Kitty Hawk Wind

AVANGRID

Construction and Operations Plan

Chapter 3 - Description of Proposed Activity

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Submitted by
Kitty Hawk Wind, LLC
1125 NW Couch Street, Suite 600
Portland, Oregon 97209

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Road
Sterling, Virginia 20166

Prepared by
Tetra Tech, Inc.
10 Post Office Square, 11th Floor
Boston, Massachusetts 02109

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Abbreviations & Definitions

Acronym	Definition
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CTV	crew transfer vessel
DP2	dynamic positioning, IMO class 2 vessel
ESP	electrical service platform
ha	hectare
HAT	highest astronomical tide
HDD	horizontal directional drilling
IMO	International Maritime Organization
km	kilometer
kV	kilovolt
L	liter
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508
Lease Area	the designated Renewable Energy Lease Area OCS-A 0508
LNG	liquified natural gas
m	meter
mm	millimeter
m^2	square meter
m^3	cubic meter
MMO	marine mammal observation
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
onshore substation site	A site located within the Corporate Landing Business Park in Virginia Beach, Virginia, which will contain the onshore substation, interconnection lines, and switching station
PDE	Project Design Envelope
Project	Kitty Hawk North Wind Project
PSO	protected species observer
ROW	right-of-way
SOV	service operation vessel

Acronym	Definition
t	metric ton
the Company	Kitty Hawk Wind, LLC
USCG	United States Coast Guard
Wind Development Area	approximately 40 percent of the Lease Area in the northwest corner closest to shore (19,441 ha)
WTG	wind turbine generator

3 DESCRIPTION OF PROPOSED ACTIVITY

A detailed description of the Project Design Envelope (PDE) is provided in this chapter, along with a description of construction and installation, operations and maintenance (O&M), and decommissioning activities. The PDE approach adopted by Kitty Hawk Wind, LLC (the Company) will define and bracket the characteristics of the Kitty Hawk North Wind Project (Project) construction activities for the purposes of environmental review, while also maintaining a reasonable degree of flexibility with respect to the selection of key Project components (e.g., wind turbine generators [WTGs], foundations, submarine cables, and electrical service platform [ESP]). To assess potential impacts and benefits to various resources within the Project Area, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established on a resource-specific basis (BOEM 2018). A quick reference guide to the Project terms, components, and activities that will be referenced throughout the Construction and Operations Plan (COP) can be found in the Executive Summary.

3.1 Project Location

At this time, the Company is proposing to develop the northwest portion of the designated Renewable Energy Lease Area OCS-A 0508 (Lease Area) closest to land (19,441 hectares [ha]; hereafter referred to as the Wind Development Area), approximately 44 kilometers (km) offshore of Corolla, North Carolina.[1] The offshore components of the Project, including the WTGs, ESP, and inter-array cables, will be located in federal waters within the Lease Area. The offshore export cable corridor will traverse both federal and state territorial waters of Virginia. Onshore Project components, including the export cable landfall location, onshore export cables, onshore substation, and switching station, will be located in the City of Virginia Beach, Virginia. A Project overview is provided in Figure 3.1-1 and Figure 3.1-2.

For the purposes of this COP, the Project Area refers to the maximum footprint of the facilities, including the offshore Project facilities (WTGs, ESP, and inter-array cables), export cable corridors, and all onshore Project facilities (landfall, onshore substation and switching station, and onshore export cables).

3.1.1 Supporting Facilities

The Project anticipates utilizing various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels. Improvements may be needed to these ports in order to accommodate offshore wind construction and staging activities; port improvements and the associated permitting activities will be able to support multiple projects up and down the Eastern Seaboard and will be the responsibility of port owners/operators.

The Company will look to contract as many Project components and services as practicable domestically, utilizing vessels originating from the range of ports listed above. However, certain Project components may be fabricated outside of the U.S., pending market availability, and will be transported by vessels originating from international ports.

Additionally, the Company is considering the following locations for O&M facilities, as described in Section 3.3:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

[1] For reference, one km equals 0.62 statute miles, or 0.54 nautical miles (nm). Measurements in this COP are presented in International Standard units. Where relevant regulations are written in U.S. customary system units, both units are presented.

