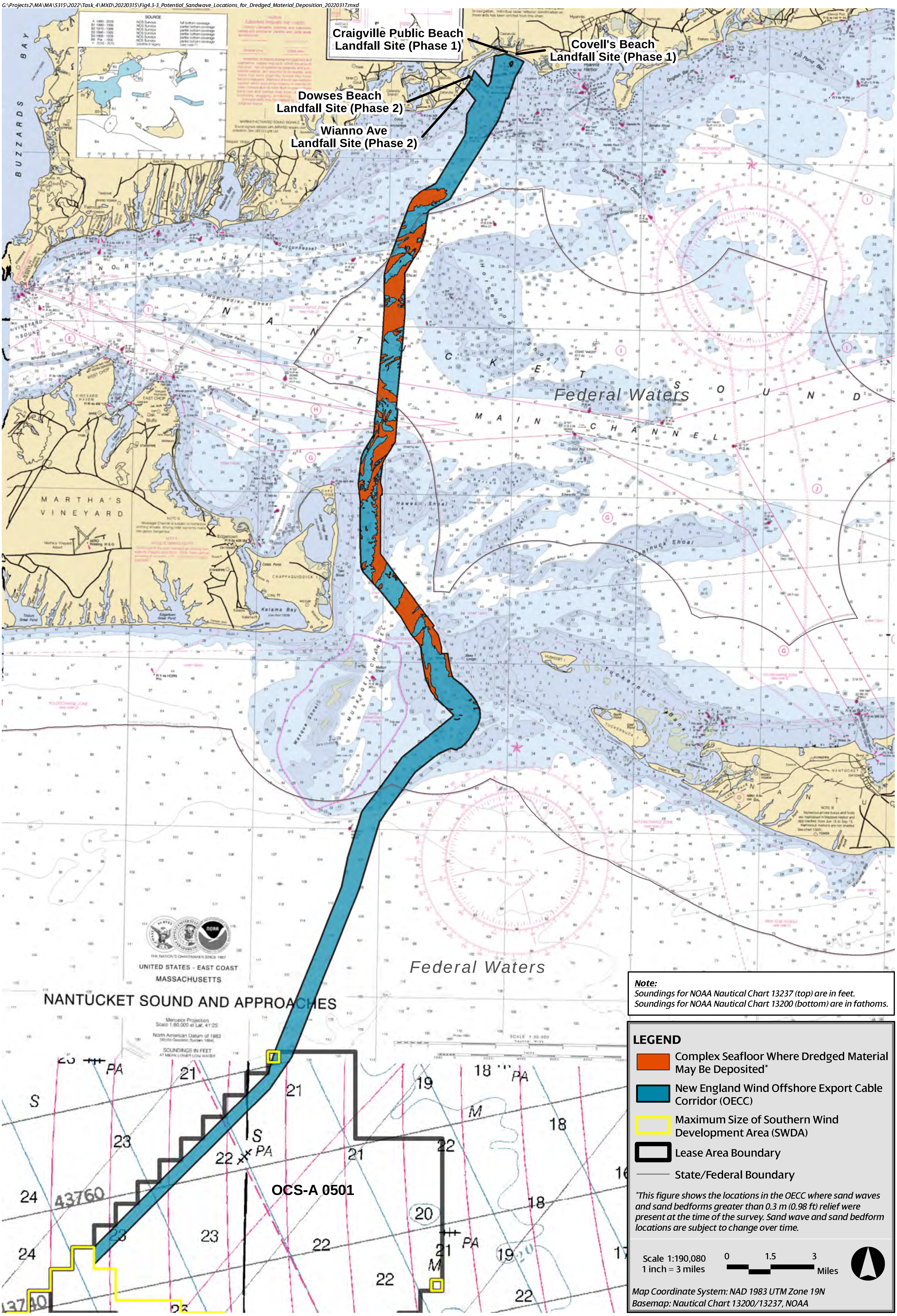


Figure 4.3-3

Potential Sand Wave Locations for Dredged Material Deposition

A TSHD can be used in sand waves of most sizes, whereas the controlled flow excavation technique is most likely to be used in areas where sand waves are less than 2 m (6.6 ft) high. Therefore, sand wave dredging could be accomplished entirely by the TSHD on its own or through a combination of controlled flow excavation and TSHD, with controlled flow excavation used for smaller sand waves and TSHD used to remove larger sand waves.

4.3.1.3.6 Cable Installation

The offshore export cables will have a target burial depth of 1.5 to 2.5 m (5 to 8 ft) below the seafloor, which the Proponent's engineers have determined is more than twice the burial depth required to protect the cables from fishing activities and also provides a maximum of 1 in 100,000 year probability of anchor strike, which is considered a negligible risk (see Appendix III-P).

Several possible techniques may be used during cable installation to achieve the target burial depth (see further description below). Generally, jetting methods are better suited to sands or soft clays whereas a mechanical plow or mechanical trenching tool is better suited to stiffer soil conditions (but is also effective in a wide range of soil conditions). While the actual offshore export cable installation method(s) will be determined by the cable installer based on site-specific environmental conditions and the goal of selecting the most appropriate tool for achieving adequate burial depth, the Proponent will prioritize the least environmentally impactful cable installation alternative(s) that is/are practicable for each segment of cable installation.

In addition to selecting an appropriate tool for the site conditions, the Proponent will work to minimize the likelihood of insufficient cable burial. For example, if the target burial depth is not being achieved, operational modifications may be required. Subsequent attempts with a different tool (such as controlled flow excavation) may be required where engineering analysis indicates subsequent attempts may help achieve sufficient burial. As discussed in Section 4.2.1.5.4, while every effort will be made to achieve sufficient burial, a limited portion of the offshore export cables may not achieve sufficient burial depth and will require cable protection.

While cable installation technologies will continue to evolve by the time Phase 2 proceeds to construction, based on currently available technologies, the majority of the offshore export cables are expected to be installed using simultaneous lay and bury via jetting techniques (e.g. jet plow or jet trenching) or mechanical plow. Both cable installation methods are described below under "Typical Techniques." However, additional specialty techniques are retained as options to maximize the likelihood of achieving sufficient burial depth (such as in areas of coarser or more consolidated sediment, rocky bottom, or other difficult conditions) while minimizing the need for possible cable protection and accommodating varying weather conditions. Additional techniques that may be used more rarely are described below under "Other Possible Specialty Techniques."

Typical Techniques

- **Jetting techniques (e.g. jet plowing or jet trenching):** Jetting tools may be deployed using a seabed tractor, a sled, or directly suspended from a vessel. Jetting tools typically have one or two arms that extend into the seabed (or alternatively a share that runs through the seabed) equipped with nozzles which direct pressurized seawater into the seafloor. As the tool moves along the installation route, the pressurized seawater fluidizes the sediment allowing the cable to sink by its own weight to the appropriate depth or be lowered to depth by the tool. Once the arm or share moves on, the fluidized sediment naturally settles out of suspension, backfilling the narrow trench. Depending on the actual jet-plowing/jet-trenching equipment used, the width of the fluidized trench could vary between 0.4–1.0 m (1.3–3.3 ft). While jet-plowing will fluidize a narrow swath of sediment, it is not expected to result in significant sidecast of materials from the trench. Offshore cable installation will therefore result in some temporary elevated turbidity, but sediment is expected to remain relatively close to the installation activities (see Section 5.2.2 of COP Volume III for a discussion of sediment dispersion modeling).

- **Mechanical plowing:** A mechanical plow is pulled by a vessel (or barge) and uses cutting edge(s) and moldboard, possibly with water jet assistance, to penetrate the seabed while feeding the cable into the trench created by the plow. While the plow share itself would likely only be approximately 0.5 m (1.6 ft) wide, a 1 m (3.3 ft) wide trench disturbance is also conservatively assumed for this tool. This narrow trench will infill behind the tool, either by slumping of the trench walls or by natural infill, usually over a relatively short period of time.

Other Possible Specialty Techniques

- **Mechanical trenching:** Mechanical trenching is typically only used in more resistant sediments. A rotating chain or wheel with cutting teeth/blades cuts a trench into the seabed. The cable is laid into the trench behind the trencher and the trench collapses and backfills naturally over time.

- **Shallow-water cable installation vehicle:** While any of the "Typical Techniques" described above could be used in shallow water, the Phase 2 Envelope also includes specialty shallow-water tools (if needed). These entail deployment of either "Typical Technique" from a vehicle that operates in shallow water in places where larger cable laying vessels cannot efficiently operate. The cable is first laid on the seabed, and then a vehicle drives over or alongside the cable while operating an appropriate burial tool to complete installation. The vehicle is controlled and powered from a shallower-draft vessel that holds equipment and operators above the waterline.

- **Pre-pass jetting:** Prior to cable installation, a pre-pass jetting run using a jet plow or jet trencher may be conducted along targeted sections of the cable route with stiff or hard sediments. A pre-pass jetting run is an initial pass along the cable route by the cable installation tool to loosen sediments without installing the cable. A pre-pass jetting run maximizes the likelihood of achieving sufficient burial during a subsequent pass by the cable installation tool when the cable is installed. Pre-pass jetting run impacts are largely equivalent to the cable installation impacts from jetting, which are described under "Typical Techniques" above.

- **Pre-trenching:** Pre-trenching is typically used in areas of very stiff clays. A plow or other device is used to excavate a trench, the excavated sediment is placed next to the trench, and the cable is subsequently laid into the trench. Separately or simultaneously to laying the cable, the excavated sediment is returned to the trench to cover the cable. It is unlikely that the Proponent will use a pre-trench method because site conditions are not suitable (i.e. sandy sediments would simply fall back into the trench before the cable-laying could be completed).

- **Pre-lay plow:** In limited areas of resistant sediments or high concentrations of boulders, a larger tool may be necessary to achieve cable burial. One option is a robust mechanical plow that would push boulders aside while cutting a trench into the seabed for subsequent cable burial and trench backfill. Similar to pre-trenching, this tool would only be used in limited areas if needed to achieve sufficient cable burial.

- **Precision installation:** In situations where a large tool is not able to operate or where another specialized installation tool cannot complete cable installation, a diver or ROV may be used to complete installation. The diver or ROV may use small jets or other small tools to complete installation.

- **Jetting by controlled flow excavation:** As described in Section 4.3.1.3.5, jetting by controlled flow excavation can be used for cable installation as well as dredging. This method is not expected to be used as the conventional burial method for the offshore export cables, but may be used in limited locations, such as to bury cable joints or bury the cable deeper and minimize the need for cable protection where initial burial of a section of cable does not achieve sufficient depth. Typically, a number of passes are required to lower the cable to the minimum sufficient burial depth, resulting in a wider disturbance than use of a jet-plow or mechanical plow. Jetting by controlled flow excavation is not to be confused with jet plowing or jet trenching (a typical cable installation method described above).

Impacts from cable installation are anticipated to include an up to 1 m (3.3 ft) wide cable installation trench and an up to 3 m (10 ft) wide temporary disturbance zone from the skids/tracks of the cable installation equipment that will slide over the surface of the seafloor (each skid/track is assumed to be approximately 1.5 m [5 ft] wide). The skids or tracks have the potential to disturb benthic habitat; however, because they are not expected to dig into the seabed, the impact is expected to be minor relative to the trench. The trench is expected to naturally backfill as sediments settle out of suspension and no separate provisions to facilitate restoration of a coarse substrate are required.

Given cable installation tools currently available, typical cable installation speeds are expected to range from 100 to 200 meters per hour (5.5 to 11 feet per minute) and it is expected that offshore export cable installation activities will occur 24 hours per day. Once offshore export cable installation has begun, to preserve the integrity of the cable, cable installation will ideally be performed as a continuous action along the entire cable alignment between splices.

Anchored cable laying vessels may be used along the entire length of the offshore export cables due to varying water depths throughout the OECC and SWDA. Anchoring during installation of the offshore export cables may require the use of a nine-point anchoring system. A nine-point anchor spread provides greater force on the cable burial tool than a spread with fewer anchors thereby enabling greater burial depth. On average, anchors are assumed to reposition approximately every 400 m (1,312 ft); however, anchor resetting is highly dependent on final contractor selection and the contractor's specific vessel(s). Each anchor is estimated to disturb approximately 30 m^2 (323 ft^2), such that a vessel equipped with nine anchors would disturb approximately 270 m^2 (2,906 ft^2) of the seafloor each time the vessel repositions its anchors.[89]

Anchored vessels may be equipped with spud legs that are deployed to secure the cable laying vessels while its anchors are being repositioned. The spud legs would disturb up to approximately 10 m^2 (108 ft^2) each time they are deployed. To install the cable close to shore using tools that are best optimized to achieve sufficient cable burial, the cable laying vessel may temporarily ground nearshore, impacting an area of up to 9,750 m^2 (2.4 acres) per cable. Should HDD or other similar trenchless methods be used at the landfall site(s), a jack-up vessel may be used to facilitate pulling the offshore export cables through conduits installed at the landfall site(s).[90] Any anchoring, jacking-up, spud leg deployment, or grounding will occur within areas of the OECC and SWDA that will have been surveyed. The total seafloor disturbance from offshore export cable installation is estimated for Phase 2 in Section 4.3.1.13.

Prior to the start of construction, contractors will be provided with a map of sensitive habitats with areas to avoid so they can plan their mooring positions accordingly. Vessel anchors and legs will be required to avoid known eelgrass beds and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable's installation. Where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, use of mid-line anchor buoys will be considered, where feasible and considered safe, as a potential measure to reduce and minimize potential impacts from anchor line sweep (see Section 6.5.2.1.6 of COP Volume III).

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89 The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the early planning stages of Phase 2.

90 Any seafloor disturbance resulting from a jack-up vessel used for cable pulling operations would be within the total seafloor disturbance from offshore export cable installation provided in Section 4.3.1.13.

4.3.1.3.7 Cable Splicing

Due to the length of the offshore export cables and other considerations, the offshore export cables may require two or three joints (splices). Upon reaching the splicing location, a cable will be retrieved from the seabed and brought inside the cable laying vessel or other specialized vessel (e.g. jack-up vessel). Inside a controlled environment (i.e. a jointing room) aboard the vessel, the two ends of the cable will be spliced together. Once cable splicing is completed, the offshore export cable will be lowered to the seafloor. Depending on the design of the cable and joint, the splicing process may take several days, in part, because the jointing process can only be performed during good weather. Prior to retrieving the cable ends from the seabed for cable splicing, cable protection may be temporarily placed over the cable ends to protect them. Permanent cable protection may also be installed over the joint once splicing is complete (see Section 4.2.1.5.4).

If a jack-up vessel is used for cable splicing operations, the vessel would impact approximately 600 m^2 (0.15 acres) of seafloor each time the vessel jacks-up. Any jacking-up will occur within surveyed areas of the OECC and SWDA. The total area of seafloor disturbance from jacking-up is provided in Section 4.3.1.13.

4.3.1.3.8 Cable Pull-in, Termination, and Commissioning

As described in Section 4.2.1.5.3, the ends of the offshore export cable will likely be protected using a cable entry protection system. The cable entry protection system would likely be mounted around the cable on board the cable laying vessel and secured to the end of the cable before the cable is pulled into the ESP.

Depending on the final construction schedule, the ends of the offshore export cables can be temporarily wet-stored or directly pulled into the ESP. To commence cable pull-in into the ESP, a ROV will likely recover a pre-installed messenger wire from the base of the foundation and connect it to the end of the offshore export cable. Using the messenger wire, a winch on the ESP will then begin to pull the cable up through the foundation into the ESP topside.

Once inside the ESP, the cable termination team will strip the cables to expose the power cores and fiber optic cables and then connect the cables to the electrical infrastructure in the ESP. After termination is completed, the export cables will be fully tested and commissioned to confirm that they can be energized. Jack-up vessels may be used for pull-in and commissioning work at the ESPs.

4.3.1.3.9 Post-Burial Cable Survey

The specific, as-built cable alignment is expected to be monitored by the cable installation tool during installation, which would record the precise location (x and y) of each offshore export cable as well as the achieved burial depth (z). If the depth of burial cannot be clearly established from any of the installation techniques, additional survey work may be undertaken.

4.3.1.3.10 Cable Protection

Cable protection may be used to protect cable joints, to secure the cable entry protection system in place, if the cables need to cross other infrastructure (e.g. existing cables, pipes, etc.), or if sufficient burial depths cannot be achieved. While every effort will be made to achieve sufficient burial, it is conservatively estimated that approximately 6% of the offshore export cables within the OECC may not achieve sufficient burial depth and will require cable protection (see Section 4.2.1.5.4 for a description of cable protection methods).

Rock protection is expected to be transported and installed by a DP fall-pipe vessel purpose-built for installing rock material in a controlled and accurate manner on the seafloor (similar to scour protection installation described in Section 4.3.1.2). An ROV located at the bottom of the fall-pipe would likely be used to control the lateral movement of the fall-pipe and monitor the installation process. The vessel would hold position or would be guided along a predefined track by the vessel's DP system. Gabion rock bags would be deployed (and recovered) from a vessel using a lifting point incorporated into the design of the bags. Mattresses would be deployed by a vessel's crane or excavator arm using an installation frame to ensure accurate placement. Half-shell pipes (or similar), if used, would be fixed around the offshore export cable on board the cable laying vessel before the cable is laid on the seabed.

4.3.1.3.11 Cable Crossings

The Phase 2 offshore export cables could require one or more cable crossings depending on the timing of Phase 2 construction and other offshore wind developers' plans to install cables. If required, a cable crossing would likely include the following steps:

1. Perform a full desktop study of any as-built and post-construction survey data for the previously installed cable.

2. Upon identification of a suitable crossing point that is agreed to by the cable owner, perform a full survey and inspection of the proposed crossing location and the existing cable using an ROV, diver-held instrument, or similar.

3. Carefully remove any existing debris surrounding the crossing point.

4. Depending on the depth of the existing cable and the cable owner's requirements, there may be a concrete mattress or other means of cable protection (see Section 4.2.1.5.4) placed between the existing cable and the Phase 2 cable. Alternatively, if there is sufficient vertical distance between the existing cable and the Phase 2 cable, there may be no manmade physical barrier between the cables.

5. During installation of the Phase 2 offshore export cable, on approach to the crossing location, the cable will be graded out of burial with the cable installation tool. At this point, some form of protection (e.g. half-shell pipe or similar) would likely be applied to the cable which is then surface laid across the seabed over the existing cable and any

previously laid cable protection. Once the Phase 2 cable has been laid over the existing cable and clears the crossing location, no further protection will be applied to the cable and the cable will be returned to burial using the cable installation tool.

6. Soon after installing the cable at the crossing, the surface-laid section of the Phase 2 cable would be protected with either additional concrete mattresses, controlled rock placement, or a similar physical barrier (see Sections 4.2.1.5.4 and 4.3.1.3.10). Remedial post-lay burial of the Phase 2 cable on either side of the crossing may be performed to lower the cable below seabed level to ensure their protection.

7. If necessary, additional cable protection will be carefully placed on and around the crossing.

8. A final as-built survey of the completed crossing will be conducted to confirm the exact location of the Phase 2 surface-laid cable and the cable protection laid over the crossing. As-built positions for the cable crossing will be shared with the existing cable's owner and provided to the National Oceanic and Atmospheric Administration for charting purposes.

Cable protection used for cable crossings may be wider than typical cable protection, but the total seafloor disturbance from cable protection will be within the area provided in Section 4.3.1.13. Cable protection methods will be designed to protect the offshore export cables against mechanical impact from above and respect the vertical distance and physical barrier (if any) to the existing cable. The cable crossing will also be designed to minimize the risk of fouling or snagging of fishing equipment. The design of the crossing structure, as well as any survey at the crossing, will be defined, planned, executed, evaluated, and documented in agreement with the cable's owner.

