Beacon Wind LLC

Beacon Wind 1
Article VII Application

Exhibit E-3
Underground Construction

May 2022

EXHIBIT E-3 – UNDERGROUND CONSTRUCTION

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ABBREVIATIONS AND ACRONYMS

BW1	Beacon Wind 1 project
CBRA	cable burial risk assessment
Commission	New York State Public Service Commission
EM&CP	Environmental Management and Construction Plan
ft	foot/feet
HDD	horizontal directional drilling
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
km	kilometer(s)
kV	kilovolt(s)
m	meter(s)
m^3	cubic meter(s)
MEC/UXO	munitions and explosives of concern/unexploded ordnance
nm	nautical mile(s)
NY Project	portions of the BW1 transmission system to be located within New York State
O&M	operations and maintenance
POI	Point of Interconnection
XLPE	crosslinked polyethylene
yd^3	cubic yard(s)

Exhibit E-3 Underground Construction

E-3.1 Introduction

Beacon Wind LLC (Beacon Wind or the Applicant) proposes to construct and operate the Beacon Wind 1 project (BW1) as one of two separate offshore wind projects to be located within the Bureau of Ocean Energy Management-designated Renewable Energy Lease Area OCS-A 0520. The proposed transmission system for BW1 will connect the offshore wind farm to the point of interconnection (POI) at the Astoria power complex in Queens, New York, and will include one 320-kilovolt (kV) high-voltage direct current (HVDC) submarine export cable circuit approximately 115 nautical miles (nm) (213 kilometers [km]) in length in New York State waters, one 320-kV HVDC onshore export cable circuit approximately 600 feet (ft) (183 meters [m]) in length, and three 138-kV high-voltage alternating current (HVAC) interconnection cable circuits approximately 1,400 ft (427 m) in length. An electric transmission line with a design capacity of 125-kV or more, extending a distance of 1 mile (16 km) or more, is subject to review and approval by the New York State Public Service Commission (Commission) as a major electric transmission facility. This application is being submitted to the Commission pursuant to Article VII of the New York Public Service Law for the portions of the BW1 transmission system to be located within the State of New York (collectively, the NY Project).

The NY Project's POI to the New York State Transmission System operated by the New York Independent System Operator will be at the existing Astoria West 138-kV Substation in Queens, New York. The Astoria West Substation is owned by the Consolidated Edison Company of New York, Inc. The following Article VII components of BW1 constitute the NY Project:

- One 320-kV HVDC submarine export cable circuit (two cables) located within an approximately 115 nm (213 km)-long submarine export cable corridor from the boundary of New York State waters 3 nm (5.6 km) offshore to the cable landfall at Lawrence Point at the Astoria power complex in Queens, New York;
- A 2,000 ft (610 m) long onshore cable route and substation facility within the Astoria power complex including:
    - One 320-kV HVDC onshore export cable circuit (two cables) installed underground from the landfall to the onshore substation facility within the Astoria power complex (approximately 600 ft [183 m]);
    - One onshore substation facility (inclusive of an onshore converter station and onshore substation) to convert HVDC power to HVAC power and step the voltage down from 320-kV to 138-kV; and
    - Three 138-kV cable circuits, each with nine HVAC onshore interconnection cables, buried underground from the onshore substation facility to the Astoria West POI (approximately 1,400 ft [427 m]).

This Exhibit addresses the requirements of 16 New York Codes, Rules and Regulations § 88.3 for the Project facilities, including a description of the cable system to be used, applicable design standards, and the number and size of conductors. The cable profile, including the cable depth and locations of vaults, is provided in **Exhibit 5: Design Drawings**.

E-3.2 Cable System Design

The submarine export cable corridor for the Project begins where the cable route crosses the state boundary 3 nm (5.6 km) offshore, which occurs in Block Island Sound approximately 8 nm (15 km) southwest of Block Island, Rhode Island, and 5 nm (9 km) northeast of Montauk, New York. From there, the submarine cable route travels the length of Long Island Sound, remaining in New York State waters, and makes landfall at the Astoria power complex in Queens, New York. The length of the submarine export cable corridor in New York is approximately 115 nm (213 km)[1] from the state boundary offshore to the cable landfall.