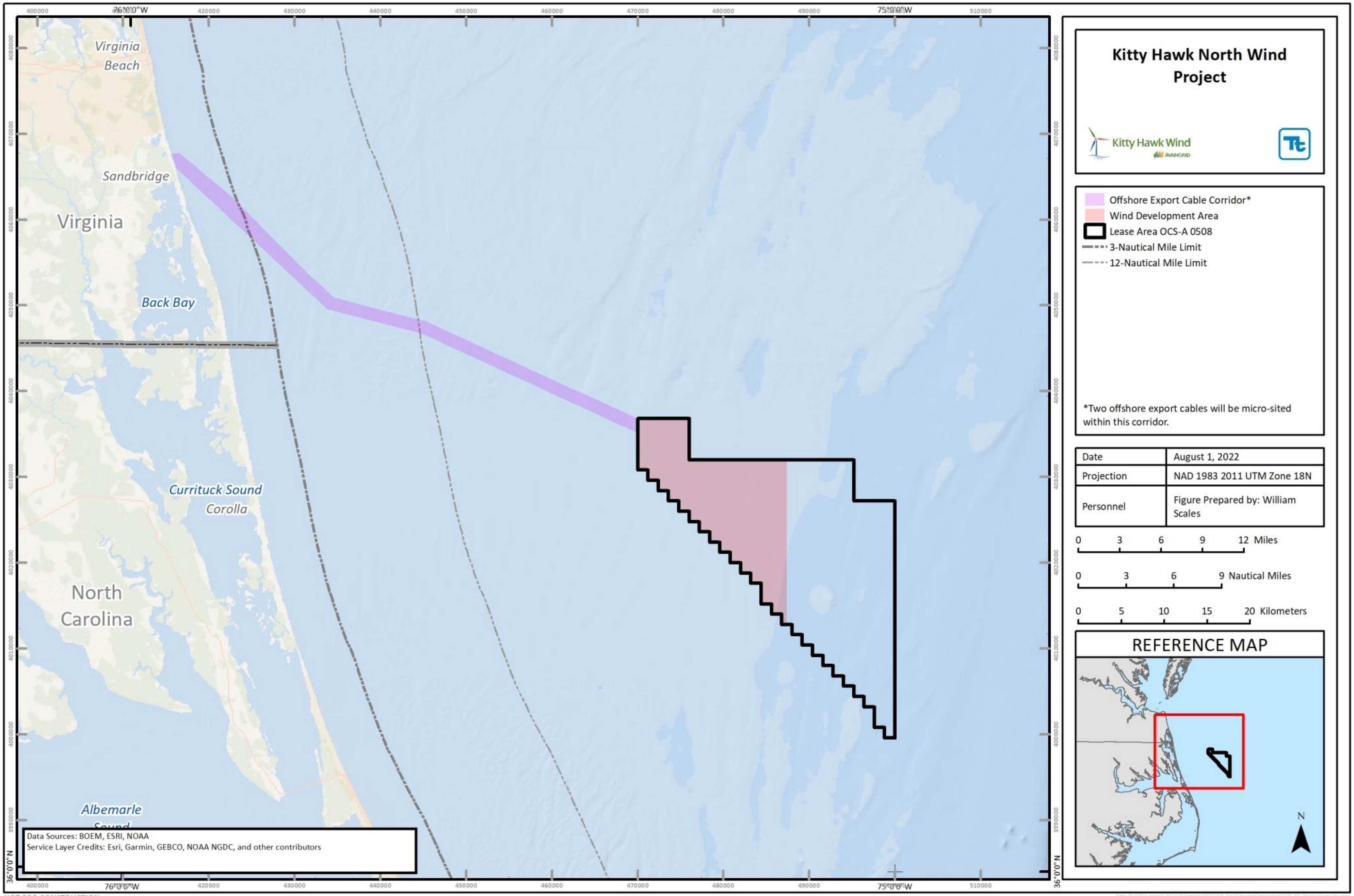


Figure 3.1-1 Offshore Project Overview

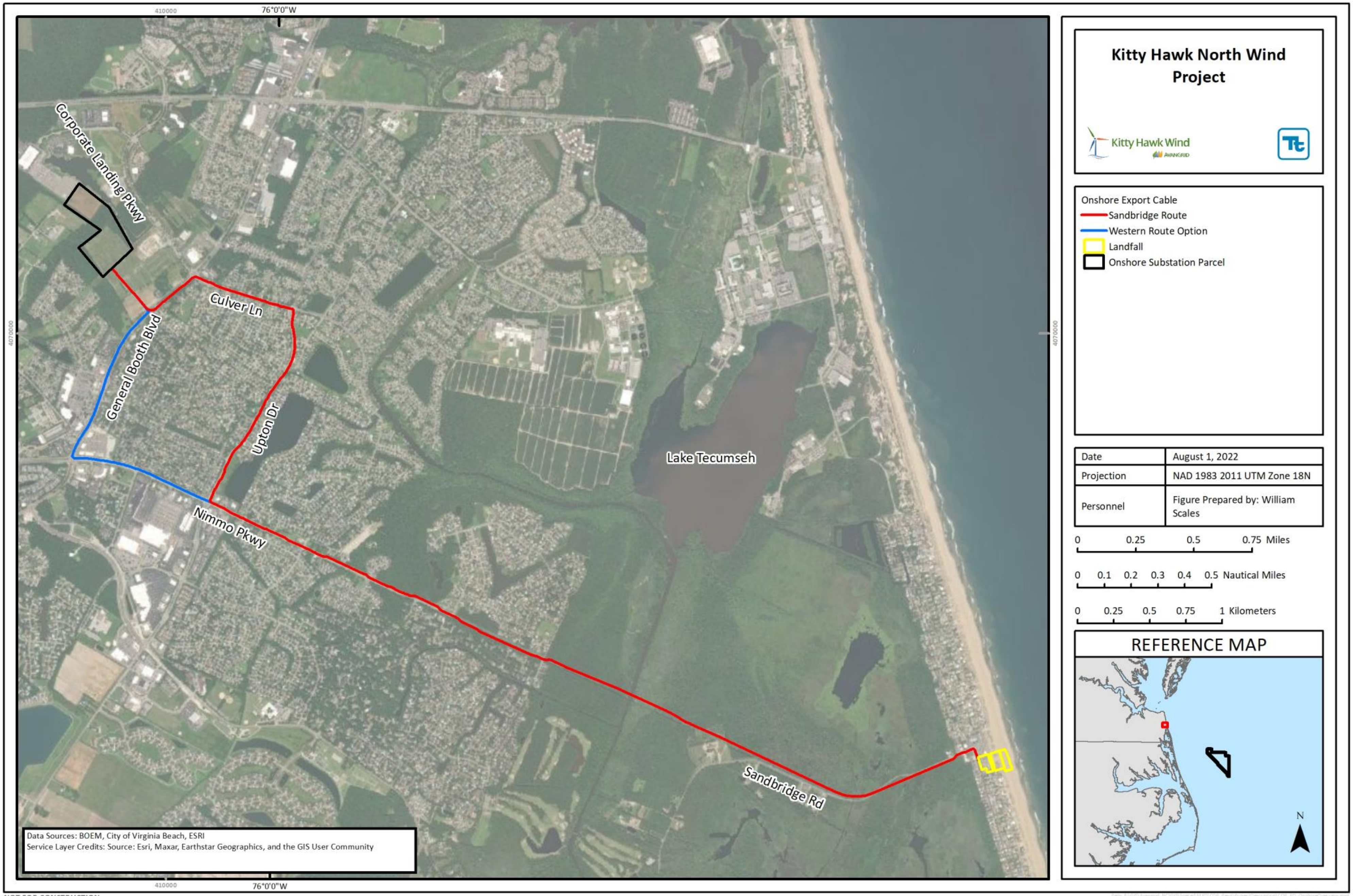


Figure 3.1-2 Onshore Project Overview

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration.

3.2 Project Design and Installation Activities

The following sections describe the proposed Project infrastructure and provide details on design and construction methodologies. Section 3.2 is organized in accordance with the standard construction sequence of an offshore wind facility as outlined in the Project schedule (see Section 1.1.3).

Detailed information about the final technique(s) selected will be included in the Facility Design Report and Fabrication and Installation Report, to be reviewed by the Certified Verification Agent and submitted to the Bureau of Ocean Energy Management (BOEM) prior to construction. Additionally, all construction related activities described below shall adhere to guidance set forth in the Safety Management System (Appendix F) as required by local, state, and federal agencies.

The PDE is informed by the site-specific ground model (see Section 4.1 Physical and Oceanographic Conditions) as well as several studies which are appended to the COP:

- Foundation Structure Concept Screening (Appendix E);
- Sandbridge Export Cable Landfall Conceptual Design Study (Appendix H)
- Preliminary Cable Burial Risk Assessment (Appendix J); and
- Climatic Conditions Report (Appendix L).

3.2.1 Onshore Substation and Switching Station Facilities

3.2.1.1 Design

Energy from the Project will be delivered to the electric grid via a new onshore substation and switching station to be constructed in the City of Virginia Beach, Virginia. The purpose of the new onshore substation is to step down the voltage to support the interconnection of the Project to the existing electrical grid. The purpose of the new switching station is to physically connect and control the connection of the Project to the existing grid infrastructure. The switching station will connect to the existing 230-kilovolt (kV) overhead line. The onshore substation and switching station will contain electrical and control equipment, some of which will be enclosed in buildings or walled structures and will be connected by interconnection lines. The facility will be compliant with City of Virginia Beach building codes, electrical standards, and environmental regulations.

The onshore substation site, which will contain the onshore substation, interconnection lines, and switching station, is located west of the intersection of Corporate Landing Parkway and General Booth Boulevard (see Figure 3.1-2). The proposed site is located within the Corporate Landing Business Park in a parcel owned by the City of Virginia Beach (see Section 7.10 Land Use and Zoning). The area is bordered by a parking lot to the northwest, a stormwater management facility to the north, an overhead high-voltage transmission line and agricultural fields to the south and east, and densely wooded area to the south and west. A single residential property is bordered by the site and is shielded from the onshore substation and switching station by a densely wooded area.

Interconnection lines will be constructed to connect the onshore substation and switching station, which will be up to 240 meters (m) in length and located entirely within the onshore substation site. Interconnection lines will be located overhead on poles up to 42 m in height. Two circuits will be constructed, each consisting of three interconnection lines, with a voltage of 230 kV.

3.2.1.2 Construction

Construction of the onshore substation site will involve site clearing and grading, foundation and equipment installation, and site restoration. The maximum area of land disturbance associated with the construction of the onshore substation site is approximately 13.1 ha; long-term, operations at the onshore substation site will encompass up to approximately 8 ha. The primary structures of both the onshore substation and switching station are assumed to be a maximum of 26 m in height, with thinner lightning protection structures that may extend to 29 m. Penetration depths for foundations may be up to 18 m if deep foundations are required.

Construction of the onshore substation and switching station will generally include the following steps:

- Safety fencing will be installed along the perimeter of the site;
- Erosion controls will be implemented in accordance with the Company's Erosion and Sediment Control Plan, as applicable;
- The site will be prepared, including clearing, filling, excavation, and grading as necessary;
- A stormwater management system will be installed in accordance with the Company's Stormwater Pollution Prevention Plan, as applicable;
- Foundations, sumps, and spread footings will be installed;
- Heavy-load vehicles will be used to deliver and place equipment;
- Cable installation will be completed, including connection of the onshore export cables;
- The onshore substation and switching station will be tested and commissioned; and
- Landscaping will be installed and/or restored as required by applicable regulations.

3.2.2 Transmission Facilities

Project transmission facilities will be comprised of both onshore and offshore components. Energy from the offshore wind facility will be delivered to the existing electric grid onshore via onshore and offshore export cables and onshore substation facilities. Two three-core submarine cables, each with an embedded fiber optic cable, will bring energy from the Wind Development Area to landfall at Sandbridge Beach, Virginia. At the landfall, each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable (for a total of six electrical and two fiber optic cables onshore).

The following sections describe the design and construction of the export cables, including cable landfall. Interconnection lines within the onshore substation site are discussed in Section 3.2.1.1.

3.2.2.1 Onshore Export Cables

The onshore export cables will convey the energy produced by the Project from the landfall at Sandbridge Beach to the onshore substation site, where the energy will be delivered to the grid. The onshore export cables will consist of underground and/or aboveground components.

From landfall, the Sandbridge route and western route option onshore export cable corridors follow the public right-of-way (ROW) for Sandbridge Road west for approximately 1.8 km, then continue straight northwest along an existing 2.3-km utility ROW, crossing Atwoodtown Road and joining Nimmo Parkway. The Sandbridge route option follows Nimmo Parkway for 1.9 km, turns northeast on Upton Drive for 1.5 km, then turns west on Culver Lane for approximately 0.7 km to General Booth Boulevard. The route then heads southwest on General Booth Boulevard for approximately 0.4 km to the onshore substation site. It then turns northwest to cross an empty field to reach the onshore substation site. The western route option follows Nimmo Parkway for 2.9 km, then turns northeast onto General Booth Boulevard, where it continues for 1.2 km and enters the onshore substation site from the southeast (Figure 3.1-2).

The City of Virginia Beach has commenced construction of its VII-A Project, which will straighten and widen the public ROW for Sandbridge Road along a portion of the proposed onshore export cable route. The onshore export cable route to support the Project will be constructed after the City of Virginia Beach VII-A Project is complete.

Preliminary design indicates that the cables will be installed underground where the route borders residential areas and will be located within a public ROW. The cables may be underground the entire route. Alternatively, the onshore export cables may be installed overhead for approximately 3.1 km in the portion of the route between Sandbridge Road, next to the water tower, and Atwoodtown Road. The utility ROW and the ROW along Sandbridge Road may be cleared of trees as necessary to support cable installation, up to 46 m in width. Ashville Bridge Creek will be crossed using trenchless methodology, either aboveground or underground, with a maximum depth of 17 m below ground surface.

The maximum design scenario for the onshore export cables, including cable lengths (combined aboveground and underground) is provided in Table 3.2-1. A cross-section of a typical onshore cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-1 Onshore Export Cable Parameters

Onshore Cable Feature	Maximum Design Scenario
Number of onshore export cables	6
Number of fiber optic cables	2
Voltage	275 kV
Conductor diameter	60 millimeters (mm)
Cable diameter (including cable protection)	131 mm
Total onshore export cable length	8.9 km
Installation corridor width (underground portion)	30 m
Installation corridor width (aboveground portion)	46 m
Onshore export cable installation corridor (area)	31.7 ha

Where the onshore export cables are located underground, duct banks will have a maximum depth of up to 6.3 m to the bottom of excavation. Splice vaults may be required along the onshore export cable route, which would have a maximum depth of up to 7.5 m. If portions of the onshore export cables are installed overhead, approximately 25 new transmission line towers up to 42 m in height, with foundations no larger than 5 m in diameter, would be constructed to support the cables. Final design of the onshore export cables will be informed by technical and engineering requirements, site-specific presence of natural resources, and engagement with federal, state, and local regulatory authorities.

3.2.2.2 Cable Landfall

The offshore export cables will make landfall within a parking lot along Sandbridge Beach, just south of Sandbridge Road and Sandbridge Seaside Market. The ocean to land transition at the landfall will be installed 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. A basis of design for the landfall has determined that either a long HDD to the -10 m Mean Lower Low Water line or a shorter HDD to the -8 m Mean Lower Low Water line is suitable. The parking lot south of Sandbridge Road near Sandbridge Beach will also serve as the temporary construction staging and operations area.

The transition from the onshore export cables to offshore export cables will occur within an underground transition joint bay located directly adjacent to the HDD. After the transition joint bay, the cables will be split into phases and enter the underground duct bank (i.e., an array of plastic conduits encased in concrete).