4.3.1.4 WTG Foundation Installation

4.3.1.4.1 Monopile Foundations

Seabed preparation may be required prior to foundation installation or scour protection installation (see Section 4.3.1.2). This could include the removal of large obstructions and/or leveling of the seabed.

After fabrication, monopile foundation components (i.e. monopile, transition piece [TP], and any secondary items) will be transported to a port facility (see Section 4.2.2.5) or directly to the SWDA. The installation concept and method of bringing components to the SWDA will be based on supply chain availability and final contracting. The monopiles are expected to be installed by one or two heavy lift or jack-up vessel(s). The main installation vessel(s) will likely remain at the SWDA during the installation phase and vessels would provide a continuous supply of foundations to the SWDA. In this scenario, the monopiles may also be floated out to the SWDA using tugboats. In addition, a tugboat may remain at the SWDA to assist feeder vessels' approach to the main installation vessel. The foundation components could be picked up directly in a US port (if Jones Act compliant vessels are available) or Canadian port by the main installation vessel(s).

One or two DP, anchored, or jack-up vessels may be used for installation of the foundations. To estimate the maximum seafloor disturbance from WTG foundation installation vessels, it is assumed that the vessels would jack-up and/or anchor up to three times at each WTG foundation, disturbing up to approximately 3,600 m^2 (0.89 acres) per foundation.[91] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. The total seafloor disturbance from jacking-up and anchoring is estimated for Phase 2 in Section 4.3.1.13.

At the SWDA, the main installation vessel will likely use a crane to upend and lower the monopile to the seabed. To stabilize the monopile's vertical alignment before and during piling, a pile frame may be placed on the seabed (atop the scour protection) or a pile gripper may extend from the side of the installation vessel. After the monopile is lowered to the seabed through the pile gripper/frame, the weight of the monopile will enable it to "self-penetrate" a fraction of the target penetration depth into the seafloor. The crane hook would then be released, and the hydraulic hammer would be lifted and placed on top of the monopile. Figure 4.3-4 shows a vessel lowering a monopile and typical jack-up installation vessels.

Next, impact pile driving will commence beginning with a soft-start.[92] A soft-start utilizes an initial set of low energy strikes from the impact hammer followed by a waiting period. Additional strike sets gradually increase energy to what is needed to install the pile (usually less than hammer capability). A soft-start ensures a monopile remains vertical and also allows any motile marine life to leave the area before pile driving intensity is increased. The intensity (i.e. hammer energy level) will be gradually increased based on the resistance that is experienced from the sediments. The maximum hammer energy for monopiles is up to 6,000 kilojoules (kJ); however, for the large majority of monopiles, the maximum hammer energy is anticipated to be 5000 kJ. Noise mitigation systems are expected to be applied during pile driving (see Sections 6.7 and 6.8 of COP Volume III). The typical pile driving operation is expected to take several hours to achieve the target penetration depth. It is anticipated that a maximum of two monopiles can be driven into the seabed per day.

[91] It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for WTG foundation installation is calculated based on vessels jacking-up three times.

[92] Soft-start procedures are also employed for surveys using sonar equipment less than 200 kHz in frequency (i.e. sub-bottom profilers).

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Figure 4.3-4

Typical Foundation Installation Vessels

In order to initiate impact pile driving the pile must be upright, level, and stable. The preferred option to achieve this is by utilizing a pile frame or pile gripper as described above. If both preferred options have unforeseen challenges, vibratory hammering may be utilized as a contingency. Vibratory pile driving would only occur for very short periods of time and only if the Proponent's engineers determine that vibratory driving is required to stabilize the pile so impact driving can begin.

Based on soil condition surveys, drilling of monopiles is not anticipated, but could be required if a large boulder or monopile refusal is encountered. If drilling is required, a rotary drilling unit would likely be mobilized to the monopile top. The interior sediment would then be drilled out and deposited on the seabed adjacent to the scour protection material until the monopile is no longer obstructed. Monopile installation would then recommence until the monopile reaches target depth. After drilling is complete, the interior sediment may be re-deposited into the monopile to provide additional stability. Alternatively, the interior of the monopile may be filled with medium/coarse sand, grout, or concrete.

After installation of the monopile, the TP will be picked up and placed on the monopile (unless an extended monopile concept is used). The connection between the monopile and the TP will likely be grouted, bolted, slip-jointed, or use a combination of these methods. If the main connection is established by bolts, grout is foreseen in a "skirt" holding the boat landing, with the following purposes:

- Support for the lower part of the boat landing
- Protecting against water ingress to the bolted connection
- Corrosion protection underneath the skirt

Grout material, if used, would likely be mixed either on the installation vessel or a separate grouting vessel. Grout would be pumped through hoses into the TP structure to fill the annulus between the monopile and the TP and will be contained at the lower extremity of the TP by a high strength rubber grout seal. The design will ensure that any overflow of grout during grouting will be directed to the inside of the foundation. Grout spill management procedures are described in Section 4.3.4.5.

If the time between the installation of the monopile and TP is longer than a few days, the amount of marine growth must be assessed and marine growth may need to be removed with a high pressure washing tool or similar equipment prior to installing the TP. Anti-fouling paint in contrasting colors may be used in select areas on the monopile (e.g. surrounding apertures) to prevent build-up of marine growth and increase visibility for ROVs performing cable pull-in operations.

4.3.1.4.2 Jacket Foundation Installation

The installation concept and method of bringing jacket components to the SWDA is similar to that for the monopiles. As with monopiles, seabed preparation may be required prior to scour protection or foundation installation.

After fabrication, the jacket components will be transported to a port facility (see Section 4.2.2.5) or directly to the SWDA on the installation vessel or a separate transport vessel. Once delivered to the SWDA, the jacket will be lifted off the transport or installation vessel and lowered to the seabed with the correct orientation. As further described in Section 4.3.1.4.1 above, anchored, DP, and/or jack-up vessels may be used for installation of the WTG foundations. The installation vessels could impact up to 3,600 m^2 (0.89 acres) for each WTG foundation installation; any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. Total seafloor disturbance from WTG foundation installation is estimated in Section 4.3.1.13.

If piled jackets are used, once the jacket structure is set on the seabed, the pin piles would be lifted and driven through the pile sleeves to the engineered depth. Alternatively, the piles may be driven prior to lowering the jacket by using a frame to orient the piles.

Impact pile driving would commence with a soft-start, as described above for the monopiles. The maximum hammer energy for jacket piles is up to 3,500 kJ. A maximum of one complete piled jacket (up to four pin piles) is expected to be installed per day. As noted above, no drilling is anticipated but it could be required if pile refusal is encountered. Similarly, use of a vibratory hammer is not anticipated, but could be used if deemed appropriate by the installation contractor.

Once all piles are driven to the target depth, the jacket would be leveled and the piles would be fixed in the pile sleeves, most likely by the use of grouting. Grout material could be mixed either on the installation vessel or a separate grouting vessel. Grout would then be pumped through hoses into the jacket structure to fill the annulus between the sleeves and piles and will be contained at the lower extremity of the sleeve by a high strength rubber grout seal. The grout level would likely be monitored visually using underwater cameras and when grout reaches the top of the sleeve, grouting would be halted. Grout spill management protocols similar to those for monopile foundations would also be used for jacket foundations (see Section 4.3.4.5).

If suction bucket jackets are used, suction pumps would be attached to the top of each bucket before being lifted from the vessel. Once the jacket is placed on the seabed, the weight of the jacket will enable it to "self-penetrate" a fraction of the target penetration depth into the seafloor. As described in Section 4.2.1.2.2, the suction pump attached to the bucket would pump water and air out of the space between the suction bucket and seafloor, reducing water pressure inside the bucket and creating a driving force that pushes the bucket down into the seafloor. Penetration of the bucket will stop when the pushing force is equal to the soil resistance below the seafloor. Once equilibrium is achieved, the suction pumps are recovered to the vessel. Any remaining interstitial space between the bucket and seafloor may be filled with grout, sand, and/or concrete.

4.3.1.4.3 Bottom-frame Foundation Installation

Bottom-frame foundation installation is similar to jacket foundation installation described above in Section 4.3.1.4.2; however, the bottom-frame foundation may require additional seabed preparation to level the seabed and ensure that the central column sits vertically.

The bottom-frame foundation could be transported to the SWDA on a vessel (e.g. a barge or jack-up vessel) in a similar manner as conventional jackets. Alternatively, the bottom-frame foundation could be augmented with buoys/ballasting tanks and floated to the SWDA using tugboats. At the SWDA, the bottom-frame structure would be carefully lowered to the seabed by gradually removing buoyancy and increasing ballast. Once firmly on the seabed, the final ballasting would occur by pumping material into the structural elements. The ballast material would typically consist of a combination of seawater and natural materials, such as sand and gravel or olivine (iron ore).

If the bottom-frame foundations are floated to the SWDA, it may be feasible for the WTGs to be pre-installed on top of the foundations and floated to the SWDA as one unit. While in port, a harbor crane would install the WTG onto the foundation while the foundation is located adjacent to the quayside. This installation method would allow the WTGs to be pre-commissioned onshore, reducing final commissioning work offshore. This method would also significantly simplify transport and installation but would require a larger foundation structure and impose greater restrictions on weather conditions during transport and installation.

As further described in Section 4.3.1.4.1 above, anchored, DP, and/or jack-up vessels may be used for installation of the WTG foundations. The installation vessels could impact up to 3,600 m^2 (0.89 acres) for each WTG foundation installation; any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. Total seafloor disturbance from WTG foundation installation is estimated in Section 4.3.1.13.

If piles are used, once the bottom-frame foundation is set on the seabed, the piles would be lifted and driven through the feet of the foundation to the engineered depth. Alternatively, the piles may be driven prior to lowering the bottom-frame foundation by using a frame to orient the piles. Impact pile driving would commence with a soft-start, as described above for the monopiles and jackets. The maximum hammer energy for bottom-frame piles is up to 3,500 kJ. A maximum of one complete piled bottom-frame foundation (up to three pin piles) is expected to be installed per day. As noted above, no drilling is anticipated but it could be required if pile refusal is encountered. Similarly, use of a vibratory hammer is not anticipated, but could be used if deemed appropriate by the installation contractor.

Once all piles are driven to the target depth, the bottom-frame foundation would be leveled and the piles would be affixed to the foundation, most likely by the use of grouting (see Section 4.3.1.4.2 above for a description of grouting piles). Grout spill management protocols similar to those for monopile and jacket foundations would also be used for bottom-frame foundations (see Section 4.3.4.5).

If suction buckets are used, as described in Section 4.3.1.4.2, suction pumps attached to the buckets would pump water and air out of the space between the suction buckets and seafloor, pushing the buckets down into the seafloor. Once full penetration is achieved, the suction pumps would be recovered to the vessel. Any remaining interstitial space between the bucket and seafloor may be filled with grout, sand, and/or concrete.

4.3.1.5 Electrical Service Platform (Topside and Foundation) Installation

Each ESP is comprised of two primary components: the topside that contains the electrical components and the foundation substructure.

Either a monopile or jacket foundation will be used to support the weight of each ESP topside. ESP foundation installation is similar to WTG foundation installation described in Sections 4.3.1.4.1 and 4.3.1.4.2 above. Either a monopile is driven vertically into the seabed or a jacket foundation is secured to the seabed with pin piles or suction buckets. Like WTG foundations, the maximum hammer energy for monopiles and jackets is up to 6,000 kJ and 3,500 kJ, respectively, although energy use is anticipated to be less. Up to two monopiles or four jacket piles will be driven per day for both WTGs and ESPs. As with WTG foundations, seabed preparation may be required prior to scour protection or foundation installation.

The ESP topside(s) will likely be transported directly to the SWDA. Alternatively, the ESP(s) could be transported to a harbor (see Section 4.2.2.5) and moved offshore on a vessel. Topside installation may be carried out by the same vessel that installs the foundation. First, the installation vessel will position itself next to the foundation. The ESP topside will arrive on a separate transport vessel (or will have been transported on the deck of the installation vessel) and the installation vessel's crane will lift the topside and place it on the foundation. The topside and the foundation will be connected using bolted connections and/or welding. Figure 4.2-8 shows construction work being performed on an ESP. If an integrated WTG/ESP concept is used (i.e. where ESP equipment that is typically located in the ESP topside is placed on one or more expanded WTG foundation platforms), the ESP equipment is anticipated to be installed on the expanded foundation platform before or after the WTG is installed (see Section 4.3.1.7) using a vessel similar to the foundation or WTG installation vessel.

ESP foundation and topside installation may be performed by a DP, anchored, or jack-up vessel. To estimate the maximum seafloor disturbance from ESP installation vessels, it is assumed that vessels would anchor and/or jack-up up to eight times at each ESP and would disturb up to approximately 9,600 m^2 (2.4 acres) per ESP.[93] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed.

After ESP mechanical installation is complete, the inter-array cables, offshore export cables, and inter-link cables (if used) will be pulled into place and terminated at each ESP. If required, once the cables are connected to the ESP(s), the corrosion protection/control system is expected to be installed around the ESP foundation structure(s) utilizing a similar design as the WTG foundations.

Following topside installation, the ESP(s) will be commissioned. ESP commissioning, which entails conducting tests of the electrical infrastructure and safety systems on the ESP(s) prior to commercial operations, may last several months. During the commissioning period, a jack-up vessel may be positioned adjacent to the ESP(s) to provide accommodations for workers performing commissioning activities.

4.3.1.6 Inter-Array and Inter-Link Cable Installation

"Strings" of multiple WTGs will be connected to the offshore ESP(s) using 66 to 132 kV inter-array cables (see Figure 4.2-15). In addition, inter-link cables may be used to connect the Phase 2 ESPs together (if two or three ESPs are installed) and/or to a Phase 1 ESP.

Prior to inter-array cable and inter-link cable installation, a pre-lay grapnel run and pre-lay survey are expected to be performed to inspect the cable route and locate and clear obstructions (see Sections 4.3.1.3.3 and 4.3.1.3.4 for a description of these activities). Based on preliminary survey data for the SWDA, dredging and boulder clearance may not be necessary prior to inter-array or inter-link cable laying, but this will be confirmed through additional data analyses.

The inter-array cables could be transported in a cable laying vessel and directly installed at the SWDA upon arrival, or they could be stored temporarily onshore and transferred to a cable laying vessel. Upon arrival at the SWDA, the first end of an inter-array cable will be pulled into a WTG or ESP foundation. Once the first end of the cable is secured inside the foundation, the cable laying vessel will install the inter-array cable as it moves towards the next foundation in the inter-array cable string. Then, the second end of the inter-array cable will be pulled into the foundation. Cable pull-in will be conducted at each foundation location and followed by cable termination works.

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93 It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for ESP installation is calculated based on vessels jacking-up eight times.

Inter-link cable transportation and installation will likely follow a process similar to inter-array or offshore export cable transportation and installation, except that the cable will be installed between ESPs. Whereas inter-array cable installation is expected to use a DP vessel, inter-link cable installation may be performed using an anchored vessel. Like the offshore export cable laying vessel (see Section 4.3.1.3.6), each anchor is estimated to disturb approximately 30 m^2 (323 ft^2), such that a vessel equipped with nine anchors would disturb approximately 270 m^2 (2,906 ft^2) of the seafloor each time the vessel repositions its anchors.[94] In addition, anchored vessels may be equipped with spud legs that would disturb up to approximately 10 m^2 (108 ft^2) each time its anchors are being repositioned. On average, anchors are assumed to reposition every approximately 400 m (1,312 ft). The total seafloor disturbance from inter-link cable installation is estimated for Phase 2 in Section 4.3.1.13.

While cable installation technologies will continue to evolve by the time Phase 2 proceeds to construction, based on currently available technologies, the expected installation method for the inter-array cables is to lay the cable section on the seafloor and then subsequently bury the cable using a jetting technique (this is referred to as "post-lay burial"). However, the cables could be installed using any techniques listed in Section 4.3.1.3.6 above. The inter-link cables will also be installed using one of the techniques listed in Section 4.3.1.3.6 above. As with the offshore export cables, the inter-array and inter-link cables will have a target burial depth of 1.5–2.5 m (5–8 ft). The Proponent expects that the position of the inter-array and inter-link cables will be documented either at the time of installation or shortly thereafter with an as-built survey.

As described in Section 4.2.1.6, each end of the inter-link and inter-array cables will likely be protected using a cable entry protection system. The cable entry protection system is expected to be mounted around the cable on board the cable laying vessel and secured to the end of the cable before the cable is pulled into the WTGs or ESP(s). Additional cable protection may be placed over the cable entry protection system to secure it in place and limit movement of the cable.

Although unlikely, cable protection may also be required for sections of the inter-array and inter-link cables where burial was not possible or where cable crossings are required (see Section 4.2.1.6). If required, cable protection for the inter-array and inter-link cables are anticipated to be installed using the same methods described for the offshore export cables in Sections 4.3.1.3.10 and 4.3.1.3.11.

94 The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the early planning stages of Phase 2.

4.3.1.7 Wind Turbine Generator Installation

Prior to the commencement of installation, WTG components may be transported to one of the ports listed in Section 4.2.2.5 to create a sufficient stock of components in order to maintain a steady pace of installation activities. Some WTG preparatory work/assembly at the port may be needed. Feeder vessels would then transport WTG components from the port to the SWDA.[95] Alternatively, WTG components may be delivered to the SWDA directly from overseas.

The WTGs are expected to be installed by one or two main installation vessels, which may be a jack-up, anchored, or a DP vessel. The WTG components will be lifted using the main installation vessel's crane and/or a "climbing crane" that crawls up the WTG tower (using the tower for support). The tower will first be erected followed by the nacelle and finally the hub, inclusive of the blades. Alternatively, the nacelle and hub could be installed in a single operation followed by the installation of individual blades. In case the tower consists of more than one section, the sections will likely be joined with a bolted connection.

To estimate the maximum seafloor disturbance from WTG installation vessels, it is assumed that the vessels would jack-up and/or anchor up to four times at each WTG, disturbing up to approximately 4,800 m^2 (1.2 acres) per WTG.[96] Any anchoring or jacking-up that occurs at the SWDA will occur within areas that will have been surveyed. The total seafloor disturbance from jacking-up and anchoring is estimated for Phase 2 in Section 4.3.1.13.

WTG installation will be followed by the commissioning period where the WTGs will be prepared for operation and energized. The WTG commissioning and testing phase will likely be conducted in parallel with the WTG installation phase. Service operation vessels (SOVs) or crew transfer vessels (CTVs) may be used to transport crew to and from the WTGs during commissioning activities.

4.3.1.8 Landfall Site Construction

As described in Section 4.2.2.1, unless technical, logistical, grid interconnection, or other unforeseen issues arise, the Phase 2 offshore export cables will transition onshore at the Dowses Beach Landfall Site, the Wianno Avenue Landfall Site, or both. The construction methods for each landfall site are described below.

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95 If the bottom-frame foundations are used, it may be technically feasible for the WTGs to be pre-installed on top of the foundations and floated to the SWDA as one unit (see Section 4.3.1.4.3).

96 It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance for WTG installation is calculated based on vessels jacking-up four times.

4.3.1.8.1 Dowses Beach Landfall Site Construction

At the Dowses Beach Landfall Site, the ocean-to-land transition will be made using horizontal directional drilling (HDD) to avoid or minimize impacts to the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. The HDD staging area would be setup in the Dowses Beach parking lot, and the drill would be advanced seaward. An approach pit at the HDD staging area will provide the contractor with access to the proper trajectory for drilling and will also serve as a reservoir for drilling fluids used to extract material from the drill head.