From the landfall at Lawrence Point (New York Power Authority site), the submarine export cables will be pulled into the horizontal directional drilling (HDD) exit and connected directly to the onshore substation facility. The onshore substation facility will convert the HVDC power delivered to shore via two 320-kV submarine export cables to HVAC power, then the voltage will be stepped down to 138-kV , after which the 138-kV onshore interconnection cables will deliver power to the POI at the existing Astoria West 138-kV Substation. The onshore interconnection cable route will extend southeast from the onshore substation facility for approximately 1,400 ft (427 m) to the Astoria West POI.

All of the NY Project’s transmission facilities are located underground or underwater, except for the onshore substation facility. The Project’s transmission system, including the submarine export cables, onshore substation facility, and onshore cables will be designed and installed to meet or exceed applicable industry standards and electrical codes, including but not limited to applicable standards of the following bodies:

- International Electrotechnical Commission;
- Insulated Cable Engineers Association;
- National Electric Safety Code;
- American National Standards Institute/Institute of Electrical and Electronics Engineers;
- International Council on Large Electric Systems;
- North America Electric Reliability Corporation;
- Northeast Power Coordinating Council;
- Reliability Rules of the New York State Reliability Council;
- Underwriters Laboratories;
- National Electrical Manufacturers Association; and
- National Fire Protection Association.

[1] The submarine export cable length accounts for additional length required for micrositing and variations in seabed bathymetry.

E-3.2.1 Submarine Export Cables

The submarine export cables will be HVDC. A separate fiber optic cable will be utilized with the HVDC cables for the automation, control, temperature and vibration monitoring, and communication signal transfer between the wind farm onshore control center and the offshore substation facilities. Each of the two HVDC submarine export cables will consist of a 320-kV HVDC stranded conductor, which will be made of annealed copper and approximately 2.5 inches (62.5 millimeters) in outer diameter. The interstices between the conductor strands will be filled with a water-tight compound to prevent longitudinal water penetration if exposed to water due to damage. A representative conductor insulation could consist of three sublayers including a semiconductive screen, a main layer of crosslinked polyethylene (XLPE), and a semiconductive insulation screen. A longitudinal sheath made of water swelling tape will provide a water barrier. A lead sheath will act both as a conductor for the highest anticipated earth fault current and as a mechanical barrier to prevent water ingress into the insulation system. The armor will be made of one layer of galvanized steel, and the outer protection sheath will be made of polyethylene. **Figure E-3-1** provides a typical cross-section of a bundled and unbundled submarine export cable system. A description of the onshore segment of the submarine export cables (the onshore export cables) is provided in **Section E-3.2.2**, and installation methods for the submarine export cables are described in **Section E.3.3-1**.

E-3.2.2 Onshore Export Cables

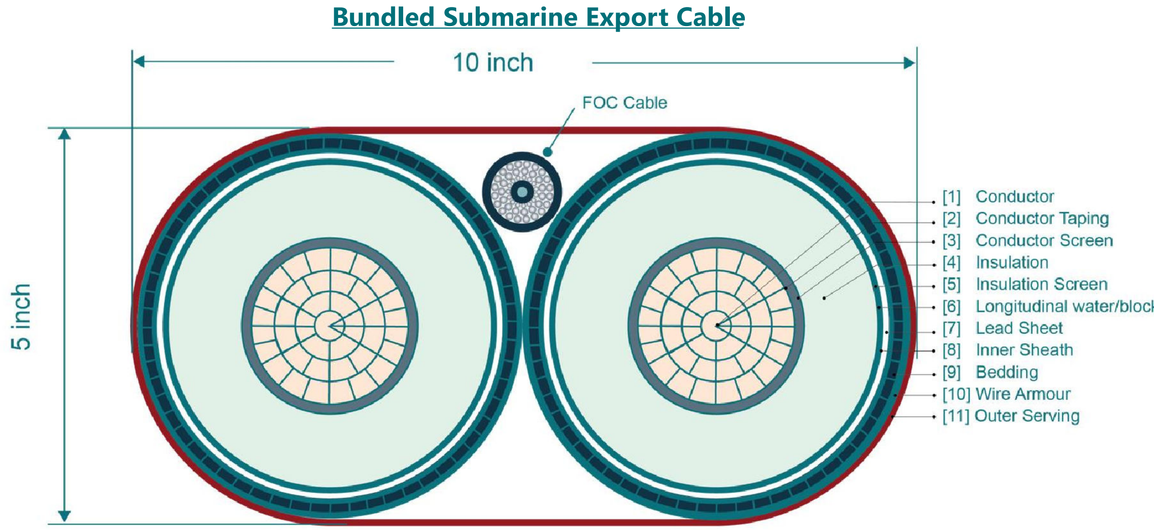
The onshore export cables will consist of the onshore part of the submarine export cables and are not expected to differ from the design of the submarine export cables described in **Section E-3.2.1**. These cables will be pulled into the HDD exit and connected directly to the onshore substation facility.