A diagram of typical HDD design is provided in Appendix G Conceptual Project Design Drawings. HDD operations for the export cable landfall will originate from the onshore landfall site. A rig will drill a borehole underneath the surface for each of the circuits. Each HDD will be approximately 660 to 910 m long, exiting 506 to 724 m offshore (Appendix H Sandbridge Export Cable Landfall Conceptual Design Study). A typical HDD would be conducted to approximately 18 m target depth. Once the drill exits onto the seafloor, the export cable duct will be floated out to sea and then pulled back onshore within the drilled borehole, followed by the offshore export cables. Each of the two offshore export cables will be jointed to three onshore export cables and one fiber optic cable. Transition joint bays at cable landfall will have a maximum excavation depth of up to 8.8 m.

Following construction, flush-mounted access covers at each transition joint bay onshore will remain at ground level for access, if required. Access to transition joint bays will be restricted to approved personnel. Land surrounding the onshore export cables will be restored to pre-construction conditions. Parking within the lots would be allowed over the top of the underground structures, as the structures will be designed to support the required load rating of the parking facility.

3.2.2.3 Offshore Export Cables

The offshore export cables will transfer energy from the ESP to the landfall at Sandbridge Beach in the City of Virginia Beach, Virginia. The export cable corridor will consist of up to two distinct buried cables, each containing a three-core 275-kV high-voltage alternating-current cable and one fiber optic cable. A cross-section of a typical submarine cable is provided in Appendix G Conceptual Project Design Drawings. The maximum design scenario for the offshore export cables is provided in Table 3.2-2.

Table 3.2-2 Offshore Export Cable Parameters

Export Cable Feature	Maximum Design Scenario
Number of cables (circuits)	2
Voltage per circuit	275 kV
Conductor diameter	51 mm
Cable diameter (including cable protection)	286 mm
Minimum separation distance between circuits	50 m a/
Total corridor length	80 km
Width of installation corridor	810 m
Requested operational ROW per circuit	61 m

Note:
a/ Separation distance between cables is based on site-specific conditions (e.g., water depth and seabed constraints). Circuits will be separated by a minimum of 50 m or four times the water depth, whichever is greater.

A Preliminary Cable Burial Risk Assessment (Appendix J) has been conducted to identify the target burial depth for the export cables within the offshore export cable corridor. Based on the findings of the Preliminary Cable Burial Risk Assessment, the offshore export cables will be buried to a target depth of approximately 1.5 to 2.5 m below stable seabed to minimize the risk of cable exposure or damage.[2] Depending on seabed conditions (e.g., clearance of potentially mobile seabed features, boulder removal) actual burial depth may vary. Cable installation typically includes a pre-installation survey, followed by clearing the cable route and a pre-lay grapnel run. Along the route, boulders may need to be relocated and some dredging of the upper portions of potentially mobile seabed features may be required prior to cable laying to achieve a sufficient burial depth below the stable seabed. Additionally, there is the possibility that unexploded ordnance would need to be disposed of, including potential detonation. However, there is uncertainty concerning both the actual potential for unexploded ordnance detonation and the variation in potential impacts depending on the size and type of ordnance. Additional information will be provided as available. The cables will be installed using one of the techniques described below.

[2] Stable seabed is the minimum seabed level over the lifetime of the Project, identified by assessing the rate of movement of mobile sediment.

The offshore export cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation (scope of installation contractor) to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

The Company has completed preliminary surveys of the export cable corridor. The Company recommends the following as the primary installation methodologies, based on the current understanding of site conditions between landfall in City of Virginia Beach, Virginia and the Lease Area:

- **Jet plowing or trenching**: A jet plow, pulled on a tractor or sled behind a vessel, or a remote-operated jet trencher uses water jets to discharge pressurized seawater, creating a trench in the seabed into which the cable is immediately laid. The displaced sediment then resettles, naturally backfilling the narrow trench.
- **Mechanical plowing**: A mechanical plow is dragged along the seabed and uses one or more cutting edges to push through the seabed, creating a trench into which the cable is immediately laid. The narrow trench is backfilled behind the tool, either by natural hydrodynamic movement or through mechanical replacement.
- **Free-lay and post-lay burial**: The cable is laid directly onto the seabed from the cable lay vessel. A second trenching vessel then launches a burial tool over the cable and conducts the post lay burial operations. In soft sediments, the burial will be conducted by jetting, in harder soils, mechanical chain cutting will be used.

Impacts from cable installation will include an up to 1-m-wide cable installation trench and an up to 8-m-wide temporary disturbance zone from the skids or tracks of the cable installation equipment, which will slide over the surface of the seafloor. Two separate trenches will be used to install the two export cables within the corridor. A joint may be required for each offshore export cable to support installation. Data from geophysical survey campaigns has confirmed that no known cables or other submarine assets will be crossed by the offshore export cables.

If minimum target burial depths cannot be achieved, additional cable protection may be required. Cable protection options under consideration include rock armor, gabion rock bags, concrete mattresses, and protective half-shells. While the Company intends to avoid or minimize the need for cable protection to the greatest extent possible, it is conservatively estimated that up to 8 percent of the offshore export cable route will require additional cable protection. The location of the offshore export cables and associated cable protection will be provided to the National Oceanic and Atmospheric Administration's (NOAA) Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Disturbances resulting from the maximum design scenario of the offshore installation corridor are presented in Table 3.2-3. The target burial depth and external cable protection, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and stakeholder engagement.

Table 3.2-3 Offshore Installation Corridor Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	6,480 ha	n/a
Support vessel anchoring	0.70 ha	n/a
Additional cable protection b/	n/a	3.84 ha

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Maximum Total Seabed Disturbance:	**6,480 ha**	**3.84 ha**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	438,256 cubic meters (m^3)	n/a
Maximum Total Volume of Dredged Material:	**438,256 m^3**	**n/a**

Notes:
a/ Assumes 810-m-wide corridor to allow for optimal routing of the cables.
b/ Assumes 8 percent of each offshore export cable will require additional cable protection as a maximum design scenario.
c/ Includes dredging for both offshore export cables. Assumes dredging will be required along selected locations of up to approximately 17.3 km of each export cable, based on preliminary seabed elevation data and non-mobile reference seabed level derived from surveyed bathymetry and identified potentially mobile bedforms. Dredge calculations will be refined as new surve y data is acquired and analyzed. Dredged material is anticipated to be side-cast. The Company is also evaluating the beneficial re-use of dredged material and will work with the appropriate stakeholders to determine if re-use is a feasible and practical solution for disposal of the material. Potentially mobile seabed features are expected to reform due to natural water movement.

3.2.3 WTG and ESP Foundations

At this time, three foundation types are being considered by the Company to support the WTGs and the ESP: monopile, 3- or 4-legged piled jacket, and 4-legged jacket on suction caisson. A maximum of three suction caisson jacket foundations may be installed. Maximum sizes for each foundation type are included in the PDE.

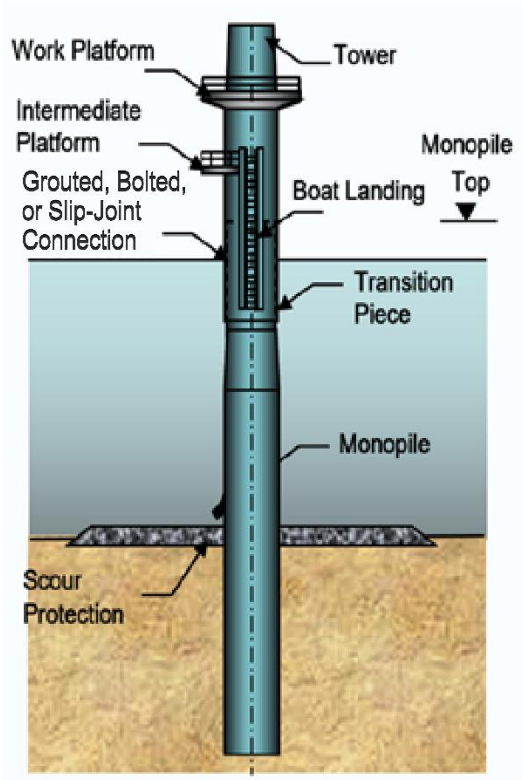
The selection of foundation types for the PDE is informed by a foundation structure concept screening study performed by Wood Thilsted. Preliminary site-specific survey data was evaluated in the study, and additional geophysical and geotechnical investigations will further inform the Company's evaluation of foundation types that are suitable for the Wind Development Area. In addition to geotechnical conditions, the study evaluated water depth range, metocean criteria, logistics (i.e., transportation and installation constraints), licensing and permitting, and turbine loading and operating frequency windows. See Appendix E Foundation Structure Concept Screening. Additionally, a pile drivability assessment was completed to identify the appropriate hammer(s), determine number of strikes, and review sediment data and ground conditions in the Wind Development Area to reach the desired penetration depth.

3.2.3.1 *Design*

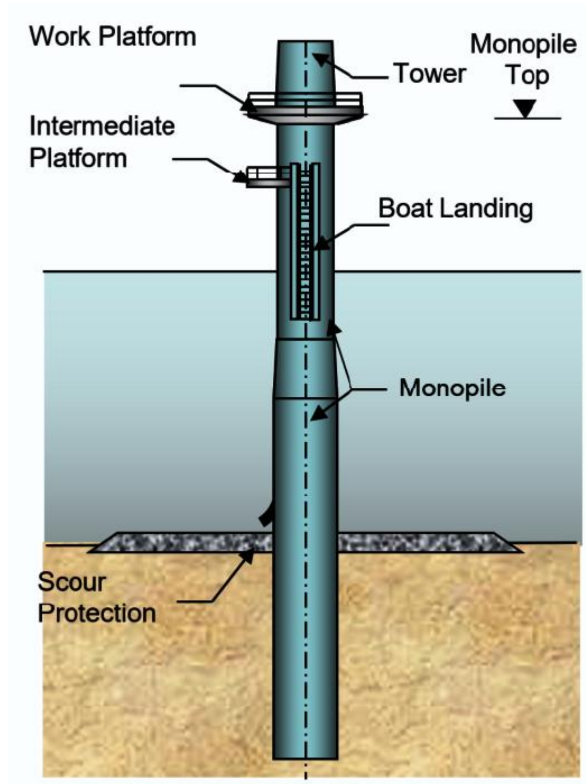
The foundation types included within the PDE are:

- **Monopile**: a single, vertical, broadly cylindrical steel pile driven into the seabed.
- **Piled Jacket**: a vertical steel lattice structure consisting of three or four legs, from which piles are inserted, connected through cross bracing.
- **Suction Caisson Jacket**: a vertical steel lattice structure consisting of three or four legs, which contain inverted bucket-like structures at the base, embedded in the seabed sediment by suction force, connected through cross bracing.