The HDD process begins with drilling bore holes between the onshore HDD staging area and an offshore HDD exit point. One bore is needed for each offshore export cable. The length of the drill or bore depends on the width of the dune and beach area, the proximity of the HDD staging area, the extent of any nearshore sensitive resources, bathymetry, and geologic conditions. Based on preliminary HDD alignments, the HDD bores for the offshore export cables' transition onto Dowses Beach are expected to be approximately 300–427 m (1,000–1,400 ft) in length, subject to further detailed engineering. Although the HDD trajectory is still undergoing engineering refinement, it is estimated that the trajectory will result in the HDD passing at a depth of approximately 9 m (30 ft) below the ground surface at Mean High Water (MHW).

Once the bore holes are completed, a plastic conduit is inserted into the bore holes. To facilitate cable pull-in and expose the conduit end, a shallow "pit" would be excavated at the HDD exit point using techniques such as controlled flow excavation. At the HDD exit point, the contractor may lower a gravity cell or cofferdam to the seafloor that would capture any incidental drilling fluid released from the end of the HDD drill. Divers will then insert the offshore export cables into the conduits, and the cables will be pulled through the conduits towards land. The seaward end of each conduit would then be reburied beneath the seafloor, likely using divers with hand-jets (i.e. using a narrow, high-pressure stream of water). If softer sediments are present, silt curtains will be employed in and around the area of hand-jetting to contain turbidity. Between the HDD entry pit and the transition vaults, the offshore export cables will be installed beneath the parking lot in open trenches using conventional excavation equipment (e.g. excavators or backhoes). Once the offshore export cables are pulled into the transition vaults, they will be connected to the onshore export cables.

Thermal grout may be used to fill the interstitial space between each offshore export cable and cable conduit to enhance the thermal characteristics of the cable (i.e. to enhance heat dissipation from the cable). Grout would be pumped from an offshore vessel into the interstitial space between the cable and the conduit, and the non-hazardous mixture of displaced water, grout, and sand would be stored, dewatered, and disposed of per applicable regulations. If grout is not used, a mix of seawater and/or sand will occupy the interstitial space between the cable and conduit.

HDD will require use of a drilling fluid (i.e. a slurry consisting predominantly of water and bentonite, which is a naturally occurring, inert, and non-toxic clay) to cool and lubricate the drill bit, stem, and other equipment as well as seal the sides of the bore. This benign, natural material would pose little to no threat to water quality or ecological resources in the rare instance of seepage around the HDD operations.

The HDD installation method will produce a slurry of two co-mingled byproducts: drill cuttings and excess drill fluids. During drilling, this slurry will be collected from the reservoir pit and will be processed through a recycling system where drill cuttings (solids) will be separated from reusable drill fluids. Non-reusable material consisting of drill cuttings and excess drill fluids will be trucked to an appropriate disposal site; this material is typically classified as clean fill that can be disposed of at gravel pits or farm fields/pastures. Filtered water will be released if it meets water quality requirements. Measures to minimize the already-remote potential for seafloor disturbance through drilling fluid seepage (i.e. frac-out) are described in Section 8.6 of COP Volume III.

The Proponent will restore the HDD staging area to match existing conditions. Any paved areas that have been disturbed will be properly repaved.

4.3.1.8.2 Wianno Avenue Landfall Site Construction

The Phase 2 offshore export cables' transition onshore at the Wianno Avenue Landfall Site may be accomplished using open trenching or HDD. Wianno Avenue is less suited for HDD than open trenching due to the parking lot's elevated topography and the steep slope of the shoreline, which would require challenging bends in the HDD bore holes. Further, use of HDD at this location would require a staging area along the east side of Wianno Avenue, resulting in a lane closure for the duration of the operation, whereas open trenching at this location could be staged primarily within the paved parking lot at the end of Wianno Avenue with minimal impact to traffic patterns. This landfall site is suitable for open trenching because the shoreline has already been altered by the installation of a riprap seawall, a portion of which would be temporarily removed and replaced following cable installation. Use of open trenching, as opposed to the more equipment intensive and time-consuming HDD, could also minimize any temporary disturbances to nearby neighbors. Regardless of the landfall site construction method used, the area of state-mapped eelgrass near the end of Wianno Avenue will be avoided.

If open trenching is used, the process will begin with the installation of a temporary, three-sided cofferdam constructed of sheet piles at the end Wianno Avenue using a vessel-mounted crane. The cofferdam will be approximately 9 m (30 ft) wide and 66 m (215 ft) long and it will be open at the landward end to allow for installation of plastic (e.g. HDPE) conduits toward the onshore transition vaults. Some riprap removal will be required at the existing seawall to accommodate sheet pile installation close to shore; this riprap and seawall will be restored to its original dimensions after the sheet piles are removed.

Once the sheet piles are installed, the tops will be cut off approximately 1.5 m (5 ft) above mean high water. The cofferdam seams will be sealed and the contained area (approximately 600 m^2 [6,450 ft^2]) will be dewatered during trench excavation to facilitate conduit installation in a dry, or semi-dry, condition. Although the cofferdam will be located outside of areas normally subject to vessel traffic, the location will be properly marked to warn vessels of the temporary cofferdam's presence.

A trench for the conduits will be excavated from within the cofferdam towards the onshore transition vaults using a vessel; excess trench spoils are expected to be placed on the vessel in containment with dewatering features to allow filtered water to return to the ocean. Each trench will then be partially backfilled with clean sand and gravel to achieve the required bedding elevation for placement of the conduits. After the conduits are installed within the trench, each with an anti-floatation collar on the seaward end, the trenches will be backfilled with sand and gravel fill. After conduit installation is complete, the sheet piles will be removed using barge-mounted equipment.

After the conduits have been installed and the cofferdam has been removed, the seaward end of the conduits will be left unburied in preparation for the offshore export cables. The offshore export cables (one per conduit) will be pulled through the conduits toward the transition vaults. The seaward end of the conduits would then be reburied beneath the seafloor. The transition vaults and the duct bank landward of these vaults will be installed via open-trench methods using conventional excavation equipment. Within the transition vaults, the offshore export cables will be connected to the onshore export cables.

If HDD is used at the Wianno Avenue Landfall Site, the process will follow the steps described above for HDD at the Dowses Beach Landfall Site (see Section 4.3.1.8.1).

4.3.1.9 Onshore Substation Construction

As described in Section 4.2.2.3, the Phase 2 onshore export cables will connect to one or two new onshore substations in the Town of Barnstable.[97] The properties needed for the onshore substation site(s) have not yet been secured, but the site(s) will be located generally along the routes shown in Figure 4.1-2. Generally, construction of the onshore substation(s) is anticipated to include the following steps:

- Install perimeter construction fencing, a security gate, and erosion controls.
- Prepare the site for construction (e.g. clearing and grading the site, installing retaining walls, and excavating areas required for foundations, containment, or drainage).

97 If electricity generated by Phase 2 is delivered to a second grid interconnection point, Phase 2 could include one onshore substation in Barnstable and/or an onshore substation(s) in proximity to the second grid interconnection point (see Section 4.1.4).

- Construct component foundations, any containment sumps, and footings for other equipment.

- Deliver and place equipment using appropriate heavy-load vehicles and equipment.

- Trench areas for underground cabling, install duct bank, and backfill.

- Complete buswork, bring the onshore export cables into the site, and bring the grid interconnection cables to the grid interconnection point.

- Complete cabling, control wiring, and installation of protection systems.

- Test and commission the onshore substation.

- Install permanent perimeter security fencing and screening, restore and landscape at the periphery of the site (if required), and remove construction stage erosion controls.

Ground disturbing activities during Phase 2 onshore substation construction are expected to include excavation and grading at each onshore substation site. The maximum area of ground disturbance during construction of each onshore substation is 0.08 km^2 (19 acres), resulting in a total maximum of disturbance of 0.15 km^2 (38 acres) for two Phase 2 onshore substations. The maximum area of tree clearing that may be required to accommodate grading and access during Phase 2 onshore substation construction is approximately 0.03 km^2 (8 acres) for each site or 0.06 km^2 (16 acres) in total. As noted in Section 4.2.2.3, the Proponent may plant vegetated screening following construction pursuant to final design plans.

Lastly, modifications at the West Barnstable Substation will be required to accommodate the Phase 2 interconnection. The design and schedule of this work will be determined by the results of the ISO-NE cluster study and coordinated with Eversource. Any additional system upgrades would be constructed by Eversource.

4.3.1.10 Onshore Export and Grid Interconnection Cable Installation

As described in Section 4.2.2.2, underground onshore export cables will connect the Phase 2 landfall site(s) to the new onshore substation(s). Then, onshore grid interconnection cables will connect the onshore substation(s) to the grid interconnection point.[98] The onshore cables are expected to be installed within a duct bank via open trenching. Where the onshore cables cross wetlands, waterbodies, or busy roadways, specialized construction methods may be employed.

98 As described in Section 4.1.3.3, one or more Phase 2 offshore export cables may deliver power to a second grid interconnection point if technical, logistical, grid interconnection, or other unforeseen issues arise.

4.3.1.10.1 Typical Onshore Cable Installation Within Duct Bank

Installation of the onshore cables within a duct bank will occur in two steps. The first step will consist of installing the concrete duct bank and splice vaults that will house the onshore cables and associated infrastructure. Construction of the duct bank is expected to be performed via open trenching with conventional construction equipment (e.g. hydraulic excavator, loader, dump trucks, flatbed trucks, crew vehicles, cement delivery trucks, and paving equipment). The second step will consist of pulling the onshore cables through the conduits in the duct bank, followed by splicing and terminating the cables. The onshore cables will be pulled into place from underground vaults using a cable reel transport vehicle, a pulling rig, and the necessary crew and support vehicles. Installation of the in-road underground cabling will typically be performed during the off-season, where feasible, to minimize traffic disruption. All work will be performed in accordance with local, state, and federal safety standards, as well as any company-specific requirements.

More specifically, installation of the duct bank and onshore cables along the selected Onshore Export Cable Route(s) and Grid Interconnection Route(s) includes the following steps:

- Survey and mark splice vault and duct bank locations.
- Set up erosion and siltation controls, including silt sacks or similar protection for existing storm drains.
- Set up traffic management measures in coordination with local police and public works officials.
- Open roads and remove pavement (if needed), excavate and shore trenches via open trenching, and excavate splice vault locations. Excavated material will be hauled away in trucks daily and recycled or disposed of in accordance with state regulations.
- Install plastic pipes (pipes may be stockpiled in a local staging area or along the road), pour concrete duct bank, and install prefabricated vaults.
- Backfill the trenches. Trenches that are not backfilled by day’s end will be secured with steel plates that are set in place to cover and protect the trench overnight. Openings in the shoulder will be protected and barricaded to ensure traffic and pedestrian safety. Subject to local permit conditions, temporary pavement will be placed at completed trench sections.
- Pull the onshore cables into the duct bank and splice the cables together.
- Test and energize the onshore cables.

- Repave roads in accordance with Massachusetts Department of Transportation (MassDOT) and Town specifications to as-new conditions and restore disturbed vegetated areas to match pre-existing vegetation.

- Clean up the work area and remove erosion controls.

The duct bank layout, and hence the excavated trench dimensions, will vary along the Onshore Export Cable Route(s) and Grid Interconnection Route(s). The proposed duct bank will be formed using cast-in-place concrete installed in open trenches measuring up to approximately 2.6 m (8.5 ft) in depth, 3.2 m (10.5 ft) in width at the bottom, and 4.3 m (14 ft) in width at the top. In locations where splice vaults are necessary, the excavated area will be larger (approximately 6 m [20 ft] wide by 15 m [50 ft] long) to accommodate a pre-cast concrete splice vault. Both the duct bank and the splice vaults may be installed anywhere along the Onshore Export Cable Route(s) and Grid Interconnection Route(s); therefore, the maximum extent of disturbance along the entire route within roadway layouts will be based on the dimensions of the area excavated for splice vaults. The top of the duct bank typically has a minimum of 0.9 m (3 ft) of cover comprised of properly compacted sand topped by pavement. However, if required due to existing conditions (e.g. at certain utility crossings), the minimum cover will be 0.8 m (2.5 ft).

Trenching will occur primarily within existing roadway layouts where excavation will occur within paved areas or within 3 m (10 ft) of pavement. Minimal tree trimming and/or tree clearing may be needed where the routes follow existing roadway layouts, depending on the final duct bank alignment.

Certain potential onshore routes also utilize existing utility rights-of-way (ROWs). Installation of duct bank and splice vaults within these ROWs would require clearing and grading within a corridor wide enough to accommodate excavation and stockpiling of soils and provide space for construction equipment access along the work zone. The work, however, will be confined to as narrow a corridor as possible and will not impact adjacent wildlife habitat located outside of that corridor elsewhere within the utility ROW. Some stretches of existing utility ROWs may also require tree clearing where those ROWs have not been maintained to their full widths. For construction within the utility ROW, any disturbed vegetated areas will be loamed and seeded to match pre-existing vegetation.

Dewatering of the duct bank trench will be necessary in areas where groundwater is encountered, where soils are saturated, or at times when the trench is affected by storm water. Areas where groundwater may be encountered will be identified as part of the pre-construction environmental investigation of soils. In these areas, groundwater would be pumped from one or more sumps within the trench or vault using submersible pumps. Trench dewatering management will be accomplished using a combination of best management practices to avoid pumping sediment-laden water from the excavated areas; collected water will be passed through a dewatering fractionization tank (frac tank) and filtered prior to release. Standard erosion control practices will be employed to minimize erosion during trenching operations and construction activities in general.

4.3.1.10.2 Trenchless Crossing Techniques

Specialty trenchless crossing methods are expected to be used if the Phase 2 Onshore Export Cable Route(s) and Grid Interconnection Route(s) traverse unique features such as busy roadways, wetlands, and waterbodies in order to avoid impacts to those features. Trenchless crossing methods primarily include:

- **Horizontal directional drilling:** HDD involves drilling a bore hole in an arc beneath a feature (e.g. a beach, wetland, roadway), enlarging the bore hole, and then inserting a plastic conduit into the bore hole. The cables are subsequently pulled through the conduits. For additional description of HDD, see Section 4.3.1.8.1.

- **Pipe jacking:** Pipe jacking uses hydraulic jacks to thrust a specially designed casing pipe through the ground, led by a guidance system, to excavate a tunnel from a jacking shaft to a receiving shaft. Pipe jacking methodologies include microtunnel, earth pressure balance machines, conventional non-pressurized tunnel-boring machines, and open shield machines.

- **Direct pipe:** The direct pipe trenchless drilling method uses a drill head welded to a pipe casing. As drilling progresses, the pipe casing is extended. Once the drill path beneath the feature is complete, the drill head is cut off and the pipe remains in place, becoming the casing for the cables.

East Bay Crossing

If the Dowses Beach Landfall Site is used, the Phase 2 onshore export cables may be installed beneath East Bay using a trenchless crossing to reach one of two potential locations on East Bay Road (see Figure 4.1-2). At this time, the Proponent expects to use a microtunnel to bury the onshore export cables beneath East Bay, although other trenchless crossing methods (e.g. HDD) may be used.

Microtunneling is a pipe jacking operation that uses a microtunnel boring machine (MTBM), which is pushed into the earth by hydraulic jacks mounted and aligned in a jacking shaft. To accomplish the East Bay crossing, a single approximately 170 m (558 foot) long microtunnel drive would be used to install an approximately 1.8 m (6 ft) diameter steel casing under the bay between the Dowses Beach parking lot and one of two locations on East Bay Road. The casing would house the onshore export cable and fiber optic cable conduits and interstitial space within the casing would be filled with thermally conductive grout to dissipate heat. As the MTBM is advanced along the planned alignment, segments of the casing are lowered into the shaft and inserted into the bore. A minimum depth of approximately 3.7 m (12 ft) of cover between the top of the casing and the bottom of East Bay is needed to complete the microtunnel drive and maintain tunnel face stability. Once the MTBM completes the microtunnel drive beneath the bay, it will be recovered from a receiving shaft (located at either the Dowses Beach parking lot or on East Bay Road). The jacking shaft, staging area, and receiving shaft will be located entirely within the Town of

Barnstable property and/or roadway layout; the final location of the jacking shaft and receiving shaft will be coordinated with the Town of Barnstable to avoid any conflicts with future sewer projects planned for the area. Trenchless methods (e.g. auger bore, pipe ramming) or open-cut excavation could be used to transition the cable at depth up to the duct bank depending on geotechnical and hydrogeological conditions, duct bank connection locations, and the available staging area.

Highway Crossing

As described in Section 4.2.2.2, all Phase 2 onshore routes must cross Route 6 (the Mid-Cape Highway) to reach the West Barnstable Substation (see Figure 4.1-2). If the onshore cables are installed along Route 132, the cables would simply follow Route 132 under the Route 6 overpass. If the cables cross Route 6 within ROW #342 or ROW #381, the trenchless crossing is expected to be performed using pipe jacking. The open shield method is the preferred pipe jacking method for the Route 6 crossing because it allows for the removal of any large boulders (using pneumatic jack hammers) and is the most appropriate method for the expected low groundwater application and the relative depth of cover under Route 6.

To accomplish the Route 6 crossing within ROW #381, the Proponent may use an approximately 0.011 km^2 (2.8 acre) parcel of land, assessor map parcel #214-001 ("Parcel #214-001"), located immediately southeast of the West Barnstable Substation as the northern terminus of the trenchless crossing. It is anticipated that a single approximately 240 m (464 ft) long drive would be used to install a steel casing pipe under the highway between a jacking shaft constructed on Parcel #214-001 and a receiving shaft constructed south of Route 6 in the vicinity of Service Road. The 1.5 m (60 in) or 1.8 m (72 in) diameter steel casing pipe will contain several plastic conduits for the power cables, fiber optic cables, and ground cables. The casing pipe will likely be filled with thermal grout to dissipate heat. Some tree clearing in the vicinity of the jacking shaft may be required to accomplish the Route 6 crossing.

While the same crossing methodology is expected to be used for ROW #342, the crossing within ROW #342 would be more challenging due to topography and space constraints.

Other Unique Crossings

Pending final onshore route engineering, the Proponent may identify other busy roadways, wetlands, and waterbodies that require a trenchless crossing. For example, the use of ROW #345 would likely require a trenchless crossing within the utility ROW to avoid impacts to a wetland.

4.3.1.10.3 Construction Staging Areas

The contractor will identify laydown/construction staging areas necessary to complete construction. These construction staging areas will not be located within 30 m (100 ft) of any wetland resource areas, within 61 m (200 ft) of perennial waterways, or within the Zone I area of any public water supply wells.

4.3.1.11 Surveys, Equipment Inspections, and Environmental Monitoring

Offshore and nearshore geophysical surveys are expected to be conducted just prior to construction, during construction, and post-construction for activities such as pre-lay surveys, verifying site conditions, ensuring proper installation of Phase 2 components, conducting as-built surveys, inspecting the depth of cable burial, and inspecting foundations. Unexploded ordnance (UXO) surveys may also be conducted prior to the installation of the offshore facilities. In instances where avoidance, physical UXO removal, or deflagration is not feasible due to layout restrictions or personnel safety, UXO may need to be detonated in situ. Geophysical instruments may include, but are not limited to, side scan sonar, single and multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers. A detailed list of geophysical survey equipment that may be used during Phase 2 is provided as Appendix I-H.