E-3.2.3 Onshore Interconnection Cables

The interconnection between the onshore substation facility and the Astoria West POI will consist of three 138-kV circuits. Each circuit will consist of nine HVAC single core XLPE solid dielectric cables with copper conductors enclosed in XLPE insulation and a maximum design voltage of 145-kV. Each onshore interconnection cable will be approximately 5.5 inches (140 millimeters) in outer diameter. **Figure E-3-2** provides a cross-section of the onshore interconnection cable. Three separate fiber optic cables will be used for communication and temperature measurements and will be installed alongside the interconnection cables.

The onshore interconnection cables will be housed in three separate concrete duct banks, which will be buried to a target depth of between 3.0 ft and 16.4 ft (0.9 and 5 m) beneath the surface. Shallower burial may be required with the potential need for additional protection depending on subsurface obstructions encountered. The configuration of the 27 onshore interconnection cables and three fiber optic cables within the duct banks are depicted in **Exhibit 5**. Each of the concrete duct banks will be approximately 3 ft (1 m) high by 11 ft (3.4 m) wide, for a total width of 33 ft (10 m). Up to four joint pits (manholes) will be located along the interconnection cable corridor to provide access and the spacing between joint pits will vary due to site-specific and cable installation constraints. Final locations and design will be provided in the Environmental Management and Construction Plan (EM&CP).

Figure E-3-1. Representative Cross-Section of Bundled and Unbundled Submarine Export Cable