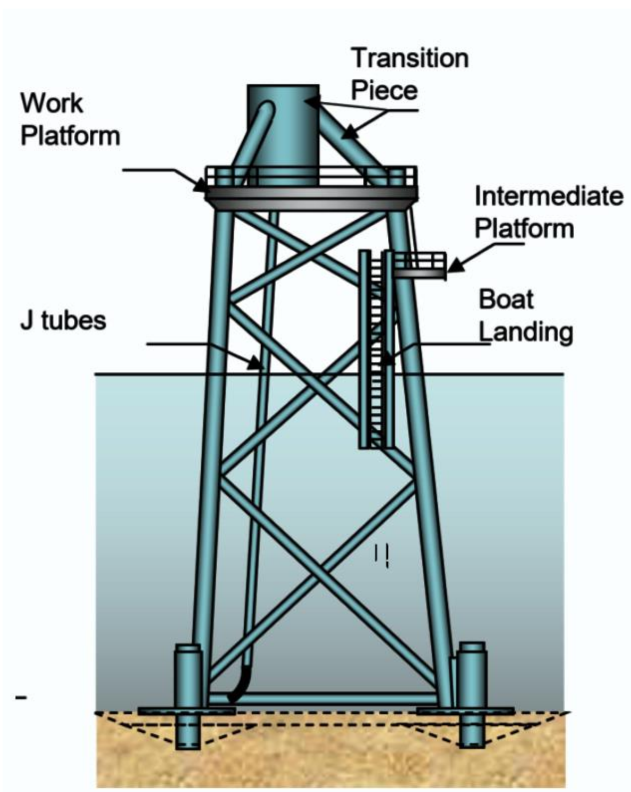
An illustration of the foundation types included in the WTG and ESP foundation PDE is presented in Figure 3.2-1 and a summary of PDE parameters is included in Table 3.2-4.



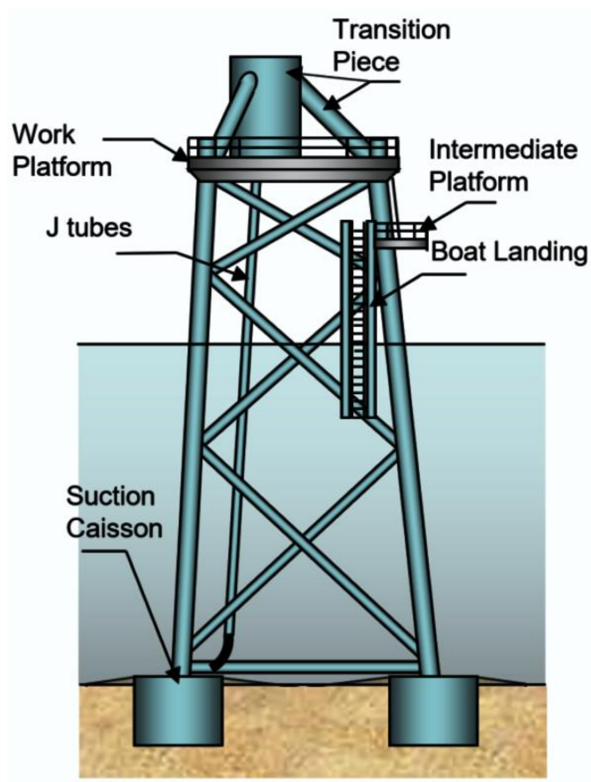
Monopile with transition piece



Monopile without transition piece



Piled jacket



Suction caisson jacket

Figure 3.2-1 WTG and ESP Foundation Types

1 **Table 3.2-4 Summary of WTG and ESP Foundation Parameters**

Foundation Parameter	Maximum
Monopile	
Base diameter	13.5 m
Seabed penetration	55 m
Seabed footprint (without scour protection) a/	143 m^2
Seabed footprint (with scour protection) b/	3,188 m^2
Diameter at highest astronomical tide (HAT)	12 m
Piled Jacket (3 legs)	
Number of piles	6
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	76 m^2
Seabed footprint (with scour protection) b/	1,698 m^2
Leg spacing at HAT	35 m x 35 m
Piled Jacket (4 legs)	
Number of piles	8
Leg spacing at seabed	40 m x 40 m
Pile diameter	4 m
Seabed penetration	95 m
Seabed footprint (without scour protection) a/	101 m^2
Seabed footprint (with scour protection) b/	2,813 m^2
Leg spacing at HAT	35 m x 35 m
Suction Caisson Jacket (4 legs)	
Leg spacing at seabed	40 m x 40 m
Bucket diameter	17.5 m
Seabed penetration	18 m
Seabed footprint (without scour protection) a/	963 m^2
Seabed footprint (with scour protection) b/	3,848 m^2
Leg spacing at HAT	35 m x 35 m
Notes: a/ Per foundation b/ Per foundation if scour protection is required	

The maximum long-term seabed footprint presented in the PDE is represented by 67 monopile foundations and three suction caisson jacket foundations with maximum scour protection, representing a total of 69 WTGs and one ESP, covering an overall area of 225,140 square meters (m^2).

3.2.3.2 Construction

As discussed previously in Section 3.2.3.1, the Company is currently considering three foundation types. For each parameter identified in Table 3.2-5 below, the relevant foundation option which represents the maximum disturbance has been identified in bold.

The details related to the construction of each foundation type are described in the following sections. Geophysical and geotechnical surveys will be conducted to identify site-specific seabed conditions, debris, and potential unexploded ordnance. Seabed debris and unexploded ordnance will be cleared as necessary, in accordance with industry guidelines and best management practices.

Monopile

The installation vessel positions itself at the foundation location, and the steel pile is upended, lifted into a vertical position, and lowered onto the seabed through a pile gripper, which is used to provide stability and guide the monopile while it is hammered to the required depth. A crane-mounted hydraulic impact hammer is driven onto the top of the pile, driving it into the ground. If the pile meets refusal before reaching the full penetration depth, drilling of sediment may be required to reduce resistance. The transition piece, if used, is then fitted onto the pile for the eventual attachment of the WTG or ESP. The transition piece may be secured in place by a bolted, grouted, or slip joint connection (i.e., a conical connection between the monopile and transition piece held in place by gravity without bolts or grout), or combination of these methods.

Piled Jacket

The installation vessel positions itself at the foundation location, and the jacket structure is lifted into a vertical position and lowered onto the seabed. The support piles are then placed in the jacket structure and driven into the seabed using the same method described above for monopiles. Once the piles are in place, the jacket structure is secured to the piles. In certain seabed formations, a template may be used to drive the piles first, prior to lifting the jacket into its engineered position, lowering it to the seabed, and securing it to the piles.

Suction Caisson Jacket

The installation vessel positions itself at the foundation location. The suction caissons are fitted with pumps and control units, and then the jacket structure is lowered onto the seabed. The water contained within the caisson is pumped out, creating a suction force. This negative pressure causes the caisson to bury itself securely into the seabed. Water jets within the caisson may be used to assist in penetrating the sediments and to help control the installation process. A layer of grout may be added to the top of the caisson, if necessary, to provide a uniform bearing surface with the top of the seabed.

Table 3.2-5 WTG and ESP Foundation Installation Maximum Design Scenarios

Parameter	Relevant Foundation Option	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance			
Maximum seabed footprint per foundation	Monopile or suction caisson jacket	1,200 m^2 a/	3,848 m^2 b/
Maximum WTG array total area of seabed disturbance	**3 suction caisson jackets and 67 monopiles**	**84,000 m^2**	**225,140 m^2**
Volume of Dredged Material			
Material dredged for seabed preparation per foundation c/	4-legged suction caisson jacket	n/a	7,327 m^3
Maximum WTG array total volume of dredge material	**3 suction caisson jackets and 67 4-legged piled jackets**	**n/a**	**442,942 m^3**
Volume of Fill			
Seabed preparation grout per foundation	3-legged piled jacket	n/a	2,013 m^3
Scour/rock protection per foundation	Monopile	n/a	6,090 m^3
Maximum WTG array total volume of grout and scour protection	**3-legged piled jacket**	**n/a**	**567,210 m^3**
Pile Driving			
Maximum impact hammer energy	Monopile	5,500 kilojoules	n/a
Average piling duration per foundation d/	Monopile	3 hours	n/a

Notes:

a/ Area is inclusive of the seabed clearance and installation vessel jacking and/or anchoring performed by jack-up vessels with up to six legs and/or anchored installation barges with a maximum 8-point anchor spread.

b/ Area is inclusive of the footprint of the foundation structure and scour/rock protection.

c/ Dredged material may be covered by structures such as scour protection and is therefore not expected to return to its original location.

d/ Up to two monopiles or up to four pin piles will be installed per day.

Scour Protection for Foundations

Final engineering design may indicate that scour protection is necessary for the selected foundation type. Scour protection is designed to prevent foundation structures from being undermined by hydrodynamic and sedimentary processes, resulting in seabed erosion and subsequent scour hole formation. The shape of the foundation structure is an important parameter influencing the potential depth of scour hole formation.

Scour around foundations is typically mitigated by the use of scour protection measures. Scour protection may be installed prior to or directly following the installation of the foundations. Several types of scour protection exist, including rock armor, rock bags, grout bags, and concrete mattresses.

The amount of scour protection required will vary for the different foundation types being considered and based on the local site conditions. Flexibility in scour protection choice is required to anticipate changes in available technology, accommodate Project economics within the PDE, and provide the most appropriate engineering solution. The final choice and detailed design of a scour protection solution for the Project will be made after detailed design of the foundation structure is completed, taking into account a range of aspects including geotechnical data, metocean data, water depth, foundation type, maintenance strategy, agency coordination, stakeholder concerns, and cost.

The maximum anticipated area of scour protection per foundation type is provided in Table 3.2-4, and the maximum amount of material assumed for the purpose of the COP and associated environmental assessments is provided in Table 3.2-5.