Surveys would be performed in accordance with the stipulations in Lease OCS-A 0534 that are in effect at the time Phase 2 proceeds, National Marine Fisheries Service's (NMFS's) *Project Design Criteria (PDC) and Best Management Practices (BMPs) for Threatened and Endangered Species for Site Characterization and Site Assessment Activities to Support Offshore Wind Projects*, and/or any requirements imposed by NMFS where an Incidental Take Authorization is sought, as applicable. See the best management practices outlined in Table 4.2-2 of COP Volume III as well as Sections 6.7 and 6.8 of COP Volume III for a discussion of measures to protect marine mammals and sea turtles during survey work.

Offshore geotechnical work would only be conducted in areas already reviewed and cleared for cultural resources. Any unanticipated discoveries of cultural resources would be managed in accordance with the Section 106 Memorandum of Agreement.

To monitor weather and sea state conditions during Phase 2 construction, the Proponent expects to temporarily deploy one or more meteorological oceanographic ("metocean") buoys in up to 50 locations within the SWDA (only within areas that will have been surveyed). These buoy(s) will provide forecasting and current weather conditions to inform contractors if conditions (especially wave height) are suitable for installation activities.

The floating metocean buoy(s) are expected to be anchored to the seafloor using a steel chain connected to a single concrete or steel mooring weight on the seafloor. The mooring weight will occupy an expected seafloor footprint of approximately 4 m^2 (43 ft^2) and is expected to vertically penetrate to a depth of approximately 2.5 m (8 ft). The total maximum temporary seafloor disturbance from metocean buoys during Phase 2 construction is 200 m^2 (2,153 ft^2).[99] The selected metocean buoy(s) will not use fuel oil to avoid the risk of accidental release and emissions into the environment. The buoy(s) will be equipped with the proper lighting, marking, and

[99] The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.

signaling equipment per USCG Private Aid to Navigation (PATON) requirements. The location of the buoy(s) will be monitored daily using a Global Positioning System (GPS) and Automatic Identification System (AIS) devices.

4.3.1.12 Vessels, Vehicles, and Aircraft

4.3.1.12.1 Offshore Construction

Deployment of the necessary vessels and construction equipment will be sequenced based on the construction schedule (see Sections 4.1.1.3 and 4.3.1.1).

Offshore construction will require an array of vessels, many of which are specifically designed for offshore wind construction and cable installation. In general, while performing construction work, vessels may anchor, moor to other vessels or structures, operate on DP, or jack-up. DP enables a vessel to maintain a very precise position by continuously adjusting the vessel's thrusters and propellers to counteract winds, currents, and waves. Jack-up vessels are self-propelled or non-self-propelled vessels with legs that extend to the ocean floor to elevate the hull to provide a safe, stable working platform.[100] In addition to vessels, helicopters may be used for crew transfer and fast response visual inspections and repair activities during both construction and operations.

Based on current methodologies for offshore wind construction, the expected vessel types for each major element of construction have been provided in Table 4.3-1. Table 4.3-1 is organized by major construction element and includes the basic data on anticipated vessel type and use. All specifications are subject to change. Vessel data is highly speculative at this stage of the development process, especially given that transportation and installation methodologies will continue to evolve by the time Phase 2 proceeds to construction. Vessel details are anticipated to be further refined in the Fabrication and Installation Report (FIR). Due to variable availability and limitations associated with the Jones Act, vessels may even be changed just prior to or during construction.

For these reasons , it is challenging to precisely quantify the number of vessels and vessel trips from each port at the early planning stages of Phase 2. The estimates of vessel counts and vessel trips presented below, which are based on current understanding of a potential Phase 2 schedule, are likely conservative and subject to change.

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[100] Jacking-up may also occur in port.

Assuming the maximum design scenario, it is estimated that an average of ~30 vessels would operate at the SWDA or along the OECC at any given time during Phase 2 offshore construction.[101] During the most active period of construction, it is conservatively estimated that a maximum of approximately 60 vessels could operate in the Offshore Development Area at one time. However, the number of vessels present at any given time during Phase 2 offshore construction is highly dependent on the final construction schedule, the number of WTGs and ESPs installed, the final design of the offshore facilities, the ports ultimately used, and the logistics solution used to achieve compliance with the Jones Act.

For the maximum design scenario of Phase 2, approximately 3,800 total vessel round trips[102] are expected to occur for Phase 2 offshore construction, which equates to an approximate average of seven vessel round trips per day under an 18-month offshore construction schedule. During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur. See Section 7.8 of COP Volume III and the Navigation Safety Risk Assessment in Appendix III-I for further discussion of vessel activity during construction.

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[101] It is possible that Phase 2 construction could begin immediately following Phase 1 construction. Under this scenario, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g. Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). The number of vessels present at the SWDA or along the OECC during Phase 2 construction accounts for the possibility of Phase 1 and Phase 2 vessels being present at the same time.

[102] For the purposes of estimating vessel trips, tugboats and barges are considered one vessel.

Table 4.3-1 Representative Vessels Used for Phase 2 Construction

			Approx. Size		Displacement		Approximate Vessel Speed					
Role	Vessel Type	#	Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed	Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device (MSD)	Crew Size
Foundation Installation												
Scour Protection Installation	Scour Protection Installation Vessel (e.g. Fall-pipe Vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	International Maritime Organization (IMO) compliant	20–60
Overseas Foundation Transport	Heavy Transport Vessel	2–5	24–56 m (79–184 ft)	120–223 m (394–732 ft)	12,000–25,000 t (13,228–27,558 US tons)	10,000–62,000 t (11,023–68,343 US tons)	12–18 kn	12–18 kn	Blade propeller system / blade thrusters	260,000–1,800,000 L (68,680–475,510 gal)	MSD: Type II and Type III, IMO compliant	15–25
Foundation Installation (Possibly Including Grouting	Jack-up Vessel or Heavy Lift Vessel	1–2	40–106 m (131–346 ft)	154–220 m (505–722 ft)	20,000–50,000 t (22,046–55,116 US ton)	10,000–80,000 t (11,023–88,185 US ton)	0–10 kn	6.5–14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	25–374
Tugboat to Support Main Foundation Installation Vessel(s)	Tugboat	1	6–10 m (20–33 ft)	16–35 m (52–115 ft)	75–500 t (83–551 US tons)	50–200 t (55–220 US tons)	10–14 kn	10–14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	not specified	5–10
Transport of Foundations to SWDA	Barge	2–5	~25 m (82 ft)	100 m (328 ft)	N/A	9,600 t (10,582 US tons)	N/A	N/A	N/A	N/A	N/A	N/A
Transport of Foundations to SWDA	Tugboat	3–4	~10 m (33 ft)	~35 m (115 ft)	200–500 t (220–551 US tons)	200–300 t (220–331 US tons)	8–10 kn	10–14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	5–10
Secondary Work and Possibly Grouting	Support Vessel or Tugboat	1	~10 m (33 ft)	30–80 m (98–262 ft)	500–900 t (551-992 US tons)	120 t (132 US tons)	10-14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	10-100
Crew Transfer	Crew Transfer Vessel	1–3	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 (2,110 gal)	IMO compliant	2–24
Noise Mitigation	Support Vessel or Anchor Handling Tug Supply vessel	1	~15 m (49 ft)	65–90 m (213–295 ft)	1,900–3,000 t (2,094–3,307 US tons)	2,200–3,000 t (2,425–3,307 US tons)	10 kn	13 kn	Blade propeller system / blade thrusters	~740,000 L (195,490 gal)	IMO compliant	5–14
Acoustic Monitoring	Support Vessel or Tugboat	1	~10 m (33 ft)	~30 m (98 ft)	50–500 t (55–551US tons)	20 t (22 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	Non-IMO	5–10
Marine Mammal Observers and Environmental Monitors	Crew Transfer Vessel	2–6	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
ESP Installation												
ESP Installation	Heavy Lift Vessel	1	40–106 m (131–346 ft)	154–220 m (505–722 ft)	N/A	10,000–48,000 t (11,023–52,911 US tons)	0–12 kn	6.5–14 kn	N/A	N/A	Non-IMO	20–374
Overseas ESP Transport	Heavy Transport Vessel	1–2	24–40 m (79–131 ft)	20–223 m (66–732 ft)	12,000–50,000 t (13,228–55,116 US tons)	10,000–62,000 t (11,023–68,343 US tons)	10–18 kn	13–18 kn	Blade propeller system / blade thrusters	260,000–1,800,000 L (68,680–475,510 gal)	MSD: Type II and Type III, IMO compliant	15–25
ESP Transport to SWDA (if required)	Tugboat	2–4	~10 m (33 ft)	~35 m (115 ft)	200–500 t (220–551 US tons)	200–300 t (220–331 US tons)	0–14 kn	14 kn	Blade propeller system / blade thrusters	~215,000 L (56,800 gal)	IMO compliant	5–10
Crew Transfer	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Service Boat	Crew Transfer Vessel or Support Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Refueling Operations to ESP	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Crew Accommodation Vessel During Commissioning	Jack-up	1	~40 m (131 ft)	~55 m (180 ft)	500 t (551 US tons)	N/A	0–6 kn	6 kn	Blade propeller system / blade thrusters	~280,000 L (73,970 gal)	Non-IMO	20–100
	Accommodation Vessel		10–12 m (33–39 ft)	70–100 m (230–328 ft)	800–9,000 t (882–9,921 US tons)	120–4,500 t (132–4,960 US tons)	10 kn	13.5 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	50–201

Table 4.3-1 Representative Vessels Used for Phase 2 Construction (Continued)

Role	Vessel Type	#	Approx. Size		Displacement		Approximate Vessel Speed		Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device	Crew Size
			Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed				
Offshore Export Cable Installation												
Pre-Lay Grapnel Run	Support Vessel	1	8–15 m (26–49 ft)	30–70 m (98–230 ft)	700–4,000 t (772–4,409 US tons)	2,200–2,500 t (2,425–2,756 US tons)	4–15 kn	15 kn	Blade propeller system / blade thrusters	~120,000 L (31,700 gal)	IMO compliant	2–25
Pre-Lay Survey	Survey vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 liters ("L") (2,110–13,800 gallons ["gal"])	IMO compliant	2–70
Cable Laying (and Potentially Burial)	Cable Laying Vessel	1–2	22–35 m (72–115 ft)	80–150 m (262–492 ft)	7,000–16,500 t (7,716–18,188 US tons)	1,200–1,5000 t (1,323–16,535 US tons)	5–8 kn	14 kn	Blade propeller system / blade thrusters	~1,200,000 L (317,010 gal)	IMO compliant	15–45
Boulder Clearance	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2,500–8,000 t (2756–8818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	5–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Support Main Vessel with Anchor Handling	Tugboat or Anchor Handling Tug Supply Vessel	1–3	6–15 m (20–49 ft)	16–65 m (52–213 ft)	75–1,900 t (83–2,094 US tons)	50–2,200 t (55–2,425 US tons)	5–14 kn	10–14 kn	Blade propeller system / blade thrusters	120,000–150,000 L (31,701–39,626 gal)	not specified	5–20
Trenching	Cable Laying Vessel or Support Vessel	1	~25 m (82 ft)	~128 m (420 ft)	N/A	~7,500 t (8,267 US tons)	10 kn	15 kn	Blade propeller system / blade thrusters	~2,000,000 L (528,344 gal)	IMO compliant	N/A
Crew Transfer	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Install Cable Protection	Cable Protection Installation Vessel (e.g. Fall-pipe vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	20–60
Dredging	Dredging Vessel	1	~30 m (98 ft)	~230 m (755 ft)	33,423 t (36,843 US tons)	59,798 t (65,916 US tons)	10–16 kn	16 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	30–60
Cable Landing	Tugboat or Jack-up Vessel	1	6–15 m (20–49 ft)	16–65 m (52–213 ft)	75–1,900 t (83–2,094 US tons)	50–2,200 t (55–2,425 US tons)	10–14 kn	10–14 kn	Blade propeller system / blade thrusters	120,000–150,000 L (31,701–39,626 gal)	not specified	5–20
Shallow Water Cable Burial	Cable Laying Vessel	1	13 m (43 ft)	34 m (112 ft)	499 t (550 US tons)	N/A	0–10 kn	10 kn	N/A	220,000 L (58,118 gal)	N/A	19
Safety Vessel	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Inter-Array Cable Installation												
Pre-Lay Grapnel Run	Support Vessel	1	8–15 m (26–49 ft)	30–70m (98–230 ft)	700–4,000 t (772–4,409 US tons)	2,200–2,500 t (2,425–2,756 US tons)	4–15 kn	15 kn	Blade propeller system / blade thrusters	~120,000 L (31,700 gal)	IMO compliant	2–25
Pre-Lay Survey	Survey Vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 L) (2,110–13,800 gal)	IMO compliant	2–70
Cable Laying (and Potentially Burial)	Cable Laying Vessel	1	22–35 m (72–115 ft)	80–150 m (262–492 ft)	7,000–16,500 t (7,716–18,188 US tons)	1,200–15,000 t (1,323–16,535 US tons)	5–8 kn	14 kn	Blade propeller system / blade thrusters	~1,200,000 L (317,010 gal)	IMO compliant	15–45
Cable Installation Support	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2,500–8,000 t (2,756–8,818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	5–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Crew Transfer	Crew Transfer Vessel	2	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24

Table 4.3-1 Representative Vessels Used for Phase 2 Construction (Continued)

Role	Vessel Type	#	Approx. Size		Displacement		Approximate Vessel Speed		Type of Propeller System	Approximate Fuel Capacity	Marine Sanitation Device	Crew Size
			Width	Length	Gross Tonnage	Deadweight	Operational Speed	Maximum Transit Speed				
Inter-Array Cable Installation (Continued)												
Cable Termination and Commissioning	Support Vessel	1	15–20 m (49–66 ft)	75–120 m (246–394 ft)	2,500–8,000 t (2,756–8,818 US tons)	2,000–7,000 t (2,205–7,716 US tons)	10–12 kn	12 kn	Blade propeller system / blade thrusters	~960,000 L (253,610 gal)	IMO compliant	20–60
Trenching	Cable Laying Vessel or Support Vessel	1	21–25 m (69–82 ft)	95–128 m (311–420 ft)	N/A	4,700–7,500 t (5,180–8,267 US tons)	10–15 kn	15 kn	Blade propeller system / blade thrusters	1,2000,000–2,000,000 L (317,010–528,344 gal)	IMO compliant	N/A
Install Cable Protection	Cable Protection Installation Vessel (e.g. Fall-pipe vessel)	1	30–45 m (98–148 ft)	130–170 m (427–558 ft)	15,000–28,000 t (16,535–30,865 US tons)	25,000 t (27,558 US tons)	10–14 kn	14 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	20–60
Safety Vessel	Crew Transfer Vessel	1	7–12 m (23–39 ft)	20–30 m (66–98 ft)	100–150 t (110–165 US tons)	20–75 t (22–83 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
WTG Installation												
Overseas WTG Transport	Heavy Transport Vessel	1–5	15–20 m (49–66 ft)	130–150 m (427–492 ft)	6,300–8,600 t (6,945–9,480 US tons)	8,000–9,400 t (8,818–10,362 US tons)	14–18 kn	14–18 kn	Blade propeller system / blade thrusters	455,000–1,090,000 L (120,200–287,950 gal)	IMO compliant, MSD Type II	15–19
Overseas Transport of WTG Installation Vessel(s)	Heavy Transport Vessel	1	~56 m (184 ft)	~214 m (702 ft)	N/A	~64,900 t (71,540 US tons)	10–11.5 kn	11.5 kn	N/A	N/A	N/A	~40
WTG Transport to SWDA	Jack-up Vessels[103] or Tugboat	2–6	6–50 m (20–164 ft)	35–100 m (115–328 ft)	4,000 t (4,409 US tons)	2,000–8,000 t (2,205–8,818 US tons)	0–10 kn	13–14 kn	Blade propeller system / blade thrusters	215,000–280,000 L (56,800–73,970 gal)	IMO compliant	15–80
WTG Transport Assistance	Tugboat	1–6	6–12 m (20–40 ft)	15–38 m (49–125 ft)	75–500 t (83–551 US tons)	50–200 t (55–220 US tons)	0–10 kn	13–14 kn	Blade propeller system / blade thrusters	215,000–598,000 L (56,800–158,000 gal)	N/A	4–8
WTG Installation	Jack-up Vessel or Heavy Lift Vessel	1–2	35–55 m (115–180 ft)	85–165 m (279–541 ft)	15,000–25,000 t (16,535–27,558 US tons)	4,500–20,000 t (4,960–22,046 US tons)	0–10 kn	8–13 kn	Blade propeller system / blade thrusters	N/A	IMO compliant	80–150
Crew Transfer	Crew Transfer Vessel	3	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
WTG Commissioning												
WTG Commissioning Vessel	Service Operation Vessel	1	~18 m (59 ft)	~80 m (262 ft)	N/A	~2,500 t (2,756 US tons)	10–12 kn	13 kn	Blade propeller system / blade thrusters	1,140,000 L (301,156 gal)	N/A	~27
Crew Transfer	Crew Transfer Vessel	1–4	6–12 m (20–39 ft)	15–30 m (49–98 ft)	10–50 t (11–55 US tons)	6–20 t (7–22 US tons)	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	N/A	2–24
Miscellaneous Construction Activities												
Refueling	Crew Transfer Vessel or Support Vessel	1	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Safety Vessel	Crew Transfer Vessel	1	~7 m (23 ft)	~20 m (66 ft)	N/A	N/A	10–25 kn	25 kn	Blade propeller system / blade thrusters	~8,000 L (2,110 gal)	IMO compliant	2–24
Geophysical and Geotechnical Survey Operations	Survey Vessel or Support Vessel	1	6–26 m (20–85 ft)	13–112 m (43–367 ft)	1,500–15,000 t (1,653–16,535 US tons)	400–3,000 t (441–3,307 US tons)	4–14 kn	25–30 kn	Blade propeller system / blade thrusters, except smaller support vessels which are jet drive propulsion	8,000–52,000 liters ("L") (2,110–13,800 gallons ["gal"])	IMO compliant	2–70

Notes:

Vessel descriptions/dimensions are based on the specification sheets of vessels that are representative of the type of vessels that will be used during Phase 2 construction; not all specification sheets provided information for each category. All values provided are subject to change.

"t" = metric tons

[103] Jacking-up in ports may occur.

4.3.1.12.2 Onshore Equipment

Onshore construction equipment is expected to be similar to that used during typical public works projects (e.g. road resurfacing, storm sewer installation, transmission line installation). Such equipment could include conventional land clearing equipment, excavators, cranes, backhoes, front end loaders, lifts, winches, concrete delivery trucks, dump trucks, cable reel trucks, and support vehicles.

4.3.1.13 Summary of Phase 2 Area of Potential Seafloor Disturbance

Table 4.3-2 summarizes the maximum area of potential seafloor disturbance within the SWDA during the construction of Phase 2. Table 4.3-3 summarizes the maximum area of potential seafloor disturbance associated with the installation of three Phase 2 offshore export cables within the OECC (which travels along the eastern side of Muskeget Channel). Table 4.3-4 compares the maximum area of potential seafloor disturbance within the OECC (from the SWDA boundary to the Phase 2 landfall site[s]) for the following scenarios:

1. Three Phase 2 offshore export cables in the OECC that travels along the eastern side of Muskeget Channel (Scenario 1 of Table 4.1-2, shown on Figure 4.1-8a);

2. Two Phase 2 offshore export cables in the OECC that travels along the eastern side of Muskeget Channel and one cable using the Western Muskeget Variant (Scenario 2 of Table 4.1-2, shown on Figure 4.1-8b); and

3. One Phase 2 offshore export cable in the OECC that travels along the eastern side of Muskeget Channel and two cables using the Western Muskeget Variant (Scenario 5 of Table 4.1-2, shown on Figure 4.1-8e).