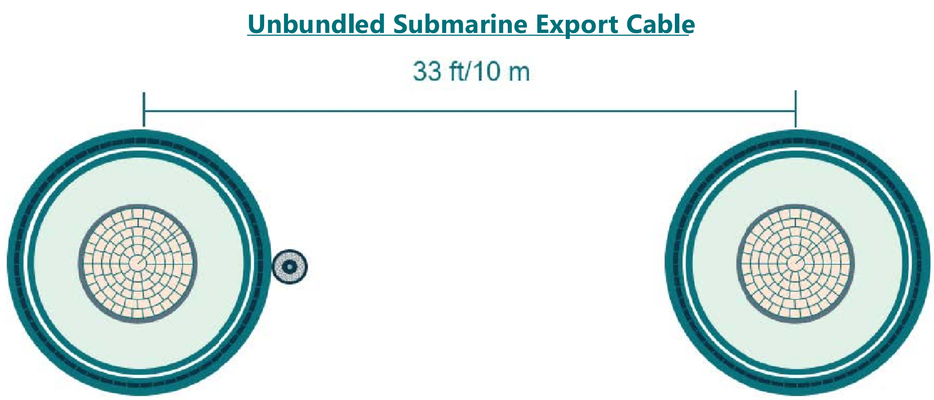


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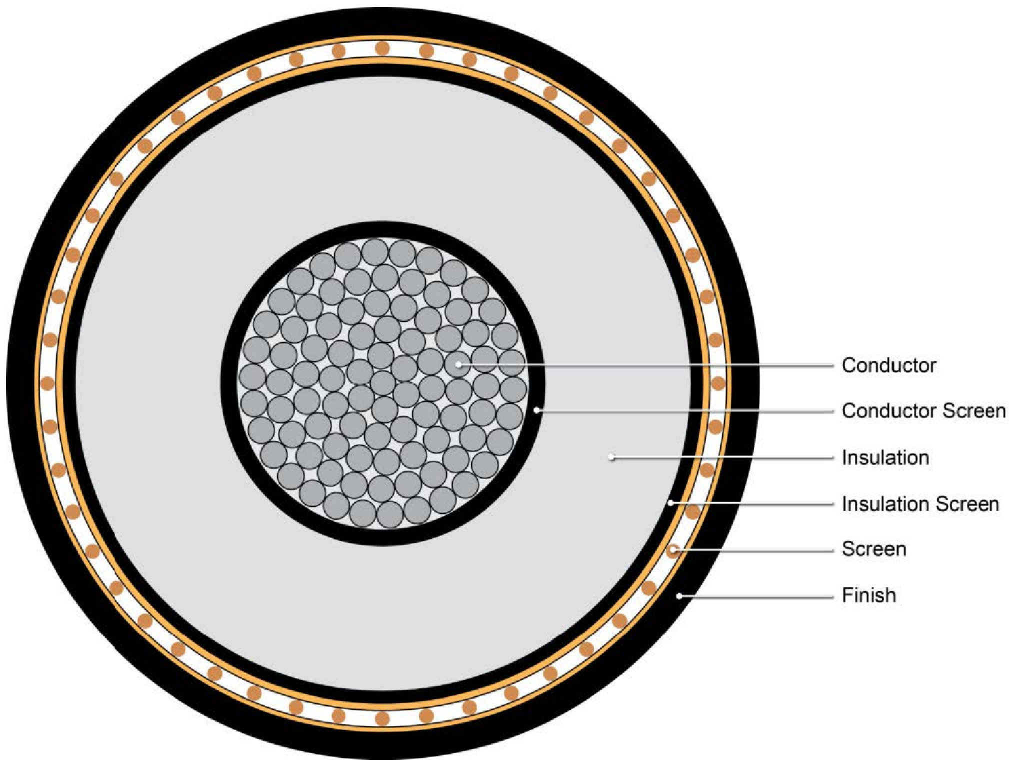
Figure E-3-2. Representative Cross-Section of Onshore Interconnection Cable



A profile view of the onshore interconnection cable, including anticipated location of manholes, as well as cross sections of duct bank configurations, is provided in **Exhibit 5**. Since the proposed onshore interconnection cables will be solid dielectric, no dielectric fluid or insulating oil is needed, and no oil pumping stations are proposed.

E-3.3 Cable System Installation

This section describes the underground cable installation methods for the submarine export cables, cable landfall, onshore export cables, and onshore interconnection cables to the POI.

E-3.3.1 Submarine Export Cable Installation

Offshore infrastructure within New York State waters will consist of the submarine export cables and cable protection (in areas where the target burial depth cannot be achieved due to existing seabed conditions or the presence of existing utilities [cables and/or pipeline] that must be crossed). The submarine export cables will be installed from specialized installation vessels/barges which will install the cable from a turntable on the lay vessel/barge. The number and type of vessels to be used for the installation of the cable will depend on factors such as seabed depth, depth of cable protection, distance to shore, installation methodology, and cable protection method to be used. The submarine export cable installation methodology selected will also depend upon a variety of factors, including seabed characteristics and target burial depth. Installation methods that may be used along different portions of the submarine export cable route are described in **Section E-3.3.1.3**.

The submarine export cables will be buried to a target burial depth of 3 to 6 ft (0.9 to 1.8 m) below the seabed outside of federally maintained (e.g., anchorages and shipping channels) areas. In locations where the cable must enter or cross federally maintained areas, the cable will be buried to a minimum target burial depth of 15 ft (4.7 m) below the current or future authorized depth or depth of existing seabed (whichever is deeper).[2] The burial depth may vary from the target depth due to a variety of factors including seafloor conditions, previously installed utilities, other existing uses, and planned and future uses. A conceptual submarine export cable plan and profile is provided in **Exhibit 5**.