3.2.4 Electrical Service Platform

3.2.4.1 *Design*

An ESP is an offshore platform containing the electrical components necessary to collect the energy generated by the WTGs (via the inter-array cable system) and step up the voltage for transmission to the Project's onshore substation via the export cable. The purpose of the ESP is to overcome any net effects of the offshore equipment and cables prior to transmitting energy to shore.

To support the Project's maximum design capacity, the Project will require the installation of one ESP. The high-voltage equipment on the ESP is expected to be rated between 66 and 275 kV. The ESP will house equipment for high-voltage transmission, including switchgears, transformers, reactors, and control and monitoring equipment. The ESP will be unmanned during normal operations, but will include facilities and equipment for maintenance personnel and emergency sheltering situations. The maximum design parameters for the ESP are listed in Table 3.2-6. The ESP will require various oils, fuels, and lubricants to support its operations, as shown below in Table 3.2-12. The ESP will be lit and marked in accordance with United States Coast Guard (USCG) requirements for navigation obstruction lighting, as described in Section 3.3.2.

Table 3.2-6 Electrical Service Platform Parameters

Parameter	Maximum Design
Number of platforms	1
Topside height above HAT	50 m
Topside length	80 m
Topside width	50 m

3.2.4.2 *Construction*

Once the foundation for the ESP is installed as described in Section 3.3.3, the topside is delivered to the location pre-assembled. The topside is lifted onto the foundation using a heavy lift vessel and secured to the foundation or transition piece.

3.2.5 Inter-Array Cables

3.2.5.1 *Design*

The inter-array cables will carry the energy produced by the WTGs to the ESP. The inter-array cable system will be comprised of a series of cable "strings" that interconnect a grouping of WTGs to the ESP. The maximum design parameters for the inter-array cables are listed in Table 3.2-7. A cross-section of a typical inter-array cable is provided in Appendix G Conceptual Project Design Drawings.

Table 3.2-7 Inter-Array Cable Parameters

Parameter	Maximum Design
Number of cores	3
Voltage per core	66 kV or 132 kV
Total length	240 km
Conductor diameter	34 mm
Cable diameter (including cable protection)	154 mm
Target burial depth	1.5 m – 2.5 m
Installation corridor width	100 m

3.2.5.2 Construction

The inter-array cables will be installed within a 100-m-wide corridor and, depending on seabed conditions, buried to a target depth of 1.5 to 2.5 m below stable seabed. Cable installation techniques for inter-array cables include jet trenching, mechanical trenching, and free-lay and post-lay burial. With the exception of mechanical trenching, these techniques are described in Section 3.2.2. A mechanical trencher uses the same burial mechanism as the mechanical plow described in Section 3.2.2 but is remote-operated rather than towed. The location of the inter-array cables and associated cable protection will be provided to the NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

Based on the identified range of cable installation methods and requirements, the Company has established a maximum design envelope for the inter-array cables that reflects the maximum seabed disturbance associated with construction and operations of the inter-array cables. Temporary seabed disturbance during inter-array cable installation includes an area up to 2,400 ha.

The final installation methods and target burial depths will be determined by the final engineering design process, informed by detailed geotechnical data, discussion with the chosen installation contractor, and coordination with regulatory agencies and stakeholders. The Company conservatively estimates that up to 8 percent of the total length of the inter-array cables may require cable protection.

Disturbances resulting from the maximum design scenario of the inter-array cables are presented in Table 3.2-8. The target burial depth and external cable protection for the inter-array cables, as well as the resulting impacts, will be further refined as Project design progresses, based on additional survey data and feedback from stakeholder engagement.

The inter-array cables typically have no maintenance requirements unless a fault or failure occurs. Cable failures are mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate integrity of the cables, the Company intends to conduct a bathymetry survey (or similar) along the cable routes immediately following installation to confirm cable burial depth. The Company may conduct up to two further maintenance surveys subject to the findings of the post-installation survey.

Table 3.2-8 Inter-Array Cable Maximum Design Scenario

Parameter	Maximum Design Scenario – Temporary Impacts	Maximum Design Scenario – Long-Term Impacts
Area of Disturbance – Cable		
Cable lay installation corridor a/	2,400 ha	n/a
Additional cable protection b/	n/a	5.7 ha
Maximum Total Seabed Disturbance:	**2,400 ha**	**5.7 ha**
Volume of Dredged Material		
Dredged material from potentially mobile seabed features c/	151,821 m^3 – 242,913 m^3	n/a
Maximum Total Volume of Dredged Material:	**151,821 m^3 – 242,913 m^3**	**n/a**

Notes:
a/ Assumes 100-m-wide corridor
b/ Assumes 8 percent of inter-array cabling will require additional cable protection as a maximum design scenario.
c/ Assumes dredging will be required along approximately 5 to 8 percent of the inter-array cables. Dredge calculations will be refined as new survey data is acquired and analyzed. Dredged material is anticipated to be side-cast.

3.2.6 WTGs

3.2.6.1 *Design*

While a range of WTG models from various suppliers may be considered to allow for flexibility within the PDE, all WTGs for the Project are expected to follow the traditional offshore WTG design with three blades and a horizontal rotor axis. Specifically, the blades will be connected to a central hub, forming a rotor which turns a shaft-connected gearbox (if required) and generator. The generator and gearbox will be located within a containing structure known as the nacelle, situated adjacent to the rotor hub. The nacelle will be supported by a tower structure affixed to the foundation. The nacelle will be able to rotate or "yaw" on the vertical axis in order to face the oncoming wind.

In support of the development of the Project, the Company is evaluating a range of WTG sizes. For the purpose of the assessments presented within this COP, the WTG design envelope has been defined by maximum parameters that are representative of the WTGs currently on the market or expected to become available in time to be used for the Project, based on ongoing discussions with suppliers.

Figure 3.2-2 shows a conceptual rendering of the WTGs with the maximum representative dimensions summarized in Table 3.2-9. Each of the WTGs will require various oils, fuels, and lubricants to support the operations of the WTGs, as shown in Table 3.2-12.