The Proponent intends to provide estimates of potential seafloor disturbance associated with the South Coast Variant in federal waters in its April 2022 COP Addendum.

Table 4.3-2 Phase 2 Maximum Area of Potential Seafloor Disturbance During Construction at the SWDA

SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO STRUCTURES OR CABLE/SCOUR PROTECTION							
Foundations and Scour Protection	**Max Number of Foundations[1]**		**Max Area of Scour Protection per Foundation[2] (m^2)**		**Total Area of Scour Protection**		
					m^2	**km^2**	**acres**
WTG Foundations and Scour Protection	85		9,754		741,304	0.74	183
ESP Foundations and Scour Protection	3		21,316		63,948	0.06	16
Cable Protection[3]	**Max Length of Cable (m)**	**Percentage Requiring Cable Protection**	**Length of Cable Protected (m)**	**Width of Cable Protection (m)**	**Total Area of Cable Protection**		
					m^2	**km^2**	**acres**
Inter-link Cable[4]	60,000	2%	1,200	9	10,800	0.01	3
Inter-array Cables	325,000	2%	6,500	9	58,500	0.06	14
Offshore Export Cables (within SWDA)	110,000	2%	2,200	9	19,800	0.02	5
					Total Scour + Cable Protection		
					m^2	**km^2**	**acres**
TOTAL BOTTOM DISTURBANCE DUE TO STRUCTURES OR CABLE/SCOUR PROTECTION IN THE SWDA					**894,352**	**0.89**	**221**
SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS							
Jack-up and/or Anchored Vessels	**Max Area Impacted by Each Jack-up or Anchored Vessel (m^2)**		**Max No. of Jack-ups/Anchor Sets**	**Max No. of WTGs/ESPs[5]**	**Total Area of Vessel Disturbance**		
					m^2	**km^2**	**acres**
WTG Foundation Installation[6]	1,200		3 per WTG	77	277,200	0.28	68
WTG Installation[6]	1,200		4 per WTG	77	369,600	0.37	91
ESP Topside and Foundation Installation[6]	1,200		8 per ESP	3	28,800	0.03	7
Inter-link Cable Installation[7]	280		150	N/A	42,000	0.04	10
Offshore Export Cable Installation (within SWDA)[7]	280		275	N/A	77,000	0.08	19
Cable Installation	**Max Length of Cable[8] (m)**		**Trench Width (m)**	**Total Skid/Track Width (m)**	**Total Area of Cable Installation Disturbance**		
					m^2	**km^2**	**acres**
Inter-link Cable	60,000		1	3	240,000	0.24	59
Inter-array Cables	325,000		1	3	1,300,000	1.3	321
Offshore Export Cables (within SWDA)	110,000		1	3	440,000	0.44	109

Table 4.3-2 Phase 2 Maximum Area of Potential Seafloor Disturbance During Construction at the SWDA (Continued)

SOUTHERN WIND DEVELOPMENT AREA – BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS (CONTINUED)					
Metocean Buoys	**Max Area Impacted by Each Buoy Anchor (m^2)**	**No. of Buoys**	**Total Area of Buoy Disturbance**		
			m^2	**km^2**	**acres**
Metocean Buoy Anchors	4	50	200	0.00	0
			Total Vessel + Cable Installation + Buoys		
			m^2	**km^2**	**acres**
BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND BUOYS IN THE SWDA			**2,774,800**	**2.77**	**686**
TOTAL SEAFLOOR DISTURBANCE IN THE SWDA[9]			**3,629,552**	**3.63**	**897**

Notes:

1. Phase 2 will include a maximum of 88 WTG/ESP positions; up to three of those positions may be occupied by ESPs, which have a larger maximum scour protection area than the WTGs. The total area of scour protection was calculated based on the sum of (1) 76 WTG foundations with suction bucket bottom-frame foundations, which require the largest area of scour protection at 9,754 m^2 each and (2) 3 ESPs. This sum provides an upper limit that also covers the scenario where more than 76 WTGs are installed (i.e., even if up to the maximum of 88 foundations are installed [of which, 3 may be ESPs]. The maximum area of potential seafloor disturbance included in Table 4.3-2 will not be exceeded).
2. The area of scour protection includes the physical footprint of the foundation.
3. The majority of the cable entry protection system and any cable protection placed over it would lie on top of the scour protection (if used) and is therefore largely included in the area of scour protection. The estimate of inter-array cable protection includes any length of the cable entry protection system beyond the scour protection.
4. The inter-link cables may not be used.
5. Phase 2 may include two co-located ESPs. In this scenario, Phase 2 could include three ESPs at two positions and 77 WTGs, resulting in 80 total foundations.
6. Vessels may be jack-up, anchored, or DP vessels. It is estimated that each jack-up vessel would impact approximately 1,200 m^2 (0.30 acres) of seafloor whereas each anchored vessel will only disturb approximately 784 m^2 (0.19 acres), excluding anchor sweep (which cannot be quantified at this early stage in the construction planning process). Thus, the maximum seafloor disturbance is calculated assuming all vessels jack-up.
7. Conservatively assumes a nine-anchor spread where each anchor impacts 30 m^2 (323 ft^2) and two spud legs that impact 10 m^2 (108 ft^2). The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.
8. Maximum total Phase 2 cable lengths.
9. To avoid double-counting impacts, the total seafloor disturbance in the SWDA does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width for the length of cable covered by cable protection.

Table 4.3-3 Phase 2 Maximum Area of Potential Seafloor Disturbance During Construction along the OECC

OFFSHORE EXPORT CABLE CORRIDOR – BOTTOM DISTURBANCE DUE TO CABLE PROTECTION							
Cable Protection	**Maximum Length of Cable (m)**	**Percentage Requiring Cable Protection[1]**	**Length of Cable to be Protected (m)**	**Width of Cable Protection[2] (m)**	**Total Area of Cable Protection**		
					m^2	**km^2**	**acres**
Offshore Export Cables (Outside SWDA)	246,000	~6%	14,280	9	128,520	0.13	32
TOTAL BOTTOM DISTURBANCE DUE TO CABLE PROTECTION IN THE OECC					**128,520**	**0.13**	**32**
OFFSHORE EXPORT CABLE CORRIDOR – BOTTOM DISTURABCE DUE TO VESSELS, CABLE INSTALLATION, AND DREDGING							
Jack-up Vessels	**Area Impacted by Each Jack-up (m^2)**		**No. of Jack-ups per Splice**	**Max No. of Splices**	**Total Area of Jack-up Disturbance**		
					m^2	**km^2**	**acres**
Jack-up Vessels for Cable Splicing	600		1	9 (3 per cable)	5,400	0.01	1
Anchoring and Grounding of Cable-Laying Vessels	**Area Impacted by Each Anchor Set/Vessel Grounding (m^2)**		**Distance Between Repositioning (m)**	**No. of Anchor Sets/Groundings**	**Total Area of Anchoring Disturbance**		
					m^2	**km^2**	**acres**
Anchoring for Offshore Export Cable Installation (Outside SWDA)[3]	280		400	615	172,200	0.17	43
Vessel Grounding for Offshore Export Cable Installation (Outside SWDA)[4]	9,750		1 per cable	3	29,250	0.03	7
Cable Installation and Preparatory Work[5]	**Max Length of Cable[6] (m)**		**Trench Width (m)**	**Total Skid/Track Width (m)**	**Total Area of Cable Installation Disturbance**		
					m^2	**km^2**	**acres**
Offshore Export Cable Installation (Outside SWDA)	246,000		1	3	984,000	0.98	243
Dredging					**Total Area of Dredging Disturbance[7]**		
					m^2	**km^2**	**acres**
Dredging Prior to Cable Installation					270,619	0.27	67
					Total Vessels + Cable Installation + Dredging		
					m^2	**km^2**	**acres**
BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND DREDGING IN THE OECC					**1,461,469**	**1.46**	**361**
TOTAL SEAFLOOR DISTURBANCE IN THE OECC[8]					**1,532,869**	**1.53**	**379**

Table 4.3-3 Phase 2 Maximum Area of Potential Seafloor Disturbance During Construction along the OECC (Continued)

Notes:

1. The percent of the offshore export cable requiring cable protection is based on the OECC route length (i.e. ~77 km per cable) rather than the length of cable with micro-siting (i.e. ~82 km).
2. The cable protection used in limited areas to cover offshore export cable joints or cable crossings may be wider, but the total cable protection area will remain the same.
3. Conservatively assumes a nine-anchor spread where each anchor impacts 30 m^2 (323 ft^2) and two spud legs that impact 10 m^2 (108 ft^2). The anchoring footprint excludes anchor sweep, which cannot be quantified at this early stage in the construction planning process.
4. Based on the footprint of a 150 x 50 m (492 x 164 ft) vessel, with extra contingency to account for multiple groundings at the same location.
5. Some pre-pass jetting may occur along limited sections of the offshore export cable alignment; however, impacts will occur within the same geographical space as cable installation.
6. Maximum total Phase 2 cable lengths.
7. To avoid double-counting impacts, the total area of dredging disturbance does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width counted above. The total dredging area including the cable installation trench is approximately 0.35 km^2 (86 acres).
8. To avoid double-counting impacts, the total seafloor disturbance in the OECC does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width for the length of cable covered by cable protection.

Table 4.3-4 Comparison of the Maximum Area of Potential Seafloor Disturbance During Construction for the Phase 2 OECC With and Without the Western Muskeget Variant

	3 Cables in OECC Through Eastern Muskeget (Scenario 1 of Table 4.1-2)	2 Cables in OECC Through Eastern Muskeget + 1 Cable in Western Muskeget Variant (Scenario 2 of Table 4.1-2)	1 Cable in OECC Through Eastern Muskeget + 2 Cables in Western Muskeget Variant (Scenario 5 of Table 4.1-2)
Maximum Total Length of Phase 2 Offshore Export Cables (Outside SWDA)[1]	246 km (133 NM)	243 km (131 NM)	240 km (130 NM)
BOTTOM DISTURBANCE DUE TO CABLE PROTECTION			
Percentage Requiring Cable Protection[2]	~6%	~7%	~8%
Total Area of Cable Protection in OECC	**0.13 km^2 (32 acres)**	**0.14 km^2 (35 acres)**	**0.15 km^2 (38 acres)**
BOTTOM DISTURBANCE DUE TO VESSELS, CABLE INSTALLATION, AND DREDGING			
Area of Disturbance from Cable Installation, Preparatory Work, and Vessels[3]	1.19 km^2 (294 acres)	1.18 km^2 (291 acres)	1.16 km^2 (287 acres)
Area of Dredging Prior to Cable Installation[4]	0.27 km^2 (67 acres)	0.29 km^2 (73 acres)	0.30 km^2 (73 acres)
Volume of Dredging	180,000 m^3 (235,400 cubic yards)	205,500 m^3 (268,800 cubic yards)	210,100 m^3 (274,800 cubic yards)
Total Disturbance Due To Vessels, Cable Installation, And Dredging in OECC	**1.46 km^2 (361 acres)**	**1.47 km^2 (364 acres)**	**1.46 km^2 (360 acres)**
TOTAL SEAFLOOR DISTURBANCE IN OECC[5]	**1.53 km^2 (379 acres)**	**1.55 km^2 (383 acres)**	**1.54 km^2 (381 acres)**

Notes:

1. The total cable length for all three Phase 2 offshore export cables from the SWDA boundary to the Phase 2 landfall site(s).
2. The percent of the offshore export cables requiring cable protection is based on the OECC route length (i.e. ~77 km per cable using the OECC through the eastern side of Muskeget Channel and ~74 km per cable using the Western Muskeget Variant) rather than the length of cable with micro-siting.
3. Includes potential impacts from a 1 m (3.3 ft) wide cable installation trench, a 3 m (10 ft) wide total skid/track width from the cable installation tool, vessel anchors that reposition every 400 m (1,312 ft) during offshore export cable installation, jack-up vessel legs during cable splicing (assumed three splices per cable), and vessel grounding (once per cable).
4. To avoid double-counting impacts, the total area of dredging disturbance does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width.
5. To avoid double-counting impacts, the total seafloor disturbance in the OECC does not include the 1 m (3.3 ft) wide cable installation trench and 3 m (10 ft) skid/track width for the length of cable covered by cable protection.

4.3.2 Operations & Maintenance Activities

4.3.2.1 Purpose and Objectives

The Proponent's primary O&M objective is to operate safe and efficient offshore wind energy facilities. This objective will be achieved through detailed planning, the use of well-thought-out procedures, reliance on experienced and well-trained personnel and contractors, a strong focus on preventive maintenance, data analysis to predict/prevent corrective maintenance, and continuous review and improvement. The O&M philosophy for New England Wind Phase 2 is based on the following principles:

- **Health, Safety and Environment (HSE) First Principles:** Putting the health and safety of people and the environment at the forefront of all O&M activities.

- **Compliance with Consents, Laws, and Regulations:** Ensuring that personnel and contractors comply with all statutory and industry regulations in effect at the time Phase 2 proceeds.

- **Continuous Improvement:** Regularly reviewing procedures and performance, identifying lessons learned, and implementing improvements.

- **Maximize Plant Reliability and Availability:** Ensuring the diligent design and selection of robust, reliable components and implementing a maintenance regime in which preventive (i.e. scheduled) maintenance reduces or eliminates the requirements for corrective (i.e. unscheduled) maintenance. In this regard, the aim is to deliver reliable offshore wind energy facilities with high production.

- **Knowledge Transfer:** Ensuring that, wherever possible, the Proponent learns from other offshore projects, wider business experience, experienced partners and contractors, and the wider industry to develop new skills in order to achieve O&M objectives.

4.3.2.2 Daily WTG Monitoring and Control

The Phase 2 WTGs will be designed to operate without attendance by any operators. Continuous monitoring is typically conducted using a supervisory control and data acquisition (SCADA) system from a remote location. Examples of parameters that could be monitored include temperature limits, vibration limits, current limits, voltage, etc. The WTGs also include self-protection systems that would be activated if the WTG operates outside its specifications or the SCADA system fails. These self-protection systems may curtail or halt WTG production or disconnect WTGs from the grid.

The Proponent and/or the selected WTG original equipment manufacturer (OEM) would be responsible for the 24/7 operation and monitoring of the WTGs. This may be achieved by utilizing the Proponent's O&M facilities, a 24/7 national control center owned and operated by Avangrid Renewables and/or a third-party's facilities.

4.3.2.3 Preventive Maintenance & Proactive Surveys

The Proponent will ensure that the Phase 2 preventive maintenance strategy aligns with best industry practice. This preventive maintenance strategy will be regularly reviewed to ensure maintenance objectives are met and continuously improved. Ultimately, preventive maintenance aims to reduce or eliminate the need for corrective maintenance and contribute to the objective of maintaining good reliability and high availability. Analysis of SCADA data and, in particular, condition monitoring systems are essential to identify potential equipment failures in advance.

In addition to the physical preventive maintenance, proactive inspections will be undertaken on a routine basis to ensure that the offshore facilities remain in a safe condition so that maintenance activities can be carried out. Geophysical survey work will likely be conducted to ensure adequate understanding of seabed conditions, particularly in areas of seabed change, and monitor components such as cables and scour protection. Geophysical instruments may include, but are not limited to, side scan sonar, single and multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers (see Appendix I-H for a detailed list of potential survey equipment).

Scheduled inspections, surveys, and maintenance activities are anticipated to generally include the following tasks:

WTGs

- Annual inspections of components/equipment and proactive repair/replacement of components due to wear and tear (e.g. brake system, pitch system, bolt tightening, blades).

- Statutory inspections of high-voltage equipment, lifting equipment, safety equipment, hook-on points, etc., which are expected to occur annually.

Foundations

- Annual visual inspections of external platforms, including ladders and boat landing structures, and internal structures (e.g. corrosion measurement, etc.).

- Statutory inspections of lifting equipment, safety equipment, hook-on points, etc., which are expected to occur annually.

- Underwater inspections of foundations and scour protection. The inspections may be conducted by ROV or other techniques (e.g. divers).[104]

- Removal of marine growth and guano.

ESP(s)

- Inspection and service of high-voltage equipment (e.g. transformers, switchgears, earthing systems) and auxiliary systems (e.g. fire protection system, communication system, heating and ventilation system).

- Statutory inspections of lifting equipment, safety equipment, hook-on points, etc.

Inter-Array Cables, Inter-Link Cables, Offshore Export Cables, and Landfall Site(s)

- High resolution geophysical surveys and monitoring cable exposure and/or depth of burial. It is expected that the cables will be surveyed within six months of commissioning, at years one and two, and every three years thereafter. This monitoring schedule may be adjusted over time based on results of the ongoing surveys. As described in Section 4.2.1.5, the cable design may include a Distributed Temperature System (DTS) or other system to monitor the temperature of the cable, which could indirectly be used to detect cable exposure.

Onshore Substation(s)

- Inspection and service of high-voltage equipment (e.g. main transformer, switchgears, earthing systems) and auxiliary systems (e.g. fire protection system, communication system, heating and ventilation system).

4.3.2.3.1 Development of Detailed Preventive Maintenance Plans

The Proponent will develop O&M plans and processes specific to Phase 2 of New England Wind. The starting point for all maintenance plans and processes will be the recommendations and instructions set out in the OEM manuals and maintenance schedules. The Proponent will also draw from Avangrid Renewables and its affiliates' experience gained working on similar projects operating globally.

Indicatively, the O&M plans and processes will cover at least the following topics:

- General Operations

[104] At this time, the Proponent expects to conduct underwater inspections for 20% of foundations each year during the first five years of operation (i.e. all foundations are expected to be inspected once during the first five years). After the first five years of operations, the frequency of surveys may be adjusted over time based on results of the ongoing surveys.

- Preventive and Corrective Maintenance
- Emergency Response Plan
- Local Operations
- Back up Control Room
- Planning and Monitoring of Works
- Warehouse Management
- Design Modifications
- Marine Coordination
- Warranty and Insurance management and claims
- Maintenance of control room systems
- Permit to work

Maintenance schedules that set forth the frequency of specific maintenance activities will be developed for each primary component (WTG, ESP, onshore substation, etc.) along with a scheduled maintenance checklist and/or method statements for each scheduled task. These checklists and method statements may be developed by the Proponent and/or its contractors.

The final strategy for execution of maintenance work will largely depend on the contracting strategy implemented for maintenance work at the various stages of the offshore facilities' life cycle. However, the following principles will be central to the execution of the maintenance:

- Ensuring that experienced operations personnel and/or contractors participate in all steps of the maintenance.
- Ensuring the spare parts and consumables strategy is sufficiently robust and managed such that spares' availability is high, allowing for quick repair times in the event of a failure.
- Ensuring that robust maintenance plans/procedures are in place and are continually reviewed and updated.
- Ensuring that the organization is structured to efficiently execute the maintenance strategy and to allow for knowledge transfer and continuous improvement.
- Planning and executing maintenance proactively to reduce or eliminate the need for corrective interventions.

4.3.2.4 Corrective Intervention/Repairs

Although preventive maintenance will reduce the need for corrective maintenance, some unscheduled, corrective maintenance will be required. The worst-case scenario, with respect to corrective intervention, is a major component failure (e.g. failure of gearbox, blades, transformers, or export cables). In this event, a potentially significant period of downtime could be experienced for a portion of Phase 2. Other potential repair activities include replacement of small components, minor structural repairs, and electrical repairs.