Other factors that determine minimum target burial depth will be considered during a cable burial risk assessment (CBRA); those factors may include non-regulated anchoring activity, seabed mobility (e.g., sandwaves), and seabed impacting fishing (e.g., hydraulic clam dredging). For example, in areas of hydraulic clam dredging, a target burial depth of at least 6 ft (1.8 m) may be appropriate pending results of the CBRA. A complete CBRA will be conducted to inform the final design. Additional information on target burial depths will be provided with the EM&CP.

In areas where the target burial depth cannot be achieved due to existing seabed conditions or the presence of existing utilities (cables and/or pipeline) that must be crossed, cable protection measures may be required (see **Section E-3.3.1.5** for additional information on rock installation protection and other protection measures).

[2] The Applicant is coordinating with the USACE as it relates to future plans associated with these USACE-managed areas, and the potential for an increase in the authorized depths. Final burial depth will be based upon a Cable Burial Risk Assessment and is subject to regulatory approval.

The typical key stages of submarine cable installation are as follows:

1. Munitions and explosives of concern/unexploded ordnance (MEC/UXO) clearance and pre-installation activities;[3]
2. Pre-sweeping and pre-trenching activities (if needed);
3. Cable lay and burial, including cable and pipeline crossings;
4. Post-installation survey; and
5. Post-crossing or remedial cable protection (if needed).

Installation of the submarine export cable is expected to take approximately 23 weeks for the submarine export cable route in New York. The actual installation schedule will be subject to seabed characteristics, installation vessel availability, and weather.

E-3.3.1.1 MEC/UXO Clearance and Pre-Installation Activities

Prior to the installation of the submarine export cable, survey campaigns and route preparation may be completed including MEC/UXO clearance, pre-installation surveys, debris clearance, boulder clearance, and pre-lay grapnel run. This is to ensure that the submarine export cable and burial equipment will not be impacted by any debris or hazards, either natural or man-made, during the burial process, which may cause equipment damage and/or delays. It also serves to ensure sufficient burial depth. Please note that clearance activities will be implemented should avoidance through micro-siting not be feasible.

In some areas, existing, out-of-service cables and pipelines may be cut away and removed in order to install the submarine export cables, in accordance with applicable industry practices in collaboration with asset owners. This removal will only be undertaken upon pre-determined cables and pipelines for which written agreement is received from the owners and/or appropriate agencies. Should such cutting or removal of existing infrastructure be required, removal will be consistent with sound engineering practices and relevant requirements. Additional details on crossing existing submarine assets are provided in **Section E-3.3.1.3**.

Assessments for MEC/UXO hazards and risks have been performed by the Applicant to produce a MEC/UXO risk mitigation strategy. MEC/UXO surveys, if required, would typically be performed two years prior to the beginning of installation activities. If MEC/UXO is identified within any portion of the submarine export cable corridor, appropriate mitigation measures will be taken, including recommended avoidance or clearance and MEC/UXO will be managed in accordance with applicable regulations. In addition, industry standard precautions will be taken during construction operations, which include accurate positioning on submerged Project equipment, to decrease the likelihood of contact with any MEC/UXO. A pre-lay grapnel run may also be completed to clear the path of seabed debris (abandoned fishing gear, wires, ropes, etc.) from the installation corridor, where feasible. The grapnel run will be carried out by towing a grapnel train from a support vessel.

The cable lay and burial operations will attempt to avoid boulders; however, if this is not possible, typically a 65.6 ft (20 m)-wide corridor will be cleared from boulders. In the areas with low boulder

[3] Pre-installation activities may include a separate pre-survey and route clearance prior to the pre-installation grapnel run and survey if there are expected to be a large quantity of debris along the route.

density where mainly surface boulders are identified, a remotely operated vehicle-based boulder grab will typically be utilized. In areas with high density of boulders, sub surface boulders are also likely to be present. A pre-lay plough will normally be mobilized, which could move surface boulders as well as create a pre-cut trench (see **Section E-3.3.1.2** for more detail on pre-trenching activities).