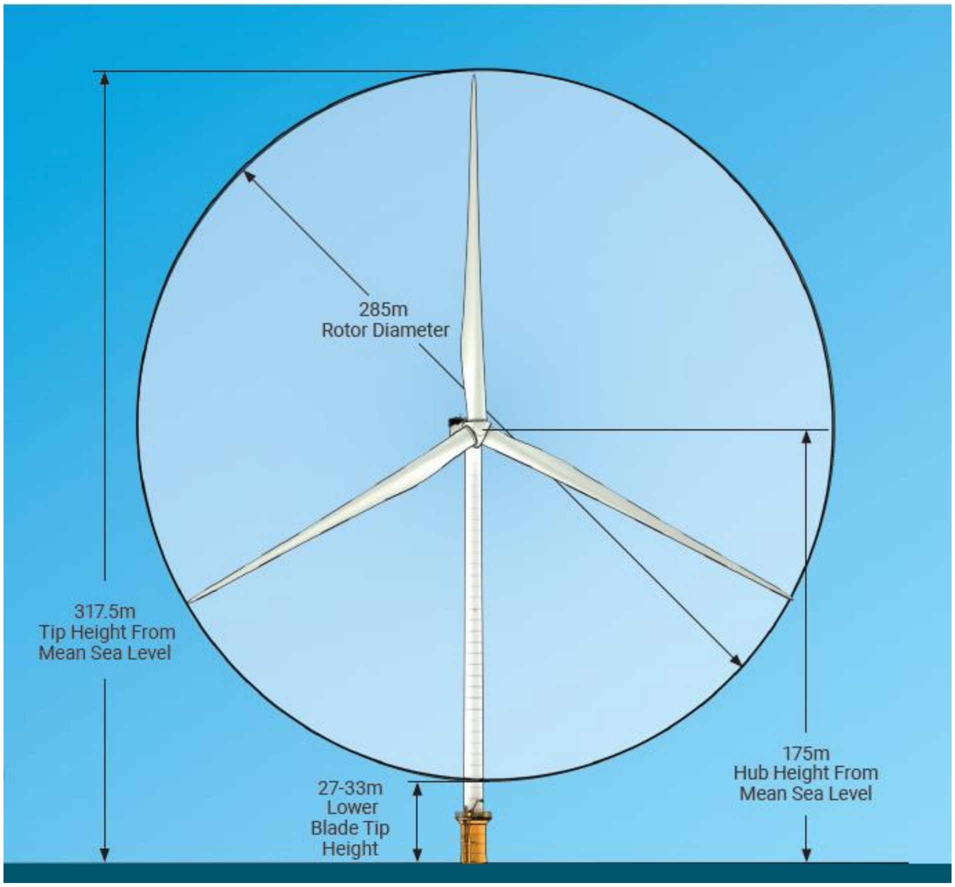


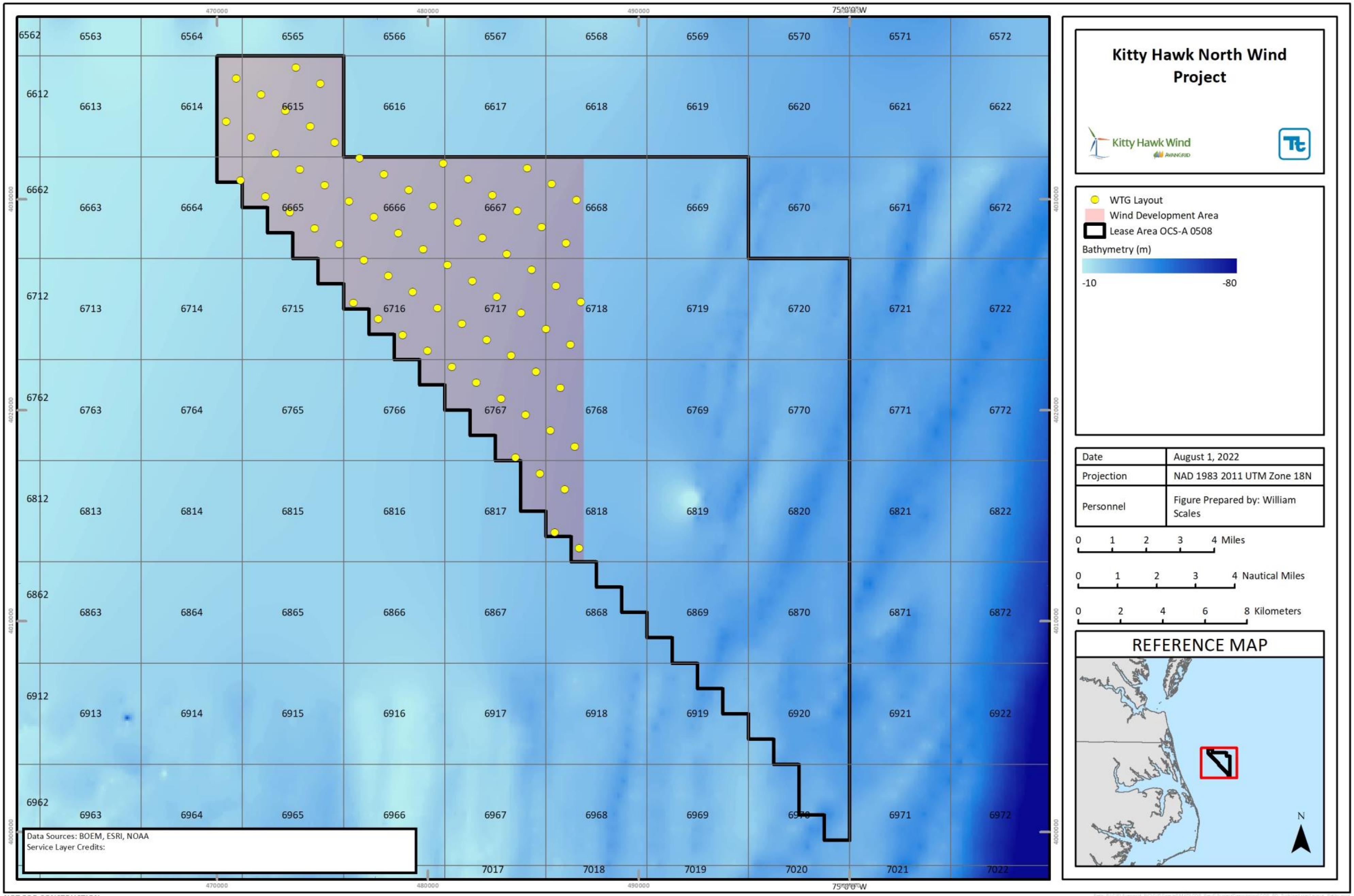
Figure 3.2-2 Conceptual Rendering of Maximum WTG Dimensions

Table 3.2-9 Summary of WTG PDE Parameters

Parameter	Maximum Representative WTG
Total number of WTGs	69
Foundation locations, including ESP	70
Hub height above mean sea level	175 m
Upper blade tip above mean sea level	317.5 m
Lower blade tip above HAT	27–33 m
Rotor diameter	285 m

WTG Layout

A WTG layout is shown in Figure 3.2-3, which includes 69 WTGs and one ESP. The layout (array) is arranged in a grid to allow traversal of the Wind Development Area by commercial, recreational, military, and emergency vessels and helicopters. The WTGs will be lit and marked in accordance with Federal Aviation Administration and USCG requirements for aviation and navigation obstruction lighting, as described Section 3.3.2.



NOT FOR CONSTRUCTION

Figure 3.2-3 WTG Layout

The closest WTGs will be spaced approximately 1.4 km apart, with rows about 2.2 km wide. The location of the WTGs and ESP will be provided to NOAA's Office of Coast Survey after installation is completed for the purposes of inclusion on nautical charts.

3.2.6.2 Construction

After the foundations have been installed as described in Section 3.2.3 (including the potential fitting of a transition piece in the case of monopile foundations), the WTGs will be transported to the Wind Development Area, either pre-assembled or in sections. If pre-assembled, a heavy-lift vessel will lift the WTG onto the foundation and secure it in place. If transported in sections, the tower will be secured first to the foundation, then the nacelle will be placed on top of the tower and secured, then each blade will be attached to the nacelle. Once installation is completed, the WTG will be connected to the inter-array cables and follow a process of testing and commissioning prior to becoming operational.

During WTG installation, if jack-up vessels are required, the heavy-lift vessel may temporarily disturb up to 0.1 ha of seafloor near the foundation. The majority, if not all of this disturbance, will be located in areas previously disturbed during foundation installation.

3.2.7 Summary of Construction Vessels and Helicopters

Construction of the Project will require the support of numerous vessels and helicopters (see Table 3.2-10). The Project will utilize various ports in the Lower Chesapeake Bay area (Hampton Roads, Elizabeth River, Cape Charles, and Cape Henry) for staging of Project components and construction vessels.

3.2.8 Oils, Fuels, and Project-Related Waste

Construction and operations of the Project will generate both solid and liquid wastes. Solid waste will primarily consist of packaging and protective wrappings from Project materials and equipment, as well as short lengths of cable trimmings. Liquid waste will primarily consist of oils, fuels and water from construction and O&M vessels. Project-related wastes will be disposed of in accordance with applicable regulations and will be reused or recycled to the extent practicable. In accordance with 30 Code of Federal Regulations (CFR) § 585.626(b)(9), the Company has provided a list of potential wastes expected to be generated during construction and O&M of the Project (see Table 3.2-11).

The Company will minimize the release of marine debris into review area waters by requiring all offshore personnel and vessel contractors to implement appropriate debris control practices and protocols. The Company will comply with Lease Condition 5.1.4 in regard to marine trash and debris prevention, including the required portions of Bureau of Safety and Environmental Enforcement Notice to Lessees and Operators No. 2015-G03. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness and elimination, the environmental and socioeconomic impacts associated with marine trash and debris, and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. All Project-related vessels will operate in accordance with regulations pertaining to at-sea discharges of vessel-generated waste.

Table 3.2-10 Preliminary Summary of Offshore Vessels for Construction

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Foundation Installation														
Heavy lift vessel	A vessel with a crane for foundation installation	WTG and ESP foundation installation and grouting	2	2	50	139	16,000 t	14,000 t	10	12	Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
Scour protection vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour protection transportation and installation	1	8	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1500 t	IMO compliant	50-60
Tug	Small vessel that pulls a barge	Barge support	4	140	12	45	161 t	1,000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	Foundation transport	Foundation transport	4	140	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7 T tank	12-14
Noise mitigation vessel	Vessel that installs noise mitigation for pile driving	Noise mitigation/DP2 support/supply	1	12	11	46	3,000 t	4,000 t	10	13	Propellers/thrusters	700 t	IMO compliant	5-12
Crew transfer vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	104	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	24-28
Safety vessel/MMO vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	24	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
WTG Installation														
Heavy lift vessel	A vessel with a crane for foundation installation	WTG installation	1	1	50	139	16,000 t	14,000 t	10	12	Azimuths thrusters	LNG Dual Fuel – unknown capacity	IMO compliant	130-140
WTG supply vessel	Nacelle, tower, and blade transport	Heavy transport	1	24	42	173	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20-25
Tug	Small vessel that pulls a barge	Barge support	2	70	12	45	161 t	1000 t	10	14	Propellers/thrusters	8 t	N/A	4-6
Barge	WTG transport	WTG transport	2	70	31.5	124	8,762 t	17,500 t	8-10	8-10	Tug assist	50 t	7.7T tank	12-14
Electrical Service Platform Installation														
Heavy transport vessel	Heavy cargo or semi-submersible	ESP transport	1	1	42	173	12,000-50,000 t	10,000-62,000 t	12-18	12-18	Propellers/thrusters	2,500 t	IMO compliant	20-25
Heavy lift vessel	Floating crane or semi-submersible	ESP installation	1	1	47	183	50,000 t approx.	unknown	10.5	12.5	6 Azimuth, DP 3	4,350 t	IMO compliant	180-210
Inter-Array Cable Installation														
Floating cable lay vessel (offshore)	DP2 vessel that transports and lays cable	Inter-array cable installation	1	6	31	150	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,300 t	IMO compliant	120-140
Floating support vessel	Supply/ anchor handling support/ guard	Inter-array cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	25-70
Floating survey vessel	Multi-role survey or support vessel	Pre-installation surveys	1	8	7	35	600 t	400-1,000 t	10	15	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	22
Pre-lay grapnel run vessel	Tows a grapnel train to clear debris	Cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	110 t	IMO compliant	5-25

Vessel Type	Description	Role	# of Vessels	Approx. Total # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Safety vessel/MMO vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Offshore Export Cable Installation														
Floating cable lay vessel (offshore)	DP2 vessel that transports and lays cable	Export cable installation	1	6	30	140	16,171 t	12,700 t	12	14	DE,DC Grid, Stern Azimuths	1,350 t	IMO compliant	100+
Floating cable lay vessel (nearshore)	DP2 or anchored vessel that transports and lays cable	Export cable installation	1	6	33.5	122	7,500 t	12,000 t	12	14	DE,DC Grid, Stern Azimuths	1,200 t	IMO compliant	100+
Floating support vessel	Supply/ anchor handling support/ guard	Export cable installation support	1	6	17	74	75-1,800 t	50-2,200 t	10-14	10-14	Propellers/thrusters	150 t	IMO compliant	5-20
Floating survey vessel	Multi-role survey or support vessel	Pre-installation surveys	1	6	7	35	400-600 t	500-800 t	10-12	12-14	Propellers/thrusters. Smaller support with jet propulsion	70 t	IMO compliant	12-24
Pre-lay grapnel run vessel	Tows a grapnel train to clear debris	Export cable route clearance	1	1	11	46	700-4,000 t	2,000-2,500 t	10	15	Propellers/thrusters	120 t	IMO compliant	5-25
Safety vessel/MMO vessel	Safety/PSO monitoring	Safety/PSO monitoring	2	12	4	12	25 t	n/a	10	10-12	Propellers	2 t	IMO compliant	2-14
Commissioning														
Service operations/ Floatel	Field Service and crew accommodation	Accommodation vessel	2	12	18	93	6,100 t	2,250 t	10	13	Blade propellers	792 t	IMO compliant	80-90
Crew transfer vessel	Brings crew to installation site from SOV	Installation support and crew transport	2	52	7	35	360 t	18.5 t	12	22	Jet propulsion	30 t	IMO compliant	20-30
Helicopters														
Helicopter	Emergency crew transfers	Emergency only	1	none	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Total trips. Refers to the number of trips performed during the entire construction phase. Number includes all vessels of the type listed (e.g., 4 tugs making 29 trips each equals 116 total trips).
CTV: Crew transfer vessel
DP2: Dynamic positioning, IMO class 2 vessel
IMO: International Maritime Organization
LNG: Liquefied natural gas
MMO: marine mammal observation
PSO: protected species observer
SOV: Service operation vessel
t: metric ton
L: liter