When corrective maintenance is required, the goals will be to:

- Minimize lost production of Phase 2;
- Minimize cost incurred during intervention and revenue loss; and
- Determine the cause in order to limit potential repetition of the failure event.

If a repair is needed, there could be seafloor disturbance from the vessels and equipment used to perform the repair as well as the repair activities themselves. For example, if an offshore export cable repair is required, there could be seafloor disturbance associated with uncovering and extracting the cable from the seabed, the vessels used to splice and rejoin the cable segments, and the cable installation tool(s) used to rebury the repaired cable. The types of activities and vessels/equipment used for corrective maintenance are similar to those during construction (see Section 4.3.1), but the impacts from repair activities would be much smaller in extent and duration.

By its nature, corrective maintenance is difficult to accurately predict. As such, being adequately prepared for corrective maintenance is essential. The Proponent will work to maintain in-house knowledge of component failure rates, maintenance requirements for such failures, repair periods, and spare part requirements. As further described below, key preparations in order to efficiently implement corrective maintenance center on: (1) spare part availability, (2) workforce availability, and (3) site accessibility (i.e. weather conditions).

Spare Part Availability

It is envisioned that a stock of recommended spare parts would be purchased along with the major components (e.g. WTGs, ESPs, cables, etc.). While this stock would be based on OEM recommendations, it is likely that the Proponent may request additional items based on its own experience. It is anticipated that smaller spare parts and consumables will mostly be stored at the Proponent's O&M facilities, while larger spare parts are likely to be stored at either the OEM facilities or other storage facilities, as required. Alternatively or additionally, the Proponent may have in place a concept where contractors/suppliers make spare parts available within a short time frame. The Proponent, together with its contractors and service providers, will constantly monitor the use of spare parts to maintain recommended stock levels and, where applicable, increase stock levels and or purchase additional parts as necessary.

Workforce Availability

By the time Phase 2 proceeds to construction, an ample workforce is expected to be available given the significant marine industries and strong engineering and technology component present in the Northeast region. The rest of the US also has well-established renewable energy and offshore oil and gas sectors with workforces that can readily transition to the offshore wind industry. While some offshore work may initially need to be supported from the European or global supply chain, the local workforce and supply chain are expected to develop quickly. For additional discussion of workforce implications, see Section 7.1. of COP Volume III.

Site Accessibility (i.e. Weather Conditions)

Remote repairs are expected to be the most common form of corrective repair. However, some corrective events will require physical intervention offshore. Among other tools, the Proponent will utilize the extensive metocean information described in Volume II to ensure safe and effective offshore maintenance work. The Proponent expects to engage a contractor to provide regular weather forecasts and the ESP(s) may include a small weather station to provide operations personnel an indication of real-time conditions offshore (see Section 4.3.2.5.1).

4.3.2.5 O&M Systems and Tools

4.3.2.5.1 Weather and Sea Monitoring Systems

The Proponent expects to engage appropriate professionals to provide regular weather forecasts. These forecasts would cover key parameters, including meteorological parameters, such as wind, temperature, visibility, and warnings (e.g. lightning), and oceanographic parameters, such as wave conditions. In addition, it is likely that a small weather station, with wind and temperature sensors, will be installed on the ESP(s) to provide operations personnel an indication of real-time conditions offshore to support the planning and execution of work.

4.3.2.5.2 Communication Systems

A communications system designed to provide coverage within the WTGs and ESP(s) will be used during Phase 2 to facilitate voice communications within the SWDA. In addition to this dedicated system, normal marine and aviation communications channels will be used for the respective logistics options (e.g. marine very high frequency [VHF] radio for ships). Standard emergency channels will also be available.

Emergency protocols will be in place for both construction and O&M and will be developed as part of the HSE Management System. These protocols will include steps for external stakeholders, such as the USCG and fishermen, to alert the Proponent of concerns related to Phase 2 at any time. A draft of the HSE Management System, which is discussed further in Section 4.3.4.1, is provided in Appendix I-B.

4.3.2.5.3 Equipment

While it is difficult to predict the precise equipment that would be used to perform O&M activities, the following table identifies representative equipment that could be used for the O&M activities listed below.

Table 4.3-5 O&M Activities and Equipment Types

Potential Activity Type	Potential Equipment
Marine inspections and surveys • Offshore and nearshore multi-beam echosounder inspections • Offshore and nearshore side scan sonar inspections • Offshore and nearshore magnetometer inspections • Offshore and nearshore depth of burial inspections • Other geophysical surveys • Geotechnical surveys • Environmental surveys	ROV or remotely operated towed vehicle (ROTV) deployed from a survey vessel. For geotechnical surveys, sampling instrumentation deployed from a survey vessel with a geotechnical spread. For a detailed list of potential geophysical survey equipment, see Appendix I-H. Cable toner survey. Aircraft or drones (autonomous underwater/ surface vessels or aerial)
Cathodic protection inspection and repair	ROV deployed from a survey vessel or divers
Hot work (welding) and ancillary equipment (including subsea)	Crew deployed to the WTG or divers deployed from diving vessel for subsea arc welding
Removal of marine growth and guano	Using a brush to break down the marine growth (where required) followed by high-pressure jet wash (sea water only). Technicians or deck hands will be deployed from CTVs or similar vessels.
External surface preparation and external protective coating repair	Technicians and equipment deployed from CTVs or similar vessels. Surface preparation to break down existing surface coating and any associated rust via blaster.
Grouted connections (if any) • Intrusive core samples • Re-grouting	Intrusive core samples: ROV deployed from a survey vessel or divers Re-grouting: Injected via one of several redundant grouting injection tubes from the TP
Component replacement or repair (e.g. WTG blade replacement, cable repair, electrical repair, etc.)	Varies according to component in question, and could include CTVs, a diving spread, construction vessels (e.g. jack-up vessel, cable laying vessel), and/or various construction equipment (e.g. cranes, cable installation tools, ROV).

4.3.2.6 O&M Logistics – Vessels, Vehicles, and Aircraft

The Proponent expects to use an SOV to execute daily O&M activities for Phase 2. Typically, an SOV is equipped with a DP system and includes sleeping quarters, shop facilities, a large open deck, appropriate lifting and winch capacity, and possibly a helipad (see Figure 4.3-5 for photos of a representative SOV).[105] The SOV, which could provide accommodations and workspace for O&M workers, would remain offshore for several days/weeks at a time. Workers would then access the WTGs and ESP(s) to perform routine inspections and/or maintenance likely via a gangway directly from the SOV, a CTV, and/or a smaller daughter craft that resides on the SOV. Daughter craft and/or CTVs would likely be used to transfer crew to and from shore.

If an SOV or similar accommodation vessel is not used, several CTVs and helicopters could be used to frequently transport crew to and from the Offshore Development Area for inspections, routine maintenance, and minor repairs (see Figure 4.3-6 for a photo of a representative CTV). Helicopters may be used when rough weather limits or precludes the use of CTVs and for fast response visual inspections and repair activities. The helicopters used to support O&M activities would ideally be based at a general aviation airport in reasonable proximity to the O&M facilities.

In addition to the SOV, CTVs, and/or daughter craft, other larger support vessels (e.g. jack-up vessels) may be used infrequently to perform some routine maintenance activities, periodic corrective maintenance, and significant repairs (if needed). These vessels are similar to the vessels used during construction (see Table 4.3-1). Surveys and inspections performed during O&M may be performed using vessels, aircraft, ROVs, remotely operated towed vehicles (ROTVs), or drones (autonomous underwater/surface vessels or aerial).

During the busiest year of Phase 2 O&M, an average of approximately five vessels are anticipated to operate in the Offshore Development Area at any given time; additional vessels may be required during certain maintenance or repair scenarios. Based on the maximum design scenario for Phase 2, approximately 290 vessel round trips are estimated to take place annually during O&M. However, the estimates of vessel counts and vessel trips during Phase 2 O&M depends on the timing and frequency of activities, the number of WTGs and ESPs installed, the final design of the offshore facilities, and the logistics solution used during O&M.

Due to the range of buildout scenarios for Phases 1 and 2, the Proponent expects the total number of vessel trips during concurrent operation of both Phases to be less than the sum of vessel trips estimated for each Phase independently.

[105] SOV, as the term is used in the COP, includes similar vessel types that can provide offshore accommodations such as floatels and service accommodation vessels (SATVs).

Figure 4.3-5
Service Operation Vessel (SOV) Examples

Figure 4.3-6

Crew Transfer Vessel (CTV) Examples

4.3.3 Decommissioning & Site Clearance Procedures

4.3.3.1 Decommissioning Plan Requirements

BOEM's decommissioning requirements are stated in Section 13, "Removal of Property and Restoration of the Leased Area on Termination of Lease," of Lease OCS-A 0534.

Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, the Proponent is required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved Site Assessment Plan (SAP), COP or approved Decommissioning Application and applicable regulations in 30 CFR Part 585. All offshore facilities would need to be removed 4.5 m (15 ft) below the mudline (see 30 CFR § 585.910(a)).

Prior to decommissioning Phase 2 of New England Wind, the Proponent will consult with BOEM and submit a decommissioning plan for review and approval. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies as well as other stakeholders.

4.3.3.2 Decommissioning Time Horizon

The WTGs, ESP(s), foundations, supporting cabling, and onshore infrastructure will be robustly designed and carefully maintained. As is typical of utility-grade generation and transmission infrastructure, the Phase 2 offshore facilities are expected to have a physical life expectancy of 30 years or more. Decommissioning will occur at the end of the Phase 2 operating term.

4.3.3.3 General Decommissioning Concept

Upon receipt of the necessary BOEM approval and any other required permits, the Proponent would implement the decommissioning plan to remove and recycle equipment and associated materials. As currently envisioned, the decommissioning process for Phase 2 is essentially the reverse of the installation process. Decommissioning of the offshore facilities is broken down into several steps:

- Retirement in place (if authorized by BOEM) or removal of the offshore cable system (i.e. inter-array, inter-link, and offshore export cable[s]) and any associated cable protection.
- Dismantling and removal of WTGs.
- Cutting and removal of foundations and removal of scour protection.
- Removal of ESP(s) (topsides and foundations).

The extent of the decommissioning of onshore components, such as the onshore export cables, is subject to discussions with the Town of Barnstable on the decommissioning approach that best meets the Town's needs and has the fewest environmental impacts. The onshore cables, the concrete encased duct bank (if used), the transition vaults, and elements of the onshore substations and grid connections could be retired in place or retained for future use.

The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

4.3.3.4 Decommissioning Plan and Procedures

The following discussion outlines decommissioning procedures and methods that would be most appropriate given today's technology. However, it is reasonable to expect that by the time Phase 2 is decommissioned, decommissioning experience in the global offshore wind industry and, more generally, technological advances in methods and equipment servicing the offshore industry, may result in increased efficiency as well as a reduced level of environmental impacts.

The offshore cables could be retired in place or removed, subject to authorization by BOEM and discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts. If removal is required, the first step of the decommissioning process would involve disconnecting the inter-array cables from the WTGs. Next, the inter-array cables would be pulled out of the J-tubes (or similar connection) and extracted from their embedded position in the seabed. In some places, in order to remove the cables, it may be necessary to fluidize the sandy sediments covering the cables. Then, the cables will be reeled up onto vessels. Lastly, the cable reels will be transported to port for further handling and recycling. The same general process will likely be followed for the inter-link and offshore export cables. If cable protection were used to cover portions of the offshore cables, it would be removed prior to recovering the cable.

Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids, according to the established operations and maintenance procedures and the Oil Spill Response Plan (OSRP) (see Section 4.3.4.3). Removed fluids would be brought to a port for proper disposal and/or recycling. Any SF_6 in gas insulated switchgear would be carefully removed for reuse. Next, the WTGs would be deconstructed (down to the foundation) in a manner closely resembling the installation process. The blades, rotor, nacelle, and tower would be sequentially disassembled and transported to port for processing using vessels and cranes similar to those used during construction.

After removing the WTGs, the steel foundation components would be decommissioned. Sediments inside monopiles, jacket piles, and/or bottom-frame piles could be suctioned out and temporarily stored on a vessel to allow access for cutting. In accordance with the BOEM's removal standards (30 CFR § 585.910(a)), the steel foundations would likely be cut below the mudline using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or a high-pressure water jet. The portion of the foundation that remains below the cut will likely remain in place. Depending upon the available crane's capacity, the foundation/TP assembly above the cut may be further cut into several more manageable sections to facilitate handling. The cut piece(s) would then be lifted out of the water and placed on a vessel for transport to an appropriate port for recycling. The sediments previously removed from the inner space of the pile would be returned to the depression left once the pile is removed. To minimize sediment disturbance and turbidity, a vacuum pump and diver or ROV-assisted hoses would likely be used.

If suction buckets are used for foundations during Phase 2, they are anticipated to be removed by reversing the installation process: water would be injected into the space between the suction bucket and seafloor to reduce the suction pressure that holds the foundation in place. The suction bucket jacket or bottom-frame foundations would then be lifted out of the water in one or more pieces and placed on a vessel for transport to an appropriate port for recycling.

As described in Section 4.2.1.4, each foundation may be surrounded by scour protection, which the Proponent would remove during decommissioning. Rock scour protection would likely be excavated with a dredging vessel, set on a vessel, and transported to shore for reuse or disposal at an onshore location.

The ESP(s) are expected to be disassembled in a similar manner as the WTGs, using similar vessels. Prior to dismantling, the ESP(s) would be properly drained of all oils, lubricating fluids, and transformer oil according to the established O&M procedures and OSRP. Removed fluids would be brought to port for proper disposal and/or recycling. Similarly, any SF_6 in gas insulated switchgear would be carefully removed for reuse. Before removing the ESP(s), the offshore export cables and inter-link cables (if present) would be disconnected, as discussed for inter-array cables above.

The ESP topside(s) would then be removed from the supporting monopile or jacket foundation and placed on a vessel for transport to port. Depending on the crane capacity available and design of the topside, some of the major electrical gear may be removed first. The ESP foundation(s) will likely be removed according to the same procedures used for the removal of the WTG foundations described above.

As noted above, the extent of the decommissioning of onshore components, such as the onshore export cables, will be determined in consultation with the Town of Barnstable, as many of the onshore components could be retired in place or retained for future use. If removal of onshore cables from duct banks is determined to be the preferred approach, the process would consist of pulling the cables out of the duct bank and transporting them offsite for recycling or possible reuse. The splice vaults, conduits, and duct bank would likely be left in place, available for reuse. This approach would avoid disruption to the streets.

During decommissioning activities, a careful inventory of all components to be removed would be made. This inventory would include the WTGs, ESP(s), foundations, offshore export cables, inter-array cables, inter-link cables, cable protection, scour protection, and so forth. As they are removed from the site, the components would be counted and noted as removed in the inventory. This careful reporting system will ensure that all of the Phase 2 components are removed. The Proponent expects to conduct seabed surveys where the Phase 2 offshore facilities were located to verify site clearance per 30 CFR § 585.910(b). Decommissioning of the offshore facilities would require the involvement of an onshore recycling facility with ability to handle the large quantities of steel and other materials and/or an approved onshore solid waste facility.

It is anticipated that the equipment and vessels used during decommissioning will be similar to those used during construction and installation. For offshore work, vessels would likely include heavy lift vessels, jack-up vessels, larger support vessels, tugboats, CTVs, and possibly vessels specifically built for installing WTGs. For onshore work, construction equipment would likely include truck-mounted winches, cable reels, and cable reel transport trucks.

4.3.3.5 Financial Assurance for Decommissioning

The Proponent will provide financial assurance for Phase 2 in accordance with the terms and conditions required by regulation or with approval from BOEM. To the extent feasible, the Proponent would like to develop a mechanism by which one financial assurance package covers decommissioning of all Phase 2 facilities regardless of whether the facilities are located within federal or state jurisdiction.

4.3.4 Health, Safety & Environmental Protection

The Proponent is firmly committed to safety and full compliance with applicable HSE protection regulations and codes in effect at the time Phase 2 proceeds. This commitment extends throughout the pre-construction, construction and installation, O&M, and decommissioning of Phase 2 of New England Wind.

4.3.4.1 Health, Safety, and Environmental Management System

During construction and O&M, New England Wind's Health, Safety, and Environmental Management System will be utilized (see the draft HSE Management System provided in Appendix I-B). The HSE Management System is a living document that contains HSE policies and procedures as well as the minimum requirements for working onsite for all New England Wind projects. The HSE Management System addresses the following requirements for a safety management system listed in 30 CFR § 585.810:

- Procedures to ensure the safety of personnel or anyone on or near the New England Wind facilities;
- Remote monitoring, control, and shut down capabilities;
- Emergency response procedures;
- Fire suppression equipment;

- Procedures for testing the safety management system; and
- Policies to ensure personnel who operate the New England Wind facilities are properly trained.

4.3.4.2 Marine Coordination

A marine coordination center is expected to be established to control vessel movements throughout the Offshore Development Area. Expected daily vessel movements, CTV manifests, and no-go zones onsite will be handled by the Marine Coordinator. The Proponent will also hold daily coordination meetings to coordinate between contractors and avoid unnecessary simultaneous operations at the port facilities and routes to the Offshore Development Area.

The Marine Coordinator is expected to manage all Phase 2 construction vessel logistics and implement communication protocols with external vessels at the harbor and offshore. The Marine Coordinator would use tools such as radio communications and safety vessels to address vessels entering construction zones. The Marine Coordinator would also work in advance of, and during construction, to coordinate activities with non-Phase 2 related vessels within and near the harbor(s). During construction, the Marine Coordinator would be the primary point of contact for day to day operations with the USCG, port authorities, state and local law enforcement, marine patrol, port operators, and commercial operators (including ferry, tourist, and fishing boat operators). As such, the Marine Coordinator would be responsible for coordination with USCG regarding any required Notice to Mariners. The responsibilities of the Marine Coordinator are discussed further in the draft HSE Management System (see Appendix I-B).

For all New England Wind projects, the Marine Operations Liaison Officer will serve as the strategic maritime liaison between the Proponent's internal parties and all external maritime partners and stakeholders, including USCG, US Navy, port authorities, state and local law enforcement, marine patrol, and commercial operators (e.g. ferry, tourist, fishing boat operators, and other offshore wind leaseholders). The Marine Operations Liaison Officer ensures compliance with permit requirements and applicable laws relating to the Proponent's vessel activities. The Marine Operations Liaison Officer is also expected to be responsible for coordinating and issuing Offshore Wind Mariner Update Bulletins to notify maritime stakeholders of the Proponent's offshore activities.

In addition, the Proponent has developed a Fisheries Communication Plan, which is periodically updated (the current version is included as Appendix III-E). The purpose of the Fisheries Communication Plan is to define outreach and engagement to potentially affected fishing interests during design, development, construction, operation, and final decommissioning of the Proponent's offshore wind projects. Fisheries communication is conducted through several roles including Fisheries Representatives (FRs) and Fisheries Liaisons (FLs). FLs are employed by the Proponent and are responsible for the implementation of the Fisheries Communication Plan whereas FRs represent the interests of different fisheries and fishing communities to the

Proponent. The Proponent will communicate with the fishing industry following the protocols outlined in its Fisheries Communication Plan to help avoid interactions with fishing vessels and fishing gear. Additional information is provided in Section 7.6.3 of COP Volume III and Appendix III-E.