E-3.3.1.2 Pre-Sweeping and Pre-Trenching Activities (if needed)

In certain limited areas of the submarine export cable corridor, pre-sweeping may be necessary prior to cable lay activities, where underwater mega ripples and sandwaves are present on the seafloor. Pre-sweeping involves smoothing the seafloor by removing any ridges or edges that may be present. The primary pre-sweeping method will involve using a Trailing Suction Hopper Dredger from a construction vessel to remove the excess sediment on the seafloor along the footprint of the cable lay; however, other types of dredging equipment may be used depending on environmental conditions and equipment availability. The Applicant anticipates that dredged material generated from the submarine export cable corridor may either be side casted near the site of installation or removed after project completion for beneficial reuse or proper disposal. The actual method of dredged material management will be based on sampling and consultation with regulatory agencies. Where required, pre-sweeping activities will occur in a corridor that is up to approximately 65.6 ft (20 m) in width along the length of the mega ripples and sand waves; the amount of clearance will vary along the submarine export cable route. Mega ripple and sand wave height vary depending on localized seabed and current characteristics. Approximately 321,077 cubic yards (yd^3) (245,481 cubic meters [m^3]) of sediment in New York State waters are anticipated to be dredged as a result of these pre-sweeping activities.

Pre-cut trenching activities may also be required along the submarine export cable route where deeper burial may be required and/or where seabed conditions are not suitable for traditional cable burial methods without seabed preparation. Pre-cut trenching involves running the cable burial equipment over portions of the route in order to soften the seabed prior to cable burial and/or the use of a suction hopper dredge to excavate additional sediment. The impacts associated with this pre-trenching method are anticipated to be the same as those described in **Section E-3.3.1.3**.

Local dredging or pre-sweeping at the locations where the submarine export cable crosses other assets may also be needed in order to reduce the shoaling of the crossing design. The final depth of the dredged area will be governed by the vertical distance between the natural seabed and the assets to be crossed and will be resolved by agreement with the asset owners through a crossing agreement or by PSC approval of the segment EM&CP. In typical scenarios the crossing design will consist of the removal of approximately 8 ft (2.4 m) of sediment within a 52.5 ft by 85.3 ft (16 m by 26 m) area at each crossing. Approximately 679 yd^3 (519 m^3) of material will be removed by suction hopper dredge and/or mass flow excavation at each crossing.

E-3.3.1.3 Cable Lay and Burial, including Cable and Pipeline Crossings

Cable Lay and Burial

Following the pre-installation grapnel run and route clearance, the submarine export cable will be brought to the appropriate section of the submarine export cable installation corridor on the cable laying vessel. From there, the cable will be laid onto the seabed and then buried or simultaneously laid and buried. In shallow areas, specifically in the East River approaching the landfall at the Astoria power complex, the submarine export cable may need to be floated into place for burial, as water depths along this stretch are inadequate for the cable lay vessel. A cable burial machine may assist in lowering and burying the submarine export cable in place, as it moves along these shallower areas. The burial machine would be operated off a separate construction vessel that could access these shallow waters.

Two options are proposed for installing the submarine export cables in the seabed:

- Cable lay with simultaneous burial using jet plow, mechanical plowing, or trenching; and
- Post-lay cable burial with either a jet trencher and/or mechanical trencher.

Depending on seabed conditions, cable burial depth targets, and other design requirements, cable lay with simultaneous burial and post-lay cable burial will utilize one or more of the following methods:

- **Jetting.** Jetting will be the primary method for cable installation. Jetting may be conducted via a towed device that travels along the seafloor surface. Jetting may also be conducted with a vertical injector fixed to the side of a vessel or barge. These methods inject high pressure water into the sediment through a blade that is inserted into the seafloor to create a trench. Simultaneously, the cable is fed from the cable ship down through the device and laid into the trench. Post-lay burial with a jetting tool may also be utilized. With this method, the cable would first be laid along the seafloor, and then the post-lay jetting tool would follow and may attempt multiple passes of the area for burial.
- The high-pressure water from the jetting tool sufficiently softens the sediment such that the cable can be pushed down through the sediment to the desired burial depth. The adjacent sediment and displaced sediment then resettles into the trench. Jetting with simultaneous cable lay, using either a jet plow or vertical injector, is considered the most efficient method of submarine cable installation in many soil types. It minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route. An example of jetting is depicted in **Figure E-3-3**.
- **Mechanical Plowing.** Plowing is conducted with a “mechanical” (i.e., non-jetting) cable plow that is pulled along the seabed, creating a narrow trench. Simultaneously, the cable is fed from the cable ship down to the plow, with the cable laid into the trench by the plow device. Gravity causes the displaced sediment to return to the trench, covering the cable. In general, material backfills naturally under wave action and tidal currents, but if necessary, additional sediment is mechanically returned to the trench using a backfill plow. Similar to a jet plow, the cable is installed and buried in a single pass. Plowing is generally less efficient than jetting methods but may be used in limited site-specific conditions. Mechanical plowing may be used for harder soils, where jetting is determined to be problematic. An example of a mechanical cable plow is depicted in **Figure E-3-3**.
- **Trenching (cutting).** Trenching (cutting) is used on seabed containing hard materials not suitable for jetting or plowing. For those areas containing hard materials, the trenching machine mechanically cuts through the hard materials using a chain or wheel cutter fitted with picks or teeth. The cutter creates a trench that the submarine export cable is laid into, and backfill is mechanically returned to the trench using a backfill plow. An example of trenching (cutting) is depicted in **Figure E-3-3**.