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Table 3.2-11 Wastes Expected to be Generated During Project Construction and Operations

Types of Waste and Composition	Approximate Total Amount Discharged	Maximum Discharge Rate a/	Means of Storage or Discharge Method
Domestic water	0.1 m^3 per person per day	n/a	Tanks or discharged overboard after treatment
Uncontaminated bilge water	Subject to vessel type	Subject to vessel size and equipment	Tanks or discharged overboard after treatment
Uncontaminated ballast water	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard or retained onboard as part of ballast management plan
Uncontaminated fresh or seawater used for vessel air conditioning	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard
Deck drainage and sumps	Subject to vessel type	Subject to vessel size and equipment	Discharged overboard after treatment
Sewage from vessel	0.1 m^3 per person per day	n/a	Tanks or sewage treatment plant
Food waste	0.3 kilograms per person per day	Dependent on location	Discharged overboard if applicable or onshore landfill
Solid trash or debris from vessel operations	0.05 m^3 per person per day	As generated	Onshore landfill or incineration
Chemicals, solvents, oils, and greases	Subject to vessel type	Subject to vessel size and equipment	Onshore landfill or incineration
Drilling cuttings, mud, or borehole treatment chemicals, if used	Dependent on HDD type selected	n/a	n/a
Oily residue	1% of daily fuel consumption	n/a	n/a

Note:
a/ Final discharge volumes and rates will be provided in the Fabrication and Installation Report following selection of both the supplier and equipment type and/or final design and location. Wastes will be managed in accordance with applicable regulations.

As planning and design proceeds, a detailed chemical and waste management plan will be developed and provided to BOEM (see Appendix I Oil Spill Response Plan). This plan will describe how each waste stream will be handled and stored, together with plans for proper disposal, recovery, recycling, or reuse.

Examples of oils, fuels, greases, and other chemicals used by the Project during construction and operations are detailed in Table 3.2-12. These will be included in the WTGs and ESP at the time of construction. During O&M, these will be replenished by transfer vessels as necessary. The spill containment strategy for each chemical is comprised of preventive, detective, and containment measures (see Appendix I Oil Spill Response Plan).

1 **Table 3.2-12 Preliminary Summary of Oils, Fuels, and Greases for Construction and Operations**

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Transformer oil (WTG and ESP)	Bio-degradable oil or highly refined mineral oil	Main 220/66 or 220/132 kV Transformers, 220 kV shunt reactors, 66 or 132 kV aux. transformers & 66 or 132 kV grounding reactor	6,000 L per WTG 466,400 L on ESP	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Lubrication oil (ESP)	Lubricant oil	Crane Emergency generator	Crane: To be defined during detailed design Emergency generator: 55 L	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
General oil (WTG and ESP)	Different kinds of oil	WTGs: Hydraulics, gear box, yaw gears, transformers, etc. Might also be used for passive damper located in tower ESP: Hydraulic oil for crane	8,000 L per WTG 3,000 L to be replaced as part of scheduled maintenance 1,320 L on ESP	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grease (WTG)	Refill of grease for main bearing, yaw bearing, blade bearing	Bearings including yaw bearing and blade bearing	40 L per WTG	Expected every year	To be brought to designated O&M port and disposed according to regulations and guidelines
Diesel fuel (WTG and ESP)	Fuel for the emergency diesel generator (if any)	Diesel storage tank	3,000 L per WTG 21,560 L on ESP	Only as required	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Inert gas extinguishing system (e.g., NOVEC, nitrogen, or similar)	Various rooms	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines

Chemical Type	Description	Use/Location	Approx. Volume	Frequency of Transfer	Treatment or Disposal
Fire extinguishing agents (WTG and ESP)	Manual extinguishers: powder, carbon dioxide (CO_2), foam	Various locations	WTG: To be defined during detailed design 11,000 L foam on ESP	Depends on fabrication	To be brought to designated O&M port and disposed according to regulations and guidelines
Fire extinguishing agents (WTG and ESP)	Other types (if any)	Various locations	To be defined during detailed design	Not anticipated; only changed if needed	To be brought to designated O&M port and disposed according to regulations and guidelines
Dielectric gas (electrical insulating gas) (WTG and ESP)	Sulfur hexafluoride (SF_6)	WTG: GIS switch gears ESP: GIS switch gears Onshore substation	Approx.18 kilograms per WTG 2,320 kilograms on ESP	Not replaced	To be brought to designated O&M port and disposed according to regulations and guidelines
Paint & coating (WTG and ESP)	Corrosion protection of steel structure paints & varnishes	Steel structure, various locations	To be defined during detailed design	Only for repairs	To be brought to designated O&M port and disposed according to regulations and guidelines
Coolants or refrigerants (WTG and ESP)	Water, glycol, other refrigerants	Heating, Ventilation, and Air Conditioning unit, Air Handling Unit	1,600 L per WTG Approx. 700 L to be replaced as part of scheduled maintenance 176 L on ESPs	Expected every 5-8 years	To be brought to designated O&M port and disposed according to regulations and guidelines
Grout (WTG and ESP)	Grout	Grout for connection between monopile and transition piece	Up to 40,000 L per WTG and ESP position	Not anticipated; only changed if needed	To be brought back to port and disposed according to regulations and guidelines

3.3 Operations and Maintenance

The Project is expected to operate up to 35 years after construction is completed. Per 30 CFR § 585.235(a)(3) and Addendum B of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0508 (Lease), the operations term of the Project is 25 years, commencing on the date of COP approval. Two years before the end of operations term, the Company may request renewal of its Lease in accordance with 30 CFR §§ 585.425 through 429.

Pursuant to 30 CFR § 585.200(b), the Company has the right to one or more project easements, without further competition, as necessary for the full utilization of the Lease, and under applicable regulations in

30 CFR Part 585. In addition to COP approval, the Company is requesting a 61-m (200-foot)-wide operational ROW centered on each offshore export cable to support necessary O&M activities, should a fault or failure occur. Additional licenses and/or easements required for the portion of the export cable corridor in state waters are discussed in Section 1.5.1.

The Project will be designed to operate with minimal day-to-day supervisory input, with key systems monitored remotely from a central location 24 hours a day. Cables will be equipped with distributed temperature sensing to alert the Company of changes in cable temperature. Distributed temperature-sensing systems use fiber optic cable alongside the electrical conductor cores to monitor the temperature at each location along the length of the entire cable. The Company will be alerted in real time should the temperature change, which often is the result of cable exposure. If a change in temperature occurs, the Company will, as appropriate, inspect that location to determine if cables have become damaged, exposed, or overburied, and will conduct necessary repairs or maintenance.

A cable monitoring plan will be provided to BOEM prior to construction. During the operations, the Project will require both planned and unplanned inspections and maintenance, which will be carried out by a team of qualified engineers, technical specialists, and associated support staff. Generally, offshore O&M activities will include surveys of the offshore export cables and inter-array cables to confirm the cables have not become exposed, cable protection measures have not worn away, and repair or replacement of worn, failed, or defective systems has been completed.

The Company will conduct a complete as-built survey of the Project, following the completion of the offshore installation activities. This as-built survey will provide the baseline conditions for future survey campaigns. In addition, the Company proposes to implement a risk-based approach for post-construction survey campaigns, which will allow the Company to survey those areas determined to be at the highest risk at the time. Following the full coverage as-built survey, risk-based inspections will be conducted for years 1 and 2, then every 3 years. Additional survey activities will be completed on an as-needed basis, determined based on various factors such as extreme weather events.

Project operations will be based out of onshore O&M facilities, which may include control rooms, administrative and management offices, training space for technicians and engineers, shop space, and/or warehouse space, which will be collocated to the extent practicable. O&M facilities will be located near existing ports to allow for mobilization of vessels performing O&M activities. Improvements may be made to these ports in order to accommodate offshore wind O&M activities. Port improvements and the associated permitting activities would be the responsibility of port owners/operators.

A final determination regarding the suitable location of the O&M facility will be made upon conclusion of thorough site assessments and due diligence of all locations under consideration, including:

- Portsmouth, Virginia;
- Newport News, Virginia;
- Cape Charles, Virginia; and
- Chesapeake, Virginia.

The O&M plan for both the Project's onshore and offshore infrastructure will be finalized as a component of the Facility Design Report and Fabrication and Installation Report. An Oil Spill Response Plan and Safety Management System will also be implemented during O&M activities (see Appendices I and F for preliminary versions of these that will continue to be developed as the Project matures).

3.3.1 Summary of O&M Vessels and Helicopters

During O&M activities, many of the types of vessels used during construction will be used for visits to the Wind Development Area. A summary of anticipated vessel activity during the O&M period is provided in

Table 3.3-1. On average, there will be approximately three Project-related vessels inside the Wind Development Area during the day, throughout the Project's operational period.

The Company may install a metocean buoy(s) within the Wind Development Area during construction and operations activities to provide real-time weather conditions. If installed, the metocean buoy will be similar to the make and model as approved in the Site Assessment Plan and will be appropriately permitted with the USCG. The proposed location(s) for buoy deployment will be within the Lease Area in areas that are otherwise evaluated (i.e., for submerged archaeological resources, sensitive benthic habitat, etc.)[3]. As appropriate, the Company will commit to similar mitigation measures as detailed in the Site Assessment Plan.

[3] Given the distance of the metocean buoy(s) from shore and the height of metocean equipment, the metocean buoy(s) that may be deployed would be below the horizon and not visible from shore. Thus, impacts associated with metocean buoy(s) are not discussed further in the COP.