4.3.4.3 Oil Spill Response Plan and Emergency Response Plan

Before construction and installation activities begin, an Oil Spill Response Plan (OSRP) and an Emergency Response Plan (ERP) will be developed and issued to vessels and contractors working on Phase 2. A draft OSRP, which will be used for both Phases of New England Wind, is provided as Appendix I-F. The OSRP and ERP will provide a method/process for communication, coordination, containment, removal, and mitigation of unforeseen incidents that may occur during construction and O&M activities in the Offshore Development Area.

In the event of an actual spill or incident, vessels' and contractors' plans will be used to contain and/or stop an incident in compliance with the requirements of the New England Wind OSRP and ERP. As such, all plans will be reviewed by the Proponent to ensure they comply with regulatory and company-specific requirements. Routine training and exercises regarding the content of the New England Wind OSRP and ERP will also be carried out on a regular basis so that personnel are prepared to respond to emergencies, should they occur.

Annex 11 of the draft OSRP provides an oil spill modeling study to assess the trajectory and weathering of oil following a catastrophic release of all oil contents from the topple of an ESP (the largest oil-containing equipment). The oil spill modeling study identifies the worst-case discharge scenario, the longest period of time that the oil discharged would reasonably be expected to persist on the water's surface, and minimum travel times for the spill to reach shore.

4.3.4.4 Chemical Use, Waste Generation, and Disposal

Construction, commissioning, and operation of Phase 2 will generate some quantity of solid wastes and some small quantity of liquid wastes. Wastes and chemical products from construction and O&M can be broadly grouped into the following five primary categories:

- **Conventional Wastes from Equipment Installation and Maintenance:** During construction and installation, solid waste is expected to consist primarily of short lengths of cable trimmings as well as material and equipment packaging or protective wrappings (paper, cardboard, plastics). Conventional wastes from equipment installation and maintenance (e.g. parts wrappings and packaging, small amounts of leftover paints and coatings, empty aerosol spray cans, etc.) will be returned to port and properly disposed of. Routine solid waste such as parts packaging (paper, cardboard, plastics) will be recycled as appropriate. Small amounts of leftover paints, coatings, and other potentially hazardous materials will be segregated for proper disposal.

- **Conventional Wastes from Vessels:** Conventional wastes from vessels include sanitary wastewater, domestic water, uncontaminated bilge and ballast water, deck drainage and sumps, food waste, and paper waste. The vessels used during construction and operation of Phase 2 will meet USCG bilge and ballast water management requirements, as further discussed in Section 5.2.2 of COP Volume III. Vessels will comply with relevant US regulations and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements in effect at the time Phase 2 proceeds.

- **Oil and Chemical Products for the WTGs:** The WTGs are large pieces of mechanical/electrical equipment that require chemical products to function properly and reliably. See Table 4.3-7 for a list of potential oils and chemical products used for the WTGs. The expected frequency of replacement and treatment, discharge, or disposal methods for each chemical type is also provided in Table 4.3-7.

- **Oil and Chemical Products for the ESP(s):** The ESP(s) include several complex mechanical and electrical systems that require oil and chemical products. The ESP(s) will likely include an oil/water separator. See Table 4.3-7 for a list of potential oils and chemical products used on the ESP(s). A preventative maintenance schedule similar to that of the WTGs is followed for the ESP(s) (see Table 4.3-7 below).

- **Chemical Products for the Onshore Substation:** Chemical products used at the onshore substations could include, but are not limited to, dielectric fluid (i.e. essentially a high-grade mineral oil), lead acid batteries, SF_6, and possibly lubricating oil.

All waste materials, whether they are smaller volumes of conventional wastes generated on a regular basis or larger volumes of spent lubricants generated on a five to eight-year major maintenance cycle, will be carefully handled and disposed of (or recycled) in accordance with applicable regulations in effect at the time. The management and handling of hazardous substances used during Phase 2 will be reviewed to ensure compliance with regulatory requirements. This includes checking that appropriate containers, labeling and equipment are used. Where possible, a hazardous substance will be substituted with a more environmentally friendly alternative.

Table 4.3-6 below summarizes potential wastes to be produced during Phase 2 of New England Wind. Examples of potential chemical products to be used on the WTGs and ESP(s) are provided in Table 4.3-7 below. As planning and design proceeds, a detailed chemical and waste management plan will be developed and provided to BOEM. This plan will describe how each waste stream will be handled and stored, together with plans for proper disposal, recovery, recycling, or reuse.

Table 4.3-6 List of Wastes Expected to be Produced during Phase 2

Type of Waste and Composition	Approximate Total Amount Discharged[1]	Maximum Discharge Rate	Means of Storage or Discharge Method
Sewerage from vessel	95-114 liters (L)/person/day (25-30 gallons [gal]/person/day)	N/A	Tanks / Sewage Treatment Plant
Domestic water	114-151 L/person/day (30-40 gal/person/day)	N/A	Tanks or discharged overboard after treatment
Drilling cuttings, mud, grout or borehole treatment chemicals, if used	Dependent on final selection of HDD technique	N/A	N/A
Uncontaminated bilge water	Volume subject to vessel type	Rate subject to vessel size and equipment	Tanks or discharged overboard after treatment
Deck drainage and sumps	Volume subject to vessel type	Rate subject to vessel size and equipment	Discharged overboard after treatment
Uncontaminated ballast water	Volume subject to vessel type	Rate subject to vessel size and equipment	Discharged overboard
Uncontaminated fresh or seawater used for vessel air conditioning	N/A	N/A	Discharged overboard
Solid trash or debris	As generated	As generated	Onshore landfill (location to be determined [TBD])
Chemicals, solvents, oils, greases	Volume subject to vessel type	Rate subject to vessel size and equipment	Incineration or onshore landfill (location TBD)

Note:

1. Final discharge volumes and rates will be provided in the FIR following execution of contract with the construction contractor and the assignment of a Marine Coordinator

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs						
Grease	Pinion & main bearing lubrication	Nacelle	1,425 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer cans to site	Approximately 500 L expected annually	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Ester oil	Biodegradable transformer oil	Nacelle (within transformer)	11,400 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer the oil to the WTGs, either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Water / glycol	Cooling liquid for Heating, Ventilation, and Air Conditioning (HVAC) unit, Air Handling Unit, candidate for WTG tower damper fluid	Nacelle or Tower (top)	22,800 L per WTG	To be included at time of WTG installation	Expected to be topped up annually (if needed) and replaced every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Hydraulic oil	Oil used for hydraulic system (pitch, low-speed brake, cranes, & winches)	Nacelle or Tower	1,590 L per WTG	To be included at time of WTG installation During O&M, vessels will transfer the oil to the WTGs, either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected to be topped up annually (if needed) and replaced every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Gearbox Oil	Lubrication for gearboxes, including yaw drive; not applicable to direct drive WTG concepts	Nacelle	5,300 L per WTG	To be included at time of WTG installation	Expected to be topped up annually (as needed); frequency of replacement depends on an oil analysis.	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Lubricant	Candidate lubricant for Tower damper fluid	Tower (top)	16,400 L per WTG	To be included at time of WTG installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Nitrogen (pressurized)	Drives pitch system during power failure	Hub	90 kg per WTG	To be included at time of WTG installation	Expected annually	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Sulfur hexafluoride (SF_6)	Insulates switchgear	Tower Base (within switchgear)	19 kg per WTG	To be included at time of WTG installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Diesel fuel	Fuel for generator (if used)	Tower Base (within diesel generator/diesel storage tank)	7,000 L per WTG	To be included at time of WTG installation or potentially transferred via hose from a vessel or container placed on the foundation	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Inert gases e.g. NOVEC, nitrogen, carbon dioxide [CO_2], or similar)	Various locations	To be defined during detailed design	To be included at time of WTG installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Powder	Various locations	To be defined during detailed design	To be included at time of WTG installation	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Water/foam	Various locations	To be defined during detailed design	To be included at time of WTG installation	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Other types of extinguishers (if any)	Various locations	To be defined during detailed design	To be included at time of WTG installation	Not anticipated; Only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
WTGs (Continued)						
Paints & coatings	Corrosion protection of steel structure, paints (including anti-fouling paint), & varnishes	Steel structure, various locations	To be defined during detailed design	To be included at time of WTG installation; additional paint only needed for repairs	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Grout	For connection between foundation components	Foundation, various locations	Up to 159 m^3 per WTG	To be included at time of WTG installation	Not anticipated; Only changed if needed	To be brought back to port and disposed according to regulations and guidelines in effect at the time
ESP(s)						
Transformer oil	Mineral/naphthenic or ester oils	ESP topside (within power transformers, auxiliary/ earthing transformers, and reactors)	671,616 L per ESP	To be included at time of ESP installation During O&M, vessels will transfer the oil to the ESP(s), either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Lubrication oil	Lubricates machinery	Crane Emergency Generator	Crane: To be defined during detailed design Emergency generator: 79 L per ESP	During O&M, vessels will transfer the oil to the ESP(s), either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
General oil	Hydraulic oil for crane	Various locations	1,267 L per ESP	To be included at time of ESP installation During O&M, vessels will transfer the oil to the ESP(s), either in cans/containers that can be hoisted to the foundation platform or in tanks/containers from which it can be pumped via a hose from the vessel	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Diesel fuel	Fuel for generator	Diesel generator/ diesel day tank/diesel storage tank	31,046 L per ESP	To be included at time of ESP installation or potentially transferred via hose from a vessel or container placed on the ESP	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Fire extinguishing Agents	Inert gases e.g. NOVEC, nitrogen, CO_2, or similar)	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Powder	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing agents	Foam/water	Various locations	16,500 L foam per ESP	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Fire extinguishing Agents	Other types of extinguishers (if any)	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Portable fire extinguisher	Various types	Various locations	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
SF_6	Insulates switchgear	ESP topside (within switchgear)	6,180 kg for ESP(s)	To be included at time of ESP installation	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Water/glycol	Cooling liquid for HVAC unit, Air Handling Unit	HVAC unit, Air Handling Unit	12,000 L per ESP	To be included at time of ESP installation	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

Table 4.3-7 List of Potential Chemical Products Used on Phase 2 WTGs and ESP(s) (Continued)

Chemical Type	Product Description	Source/ Location	Phase 2 Maximum Volume/ Weight	Method of Bringing Onsite	Number of Transfers	Treatment, Discharge or Disposal Options
ESP(s) (Continued)						
Paints & Coatings	Corrosion protection of steel structure, paints (including anti-fouling paint), & varnishes	Steel structure, various locations	To be defined during detailed design	To be included at time of ESP installation; additional paint only needed for repairs	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Grout	For connections between foundation components	Foundation, various locations	Up to 362 m^3 per ESP	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Diesel Exhaust Fluid (urea)	Injected in to exhaust to scrub nitrogen oxide (NOx), if necessary	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Only changed when needed; diesel genset only used during commissioning, servicing and grid faults	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time
Lead-acid	Batteries	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Expected every 5-8 years	To be brought to designated to O&M port and disposed according to regulations and guidelines in effect at the time
Refrigerant gas R134a or R407C	Auxiliary cooling systems	ESP topside	To be defined during detailed design	To be included at time of ESP installation	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines in effect at the time

4.3.4.5 Grout Spill Management

As described in Sections 4.3.1.4 and 4.3.1.5, grout may be used during foundation installation for the connection between the monopile and TP, to secure the boat landing, to secure foundation piles into the pile sleeves, and/or to fill the interior of the monopiles or suction buckets. Grout material will be contained by a high strength rubber grout seal that ensures any grout overflow is directed to the inside of the foundation. When grout is used, the following grout spill management procedures will be used to mitigate the potential for any grout release:

- The grout level will be monitored visually using underwater cameras and when grout reaches the top of the sleeve, grouting will be halted.

- Special couplings will be attached to the grout hoses to mitigate grout spill when grout hoses are removed after grouting, where feasible. For monopiles, hoses will be disconnected on the upper TP platform to avoid losses of grout into the water column.

- Water and grout from cleaning of hoses and other equipment will be collected on the vessel and disposed of properly on shore.

- The risk for accidental grout spill in the sea due to grout seal failure will be mitigated by pressure testing grout seals.

Section 5.0

Permitting and Stakeholder Outreach (Phases 1 and 2)

5.0 PERMITTING AND STAKEHOLDER OUTREACH (PHASES 1 AND 2)

5.1 Regulatory Framework and Permitting

Table 5.1-1 below lists the expected federal, Massachusetts, regional (county), and local level reviews and permits for New England Wind. Filing dates are provided for permit applications and review documents that have already been submitted. The table below does not include permits that vessel operators or construction firms will need to obtain.[106]

The Bureau of Ocean Energy Management (BOEM) has jurisdiction under the Outer Continental Shelf Lands Act to issue leases, easements, and rights-of-way for the development of renewable energy on the Outer Continental Shelf (OCS) and to ensure that activities conducted on the OCS are carried out in a manner that adequately addresses environmental protection, safety, protection of United States national security, and protection of the rights of others to use the OCS and its resources. BOEM authorizes development on the OCS through its review and approval of a Site Assessment Plan and Construction and Operations Plan (COP). BOEM will be the lead federal agency for New England Wind and will coordinate with other federal agencies that will issue permits for New England Wind (e.g. Environmental Protection Agency [EPA] and US Army Corps of Engineers [USACE]).

In approving a COP, BOEM must comply with its obligations under the National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the Migratory Bird Treaty Act (MBTA), the Clean Air Act (CAA), and the Endangered Species Act (ESA). Thus, BOEM coordinates and consults with numerous other federal agencies, including the National Marine Fisheries (NMFS), US Fish and Wildlife Service (USFWS), EPA, and the US Coast Guard (USCG) during the review process. When appropriate, BOEM also coordinates with states under the Coastal Zone Management Act (CZMA) to ensure that projects are consistent with state-level coastal zone management plans.

At the state level, elements of New England Wind located in Massachusetts waters, as well as onshore elements, are subject to two primary review processes: (1) a broad adjudicatory review by the Massachusetts Energy Facilities Siting Board (EFSB), which can incorporate a request for local zoning relief; and (2) an environmental review under the Massachusetts Environmental

[106] Note that the Vessel General Permit (VGP) provides National Pollutant Discharge Elimination System (NPDES) permit coverage for incidental discharges in US waters from commercial vessels 24 m (79 ft) or longer and for ballast water from commercial vessels of all sizes. Individual vessel owners/operators must obtain permit coverage under the VGP for operation of their vessel irrespective of New England Wind. Therefore, this permit is not included in the permit table. Similarly, vessels used for New England Wind will meet USCG bilge and ballast water management requirements at 33 CFR Part 151 and 46 CFR Part 162. However, these regulations are applicable to vessels irrespective of New England Wind and are therefore not included in the permit table.

Policy Act (MEPA). Portions of New England Wind within Massachusetts will also require review and/or permits from several other Massachusetts agencies as well as approvals and permits at the regional and local level.

Table 5.1-1 Required Permits/Approvals for New England Wind (Phases 1 and 2)

Agency/Regulatory Authority	Permit/Approval	Phase 1 Status	Phase 2 Status
Federal Permits/Approvals			
Bureau of Ocean Energy Management (BOEM)	Site Assessment Plan (SAP) approval	Completed.[107]	Completed.[108]
	Construction and Operations Plan (COP) approval/Record of Decision (ROD)	COP filed with BOEM July 2, 2020.	COP filed with BOEM July 2, 2020.
	National Environmental Policy Act (NEPA) Environmental Review	Initiated by BOEM June 30, 2021.	Initiated by BOEM June 30, 2021.
	Consultation under Section 7 of the ESA with NMFS and USFWS, coordination with states under the CZMA, government-to-government tribal consultations, consultation under Section 106 of the NHPA, and consultation with NMFS for Essential Fish Habitat.	To be initiated by BOEM.	To be initiated by BOEM.
	Facility Design Report (FDR) and Fabrication and Installation Report (FIR)	To be filed (TBF)	TBF
US Environmental Protection Agency (EPA)	EPA Permits under Section 316(b) of the Clean Water Act (CWA), including National Pollutant Discharge Elimination System (NPDES) Permit(s)	TBF	TBF
	OCS Air Permit	Notice of Intent (NOI) submitted on August 13, 2020.	TBF
US Army Corps of Engineers (USACE)	CWA Section 404 Permit (Required for side-casting of dredged material and placement of foundations, scour protection, and cable protection) Rivers and Harbors Act of 1899 Section 10 Individual Permit (Required for all offshore structures and dredging activities)	Joint application TBF	Joint application TBF

107 A meteorological-oceanographic buoy (metocean buoy) was installed in Lease Area OCS-A 0501 (prior to its segregation into Lease Areas OCS-A 0501 and OCS-A 0534) under an approved SAP in May 2018.

108 See previous.

Table 5.1-1 Required Permits/Approvals for New England Wind (Phases 1 and 2) (Continued)

Agency/Regulatory Authority	Permit/Approval	Phase 1 Status	Phase 2 Status
Federal Permits/Approvals (Continued)			
US National Marine Fisheries Service (NMFS)	Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA)	TBF	TBF
US Coast Guard (USCG)	Private Aid to Navigation (PATON) authorization	TBF	TBF
Federal Aviation Administration (FAA)	No Hazard Determination (for activities at construction staging areas and vessel transits, if required)	TBF	TBF
ISO New England			
ISO New England (ISO-NE)	Interconnection Authorization	Interconnection request queue position (QP) #700 submitted on December 15, 2017.	Interconnection request(s) under review.
State Permits/Approvals			
Massachusetts Environmental Policy Act (MEPA) Office	Certificate of the Secretary of Energy and Environmental Affairs on the Final Environmental Impact Report	Environmental notification form (ENF) filed on June 11, 2020. Draft Environmental Impact Report (DEIR) submitted March 19, 2021 (Certificate received June 25, 2021). Final Environmental Impact Report (FEIR) filed December 15, 2021 (Certificate received January 28, 2022).	TBF
Massachusetts Energy Facilities Siting Board (EFSB)	G.L. ch. 164, § 69 Approval	Petition filed on May 28, 2020.	TBF
Massachusetts Department of Public Utilities (DPU)	G.L. ch. 164, § 72, Approval to Construct G.L. ch. 40A, § 3 Zoning Exemption (if needed)	Petitions filed on May 28, 2020.	TBF
Massachusetts Department of Environmental Protection (MassDEP)	Chapter 91 Waterways License and Dredge Permit/ Water Quality Certification (Section 401 of the CWA)	TBF	TBF
	Approval of Easement (Drinking Water Regulations)[109]	N/A	TBF (if needed)

[109] Not required for Phase 1, which does not cross any Zone 1 areas. An Approval of Easement could be required for Phase 2 if a Phase 2 onshore route passes through a Zone I area.