Table 3.3-1 Preliminary Summary of Offshore Vessels for O&M

Vessel Type	Description	Role	# of Vessels	Approx. Annual # Trips a/	Approx. Width (m)	Approx. Length (m)	Gross Tonnage	Deadweight	Operational Speed (knots)	Max Transit Speed (knots)	Propeller System	Approx. Fuel Capacity	Marine Sanitation Device	Crew Size
Regular Operations and Maintenance														
Service operation vessel	Main operation vessel carrying personnel and components during maintenance	Service vessel	1	26/year	17	81	6,100 t	2,250 t	10	13	Blade propeller	792 t	IMO compliant	60-100
Crew transfer vessel	Auxiliary operation vessel to carry personnel and small material along the Wind Development Area	Crew transfer	2	184/year	7	35	360 t	18.5 t	22	30	Jet propulsion	30 t	IMO compliant	20-30
Daughter craft	Move personnel when CTV is not available	Crew transfer	2	0 (on board SOV)	4	12	100-150 t	20-75 t	25-30	25-30	Blades/thrusters	10 t	IMO compliant	3-8
Environmental monitoring vessel	Vessel dedicated to crew executing environmental monitoring tasks	Environmental	2	2/year	7	21	100-150 t	20-75 t	8-10	10-15	Screw propellers/thrusters	7.5 t	IMO compliant	3-8
Cable Inspection and Repairs														
Cable survey vessel	Vessel to monitor and survey export cables and inter-array cables within the Wind Development Area	Cable survey/inspections	1	8/year	12	34	600 t	400-1,000 t	10	15	Propellers/thrusters Smaller support with jet propulsion	70 t	IMO compliant	22
Export cable survey vessel	Vessel to monitor and survey export cable corridor	Export cable survey/inspections	1	1/year	5	14	150 t	50 t	10	12	Propellers	50 t	IMO compliant	10
WTG Operations, Inspection, and Repairs														
Overseas WTG component transport vessel	Transport WTG components	WTG component transport	1	1/year	16	128	23,134 t	15,000 t	13	15	Propellers/Azimuths	2,000 t	IMO compliant	20
WTG main repair jack-up vessel	Maintenance and WTG repair vessel	WTG maintenance and repair	1	6/year	45	132	15,000 t	9,000 t	10	11.5	Azimuths	4,500 t	IMO compliant	100+
Jack-up vessel	Maintenance and WTG repair vessel	Support WTG repair	1	6/year	41	56	5,300 t	1,200 t	10	11.5	Azimuths	2,000 t	IMO compliant	100+
Scour Protection Repairs														
Scour protection repair vessel	Vessel with a pipe to lower scour protection to the seafloor	Scour/cable protection repairs	1	As needed	36	158	30,000 t	27,000 t	14	15	Propellers/thrusters	1,500 t	IMO compliant	52
Helicopters														
Helicopter	Transfers crew from vessels to WTGs and ESP	Crew transfer	1	600 hours/year	3	16.7	6.8 t	N/A	146	146	N/A	2,086 L	N/A	3-4

Notes:
a/ Annual trips during Project useful life for each vessel type. Number includes all vessels of the type listed (e.g., 2 crew transfer vessels making 92 trips per year each equals 184 trips).
CTV: Crew transfer vessel
IMO: International Maritime Organization
SOV: Service operation vessel
t: metric ton

3.3.2 Lighting and Marking of Offshore Project Components

The WTGs will have a maximum rotor tip height of 317.5 m above mean sea level. The Company will comply with the April 2021 BOEM *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* subject to final design decisions and will work with USCG and BOEM to achieve equivalent levels of safety performance as Aids to Navigation if the 2021 guidance is not practical given final design. BOEM's guidelines are modeled after the Federal Aviation Administration's obstruction marking and lighting standards (see Advisory Circular 70/7460-1M) and USCG's recommendations for structure identification, lighting, and sound signal in its *NC, VA, MD, DE, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance* (USCG 2020). In accordance with relevant guidance and subject to input from regulators, proposed lighting and marking schemes consist of, but are not limited to, the following:

- All foundation structures will be painted high visibility yellow RAL 1023 up to 15.2 m (50 feet) from Mean Higher High Water.
- Ladders at the foundation base will be painted in a color that contrasts with the high visibility yellow.
- Retro-reflective material will be used, visible through a 360-degree arc, and may be applied in at least 0.6-m (2-foot) bands around structures, no less than 9.1 m (30 feet) above Mean Higher High Water.
- Above 15.2 m (50 feet), WTGs will be painted a shade of white between the RAL specifications of Pure White (RAL 9010) and Light Grey (RAL 7035).
- WTGs will be labeled with an alphanumeric marking scheme, determined in coordination with the USCG. Letters will be easily visible using retroreflective material and will be as near 3 m high as practicable. Lettering will be visible from all directions from the water's surface. The bottom of the alphanumeric characters should be located at least 9.1 m (30 feet) and no more than 15.2 m (50 feet) above Mean Higher High Water.
- Locations of each WTG and the ESP will be provided to NOAA for inclusion on navigation charts.
- Two synchronized Federal Aviation Administration "L-864" red flashing omnidirectional obstruction lights will be placed on the nacelle of each WTG. LED-based red obstruction lights will be visible to pilots using certain night vision goggle systems.
- Mid-level lighting will be placed at the halfway point of each WTG tower, consisting of at least three flashing red lights, and synchronized with the nacelle lighting.
- In accordance with USCG and BOEM guidance, lights on Significant Peripheral Structures (e.g., corner WTGs or ESP) will be quick flashing yellow with a nominal range of 9 km (5 nautical miles [nm]). Intermediate Perimeter Structures will flash yellow at 2.5 seconds at a nominal range of 6 km (3 nm). Inner boundary towers will be marked with flashing yellow lights at 6 or 10 seconds with a nominal range of 4 km (2 nm). Interior WTGs will be marked with 15-second flashing yellow lights with a nominal range of 2 km (1 nm). Flash sequences will be synchronized for each structure location. All lighting will be visible to mariners from all directions in the horizontal plane.
- Temporary components preceding the final structure completion will be marked with quick flashing yellow obstruction lights, which will be visible to mariners from all directions in the horizontal plane at a nominal range of 9 km (5 nm). Other temporary lighting may be utilized for safety purposes as necessary.
- Sound signals will be located on Significant Peripheral Structures and other outer structures such as to not exceed 6 km (3 nm) between sound signals. Signals will sound every 30 seconds (4 seconds blast, 26 seconds off), will be Mariner Radio Activated Sound Signal activated by keying VHF Radio frequency 83A five times within ten seconds, and will be timed to energize for

45 minutes after the last VHF activation. Sound signals will project to a nominal range of 4 km (2 nm).

- Automatic identification system transponder signals will be used to mark structures within the Wind Development Area, pending additional guidance from the USCG.

3.4 Decommissioning

Decommissioning requirements are defined in Section 13 of the Lease. At the end of the Project's useful life, the Project will be decommissioned in accordance with a detailed Project decommissioning plan that will be developed in compliance with applicable laws, regulations, and best management practices at that time. Unless otherwise authorized by BOEM, pursuant to 30 CFR § 585.902 the Company 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." Furthermore, in accordance with 30 CFR § 585.905, the Company is required to submit a decommissioning application 2 years before the expiration of the Lease. Accordingly, the Company will develop a detailed decommissioning and removal plan for the facility that complies with all relevant permitting requirements. This plan will account for changing circumstances during the operations phase of the Project, including new discoveries in the marine environment, technology, and any relevant amended legislation.

During decommissioning activities, the Company will mandate a careful inventory be made of all offshore Project components to be removed. As they are removed from the site, each Project component will be counted and noted, ensuring that all Project components are removed. The Company will prioritize re-use and recycling of materials as feasible and will otherwise dispose of materials in an appropriate fashion, consistent with both an approved decommissioning plan and relevant federal, state, and local regulations. The environmental impacts from these decommissioning activities would be generally similar to the impacts experienced during construction.

As currently envisioned, and subject to change based on future agreements with the appropriate agencies, decommissioning of the Project is broken down into several steps:

- Dismantling and removal of WTGs;
- Removal of ESP;
- Cutting and removal of foundations;
- Retirement in place of offshore cable system including offshore export and inter-array cables; and
- Retirement in place of onshore export cables.

After decommissioning is complete, unless otherwise authorized by BOEM, the Company will conduct a site clearance survey to ensure that all Project components are removed and that no unauthorized debris remains on the seabed. Details of the site clearance survey will be provided in the Project decommissioning plan.

It is anticipated that the equipment and vessels used during decommissioning will likely be similar to those used during construction and installation. For offshore work, vessels would likely include cable laying vessels, crane barges, jack-up barges, larger support vessels, tugboats, crew transfer vessels, and possibly a vessel specifically built for erecting WTG structures.

For onshore work, subject to discussions with the City of Virginia Beach on the decommissioning approach that has the fewest environmental impacts, the onshore cables, the concrete encased duct bank, and vaults would be left in place for future reuse, as would elements of the onshore substation and grid connections.

3.5 References

See Table 3.5-1 for data sources used in the preparation of this chapter.

Table 3.5-1 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State territorial waters boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
NOAA	Territorial sea (12-nm limit)	http://maritimeboundaries.noaa.gov/downloads/USMaritimeLimitsAndBoundariesSHP.zip	https://inport.nmfs.noaa.gov/inport-metadata/NOAA/NOS/OCS/inport/xml/39963.xml
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/thredds/catalog/crm/catalog.html?dataset=crmDatasetScan/crm_vol2.nc	https://www.ngdc.noaa.gov/mgg/coastal/crm.html

BOEM (Bureau of Ocean Energy Management). 2018. *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan. 12 Jan 2018.* Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf. Accessed 29 Oct 2020.

BOEM. 2020. *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0. 27 May 2020.* Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf. Accessed 29 Oct 2020.

BOEM. 2021. *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development*. Available online at: https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf. Accessed 09 Jun 2021.

USCG (United States Coast Guard). 2020. *NC, VA, MD, DE, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance. Published in Local Notice to Mariners; District 5; Week 38/20.* Available online at: https://www.navcen.uscg.gov/pdf/lnms/lnm05382020.pdf. Accessed 29 Oct 2020.