Table 5.1-1 Required Permits/Approvals for New England Wind (Phases 1 and 2) (Continued)

Agency/Regulatory Authority	Permit/Approval	Phase 1 Status	Phase 2 Status
State Permits/Approvals (Continued)			
Massachusetts Division of Marine Fisheries (DMF)	Letter of Authorization and/or Scientific Permit (for surveys and pre-lay grapnel run)	TBF	TBF
Massachusetts Department of Transportation (MassDOT)	Non-Vehicular Access Permits	TBF	TBF
	Rail Division Use and Occupancy License (if needed)	TBF (if needed)	TBF (if needed)
Massachusetts Board of Underwater Archaeological Resources (MBUAR)	Special Use Permit	Special Use Permit 17-003 Renewal Application submitted December 20, 2020. Permit 17-003 renewal approved February 26, 2021.	Special Use Permit 17-003 Renewal Application submitted December 20, 2020. Permit 17-003 renewal approved February 26, 2021.
Natural Heritage and Endangered Species Program (NHESP)	Conservation and Management Permit (if needed)	MESA Determination issued April 1, 2022 with conditions and will not result in a Take of state-listed species	TBF (if needed)
Massachusetts Historical Commission (MHC)	Archaeological Investigation Permits (950 CMR § 70.00)	Reconnaissance survey permit application filed May 4, 2020. State Archaeologist's Permit #4006 for Reconnaissance Survey issued May 12, 2020. State Archaeologist's Permit #4006 amended and extended March 2, 2021.	TBF
Massachusetts Office of Coastal Zone Management (CZM)/ Rhode Island Coastal Resources Management Council (CRMC)	Federal Consistency Determination (15 CFR § 930.57)	Included as Appendix III-S.	Included as Appendix III-S.
Regional Permits/Approvals			
Cape Cod Commission (Barnstable County)	Development of Regional Impact (DRI) Review	TBF	TBF
Martha's Vineyard Commission (MVC)	DRI Review	TBF	TBF

Table 5.1-1 Required Permits/Approvals for New England Wind (Phases 1 and 2) (Continued)

Agency/Regulatory Authority	Permit/Approval	Phase 1 Status	Phase 2 Status
Local Permits/Approvals			
Barnstable Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non zoning bylaws)	NOI filed April 29, 2022	TBF
Barnstable Department of Public Works (DPW) and/or Town Council	Street Opening Permits/Grants of Location	TBF	TBF
Barnstable Planning/Zoning	Zoning approvals as necessary	TBF	TBF
Edgartown Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non-zoning bylaws)	NOI filed March 23, 2022	TBF
Nantucket Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non-zoning bylaws)	NOI filed March 7, 2022	TBF
Mashpee Conservation Commission	Order of Conditions (Massachusetts Wetlands Protection Act and municipal wetland non-zoning bylaws) (if needed)	N/A	TBF (if needed)

5.2 Consultations with Agencies, Tribes, and Municipalities

As described in Section 1.6, many of the Proponent's staff, consultants, and partners were heavily involved in the development of the Vineyard Wind 1 project. Consultations with agencies, tribes, and municipalities for the Vineyard Wind 1 project began in April 2015 and created pathways for stakeholder consultation for New England Wind. As Vineyard Wind 1 progressed through the permitting process, the Proponent's team members built strong collaborative relationships with federal, state, and local regulators along with a diverse array of stakeholders and gained unique insight into the permitting process for offshore wind projects. This experience is reflected in the permitting plan for New England Wind.

New England Wind will be installed adjacent to Vineyard Wind 1 and proposes to utilize largely the same Offshore Export Cable Corridor. While separate and new permits are needed for New England Wind, the similar offshore sites and cable routes mean that the Proponent's team members have prior experience working with the relevant permitting authorities and local officials and have also developed a strong network of local supporters, all of which will facilitate the permitting of the New England Wind.

The Proponent has been actively consulting with BOEM, federal and state agencies, regional commissions, affected municipalities, and federally-recognized tribes regarding the status of New England Wind, planned studies, issues of concern, and related matters. In addition to regular BOEM consultations, the Proponent's representatives have met with a group of senior officials from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) agencies, the Connecticut Department of Energy and Environmental Protection (DEEP), the Massachusetts EFSB Director and senior staff, the Massachusetts "Ocean Team" agencies, the Massachusetts Department of Transportation, and the EPA Region 1 air quality team beginning in the fall of 2019. A list of meetings related to New England Wind conducted as of March 2021 with BOEM, other agencies, municipalities, and tribes is provided in Table 5.2-1. In addition to these meetings, members of the Proponent's team have participated in hundreds of meetings with agencies, tribes, and municipalities since 2015 regarding the development of Vineyard Wind 1.

Following the submittal of initial filings in 2020, there have been and will continue to be a number of agency-convened public hearings and informational meetings. These include BOEM/NEPA scoping sessions, Massachusetts EFSB public statement hearing(s), and a MEPA "onsite" consultation session.

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2)

Date	Group	Topic[1]
July 2019	BOEM	New England Wind COP
September 2019	BOEM	Survey updates
November 2019	BOEM	New England Wind review and updates
December 2019	EPA	New England Wind overview
January 2020	NMFS – National Oceanic and Atmospheric Administration (NOAA)	New England Wind/Lease Area overview
January 2020	NMFS	Early consultation meeting
January 2020	BOEM	New England Wind COP
January 2020	PSEG Power (Connecticut)	New England Wind introduction and update
January 2020	City of Bridgeport, Connecticut	Update on New England Wind Phase 1
January 2020	Massachusetts DPU/EFSB	Vineyard Wind 1 update and New England Wind 1 Connector (the portion of New England Wind Phase 1 in Massachusetts jurisdiction) introduction
February 2020	Rhode Island CRMC	Cable working group
February 2020	Massachusetts Ocean Team (MEPA Office, CZM, MassDEP, DMF, NHESP, NOAA, MBUAR)	Introduce New England Wind 1 Connector

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)

Date	Group	Topic[1]
March 2020	Aquinnah Wampanoag Tribe	New England Wind Pre-Survey Meeting
March 2020	Mashpee Wampanoag Tribe	New England Wind Pre-Survey Meeting
March 2020	Shinnecock Tribe	New England Wind Pre-Survey Meeting
March 2020	Rhode Island Fisheries Advisory Board Meeting	New England Wind updates and Connecticut Fisheries Liaison introduction
March 2020	MassDOT	New England Wind Phase 1 discussion
March 2020	BOEM	New England Wind lease discussion
April 2020	Connecticut Commission on Environmental Standards	1st Quarterly Meeting- General background and introduction to New England Wind Phase 1
April 2020	Briefing Call with Senator Norm Needleman, Commissioner Katie Dykes, and Green Bank's Matt Macunas	Clean energy priorities and the impact on local economic development in 2020
April 2020	MEPA Office	State pre-filing meeting
April 2020	NHESP	State pre-filing meeting
April 2020	Chappaquiddick Tribe	Pre-survey Meeting
April 2020	BOEM	(3 meetings) New England Wind updates
April 2020	Town of Barnstable	New England Wind/New England Wind 1 Connector updates
May 2020	NHESP	Avian survey update
May 2020	USFWS	Consultation
May 2020	Town of Barnstable	(3 meetings) New England Wind updates
June 2020	Rhode Island Department of Environmental Management (RI DEM)	Fisheries disaster relief
June 2020	BOEM	New England Wind update
July 2020	MEPA Office	Virtual site visit for the New England Wind Phase 1/New England Wind 1 Connector
July 2020	Town of Barnstable (with NMFS and Massachusetts CZM)	New England Wind update
July 2020	Connecticut Commission on Environmental Standards	2nd quarterly meeting – New England Wind updates, initiatives, marine mammals
July 2020	MEPA Office and Massachusetts CZM	State permitting discussion

Table 5.2-1 **Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)**

Date	Group	Topic
July 2020	Town of Barnstable	New England Wind Phase 1/New England Wind 1 Connector roadway discussion
August 2020	MEPA Office and EEA	State permitting discussion
August 2020	US Navy	Offshore cables and comment process to BOEM
August 2020	BOEM	New England Wind update
August 2020	USACE	New England Wind introduction
September 2020	Massachusetts CZM	Preparation discussion re: federal consistency review
September 2020	Town of Barnstable	New England Wind Phase 1/New England Wind 1 Connector roadway discussion
September 2020	BOEM	New England Wind updates
September 2020	Massachusetts EFSB	(2 meetings) pre-site visit coordination; site visit
October 2020	Massachusetts EFSB	(2 meetings) pre-hearing coordination; public hearing for New England Wind Phase 1/New England Wind 1 Connector
October 2020	BOEM	New England Wind update
October 2020	Barnstable Shellfish Committee	New England Wind update
November 2020	Massachusetts DMF	New England Wind update
November 2020	EPA	New England Wind update
January 2021	BOEM	(3 meetings) COP sufficiency; pre-survey; COP process discussion
January 2021	MEPA Office	State pre-filing consultation
February 2021	MEPA Office	State permitting pre-filing consultation
February 2021	Rhode Island CRMC	Consistency review discussion
February 2021	BOEM	(3 meetings) COP sufficiency
February 2021	Massachusetts DMF	New England Wind update
February 2021	Connecticut Commission on Environmental Standards	3rd quarterly meeting – environmental mitigation
March 2021	USCG	New England Wind update and Navigation Safety Risk Assessment consultation

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)

Date	Group	Topic
March 2021	Town of Barnstable	New England Wind updates
March 2021	Mashantucket Pequot Tribe	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Delaware Tribe of Indians	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Shinnecock Indian Nation	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Mashpee Wampanoag	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Wampanoag Tribe of Gay Head (Aquinnah)	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Narragansett Tribe	New England Wind and Vineyard Wind 1 pre-survey meeting
March 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 meeting
March 2021	NMFS	New England Wind update
March 2021	Massachusetts Commission on Indian Affairs	New England Wind update
March 2021	Massachusetts Fisheries Working Group on Offshore Wind (EEA & Massachusetts Clean Energy Center [MassCEC])	Projects updates including Park City Wind
April 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 meeting
April 2021	BOEM	(2 meetings) New England Wind check-in
April 2021	EPA	New England Wind Phase 1 air permit meeting
May 2021	BOEM	(2 meetings) New England Wind check-in
May 2021	Massachusetts CZM	Park City Wind update
May 2021	EPA	New England Wind Phase 1 air modeling discussion
May 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 meeting
June 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 schedule
June 2021	BOEM	(9 meetings) New England Wind check-in, Benthic Habitat discussion, tribal consultation discussion
June 2021	Chappaquiddick Wampanoag Whale Clan	New England Wind overview and update

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)

Date	Group	Topic
June 2021	Massachusetts Fisheries Working Group on Offshore Wind (EEA & MassCEC)	Projects updates including New England Wind
July 2021	EPA	Park City Wind update
July 2021	Town of Barnstable	New England Wind 1 Connector update
July 2021	Mashpee Wampanoag	Projects update including New England Wind
July 2021	BOEM	New England Wind check-in
July 2021	NJ State Department of Environmental Protection	Fisheries mitigation structure
July 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 meeting
July 2021	Town of Oak Bluffs Selectboard, Massachusetts	New England Wind project update
August 2021	BOEM	(2 meetings) New England Wind check-in
August 2021	Town of Edgartown Selectboard, Massachusetts	New England Wind update
August 2021	Town of Chilmark Selectboard, Massachusetts	New England Wind update
August 2021	Town of Tisbury Selectboard, Massachusetts	New England Wind update
August 2021	Town of Aquinnah Selectboard, Massachusetts	New England Wind update
August 2021	Massachusetts CZM	Park City Wind update
August 2021	NMFS	New England Wind update
September 2021	Barnstable Town Council	Projects update and Host Community Agreement
September 2021	Federal Permitting Improvement Steering Council	New England Wind FAST-41 meeting
September 2021	USCG, Sector Southern New England	Projects updates including New England Wind
September 2021	Massachusetts Fisheries Working Group on Offshore Wind (EEA & MassCEC)	Projects updates including New England Wind
September 2021	Town of Fairhaven, Massachusetts	Introduction to Commonwealth Wind
September 2021	Town of Acushnet, Massachusetts	Introduction to Commonwealth Wind
September 2021	City of New Bedford, Massachusetts	Introduction to Commonwealth Wind

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)

Date	Group	Topic
September 2021	City of Salem, Massachusetts	Introduction to Commonwealth Wind
September 2021	Connecticut DEEP	Park City Wind update
September 2021	BOEM	New England Wind update
October 2021	BOEM	(3 meetings) New England Wind update
October 2021	Connecticut DEEP	Park City Wind update
October 2021	Massachusetts CZM	Park City Wind update
October 2021	Massachusetts DEP	Park City Wind update
October 2021	Massachusetts CZM, DMF, DEP	Park City Wind update
October 2021	Federal Permitting Improvement Steering Council	New England Wind check in
November 2021	BOEM	(3 meetings) New England Wind update
November 2021	NMFS	Park City Wind update
November 2021	Town of Barnstable	Park City Wind update
November 2021	Connecticut DEEP	Park City Wind update
November 2021	Federal Permitting Improvement Steering Council	New England Wind check in
November 2021	Mashpee Wampanoag Tribe	New England Wind update
November 2021	City of Salem	Commonwealth Wind update
November 2021	MEPA	Park City Wind update
December 2021	City of Salem	Commonwealth Wind update; port development meeting
December 2021	Wampanoag of Gay Head (Aquinnah)	New England Wind update
December 2021	Connecticut DEEP Council on Environmental Standards (CES)	Park City Wind update
January 2022	City of Salem	Commonwealth Wind update; port development meeting

Table 5.2-1 Consultations with Agencies, Tribes, and Municipalities for New England Wind (Phases 1 and 2) (Continued)

Date	Group	Topic
January 2022	Town of Barnstable	Park City Wind update
February 2022	Town of Barnstable	Park City Wind update
February 2022	City of Salem	Commonwealth Wind update; port development meeting
February 2022	Wampanoag Tribe of Gay Head (Aquinnah)	New England Wind pre-survey meeting
February 2022	Narragansett Indian Tribe	New England Wind pre-survey meeting
February 2022	Shinnecock Indian Tribe	New England Wind pre-survey meeting
February 2022	Mashantucket Pequot Tribal Nation	New England Wind pre-survey meeting
February 2022	Mohegan Tribe of Indians (Connecticut)	New England Wind pre-survey meeting
February 2022	Delaware Tribe of Indians	New England Wind pre-survey meeting
March 2022	City of Salem	Commonwealth Wind update; port development meeting
March 2022	Town of Barnstable	Park City Wind update
March 2022	BOEM and Tribes	Section 106 consultation
March 2022	Mashpee Wampanoag Tribe	New England Wind pre-survey meeting
March 2022	Town of Barnstable, Town Council	Park City Wind update and Commonwealth Wind introduction
March 2022	Cape Cod Commission	Park City Wind introduction
March 2022	Massachusetts DEP	Park City Wind update
March 2022	Massachusetts CZM	New England Wind update
March 2022	Connecticut DEEP Council on Environmental Standards (CES)	Park City Wind update
March 2022	City of New Bedford	Commonwealth Wind update
April 2022	USACE	New England Wind update / permitting update

Note:

1. For meetings conducted prior to October 2021, "New England Wind" was known as "Vineyard Wind South" and "New England Wind 1 Connector" was known as "Vineyard Wind Connector 2."

5.3 Stakeholder Coordination

In addition to the consultations described in Table 5.2-1, extensive and ongoing consultations with key stakeholders have been conducted by the Proponent and its community partner, Vineyard Power Cooperative (Vineyard Power). The Proponent has a Community Benefits Agreement with Vineyard Power, which is a community-owned non-profit renewable energy cooperative based on Martha's Vineyard. This partnership has enabled significant input into the New England Wind design process from members of the local community, such that the design addresses local concerns and enhances opportunities for local benefits. Vineyard Power staff and its board of directors work closely with the Proponent to conduct outreach to community stakeholders, including local towns, environmental interests, and commercial and recreational fisheries.

The Proponent frequently advertises outreach events in local newspapers, social media, press releases, emails, and other media outlets to reach an array of stakeholders. The Proponent also regularly invites the public to learn more about its projects through office hours, where team members exhibit information in a public space and are available for questions or comments on the Proponent's projects. To-date, the Proponent has held dozens of information sessions and regularly holds office hours sessions in Barnstable, Covell's Beach, Martha's Vineyard, and across Cape Cod. The Proponent also sponsors and staffs information tables at a variety of environmental, fisheries-related, and community events to reach a variety of stakeholders.

The Proponent is a member of, and active participant in, the Massachusetts Fisheries Working Group on Offshore Wind Energy, the Habitat Working Group on Offshore Wind Energy, the Responsible Offshore Development Alliance (RODA), the Responsible Offshore Science Alliance (ROSA), and the New York State Energy Research and Development Authority (NYSERDA) Fisheries Technical Working Group. The Proponent also attends the Rhode Island Fishermen's Advisory Board meetings. The Proponent is in regular communication with individual fishermen from the commercial (fixed and mobile gear) and recreational fishing sectors. The Proponent's Fisheries Liaisons and Fisheries Representatives have also been consistently meeting with fisheries stakeholders (see Appendix III-E).

In addition to the agencies, tribes, and municipalities listed above in Sections 5.1 and 5.2, the following list includes, but is not limited to, the groups that have been and/or will be consulted with for New England Wind:

- Alliance to Protect Nantucket Sound
- Anglers for Offshore Wind
- Association to Preserve Cape Cod
- Barnstable Clean Water Coalition
- Buzzards Bay Coalition

- Cape and Islands Self-Reliance
- Cape and Vineyard Electrical Cooperative
- Cape Cod Fishermen's Alliance
- Cape Cod Chamber of Commerce
- Cape Cod Climate Change Collaborative
- Cape Cod Community College
- Cape Cod Technology Council
- Cape Light Compact
- Centerville Civic Association
- City of Bridgeport, Connecticut
- Climate Action Business Association
- Coalition for Social Justice
- Commercial Fisheries Center of Rhode Island
- Connecticut Green Bank
- Connecticut Roundtable on Climate and Jobs
- Conservation Law Foundation
- Coonamessett Farm Foundation
- Eastern Fisheries
- Environment Massachusetts
- Environmental Business Council of New England
- Environmental League of Massachusetts
- Falmouth Fishermen's Association
- Fishing Partnership Support Services
- Greentown Labs

- Hercules SLR
- Job Training and Employment Corporation, Cape Cod
- KSJ Seafood Inc.
- Long Island Commercial Fishing Association
- MA Fisheries Institute
- MA Fisheries Working Group on Offshore Wind Energy
- MA Fishermen's Partnership and Support Services
- MA Habitat Working Group on Offshore Wind Energy
- MA Historical Commission
- MA Lobstermen's Association
- Martha's Vineyard Fishermen Preservation Trust
- Massachusetts Audubon Society
- Massachusetts Clean Energy Center
- Mid-Atlantic Fisheries Management Council
- Mystic Aquarium
- Nantucket Rotary Club
- National Academies of Sciences, Offshore Renewable Energy Development and Fisheries Conference
- National Wildlife Federation
- Natural Resources Defense Council
- New Bedford Earth Day Group
- New Bedford Harbor Development Commission
- New Bedford Port Authority
- New England Aquarium

- New England Energy and Commerce Association
- New England Fishery Management Council
- New York League of Conservation Voters
- NYSERDA Fisheries Technical Working Group
- Northeast Fishery Sector Managers VII, VIII X, XI, XIII
- Northeast Fisheries Sciences Center
- Port of New Bedford
- PSEG Power- Connecticut
- Recreational Fishing Alliance
- RODA
- ROSA
- Rhode Island Department of Environmental Management
- Rhode Island FAB
- Rhode Island Habitat Advisory Board
- Rhode Island Marine Fisheries Council
- Rhode Island Saltwater Angler's Association
- Scallop Industry Advisors Meeting
- Seafreeze
- Sierra Club
- Southcoast Chamber
- Stoveboat- Saving Seafood
- Survival Systems USA
- The Nature Conservancy
- Town Dock

- Unitarian Church of Barnstable Green Sanctuary Committee
- University of Massachusetts (various campuses)
- Woods Hole Oceanographic Institution

The Proponent plans to maintain an active level of consultation and outreach as the environmental review and permitting processes continue and is available to meet with any interested party (see contact information in Section 1.6.1).

Section 6.0

References and Incorporation by Reference

6.0 REFERENCES AND INCORPORATION BY REFERENCE

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