The two submarine export cables will be installed bundled together with a fiber optic cable or unbundled and installed separately, and would be selected based upon available technology. **Figure E-3-4** depicts the trench burial for a bundled and unbundled scenario. Bundled submarine export cables will be installed in a single trench from the New York State jurisdictional water boundary in

Block Island Sound and continue through Long Island Sound until approximately 6.4 nm (12 km) from the landfall. At that point, the cables will be separated (unbundled) and installed in two separate trenches for the final 6.4 nm (12 km) through Long Island Sound and the East River to the landfall. A summary of the submarine export cable parameters is provided in **Table E-3-1.**

Due to the length of the submarine export cable, three or more spools of cable will be necessary to transport and install the cable. Therefore, the cable will be installed in three or more sections and will require three to six jointing campaigns, each with a duration of three to seven days, to join sections of cable together. The jointing will be performed with the cable installation vessels. During the jointing, the vessels will be on dynamic positioning, so no anchoring or other seabed intervention will be required. If there is time between the lay-down of one cable end and the jointing campaign, there may be a guard vessel patrolling the cable end area.

For all submarine export cable installation activities, additional support and guard vessels are required. Support vessels may be used for dive teams or other works crews that are deployed for specific tasks during cable installation. Environmental monitors may also be deployed on separate vessels, if necessary. Guard vessels would navigate along with construction vessels to monitor and maintain safety zones when installation activities take place.

TABLE E-3-1. SUMMARY OF SUBMARINE EXPORT CABLE PARAMETERS

Submarine Export Cable Parameter	Dimensions
Number of Routes	1
Number of HVDC Cables per Route	2
Number of Fiber Optic Cables per Route	1
Total Length a/	115 nm (213 km)
Voltage	320 kV
Dimension of Cable Bundle	10 inches (in) x 5 in (250 x 130 mm)
Target Burial Depth b/	3-6 ft (0.9-1.8 m) 15 ft (4.6 m) c/
Target Trench Depth	8 ft (2.4 m)
Maximum Trench Width d/	10 ft (3 m)
Typical Trench Width Disturbance e/	13 ft (4 m)
Maximum Trench Width Disturbance e/	33 ft (10 m)
Anchor Corridor Width f/	3,000 ft (914 m)
Siting Corridor Width g/	1,640 ft (500 m)
Permanent Easement Width h/	200 ft (60 m)

Notes:

a/ The approximate distance along the centerline of the surveyed submarine export cable siting corridor from the NYS waters boundary to the submarine export cable landfall. Actual length of cable may increase as a result of micrositing and final location of offshore substation. Final installation will be within the surveyed corridor assessed.

b/ Burial depths to be based on CBRA and/or site-specific conditions.

c/ In locations where the submarine export cable will cross federally maintained areas, in accordance with engagement with USACE and other stakeholders. This depth will be determined based upon the current or future authorized depth or the existing water depths, whichever is greater; therefore, minimum burial could be greater.

d/ The width of the trench is defined here as the subsurface width and will vary based upon the final installation method selected. The preferred trenching tool has a trench width of 1.5 ft (0.5 m).

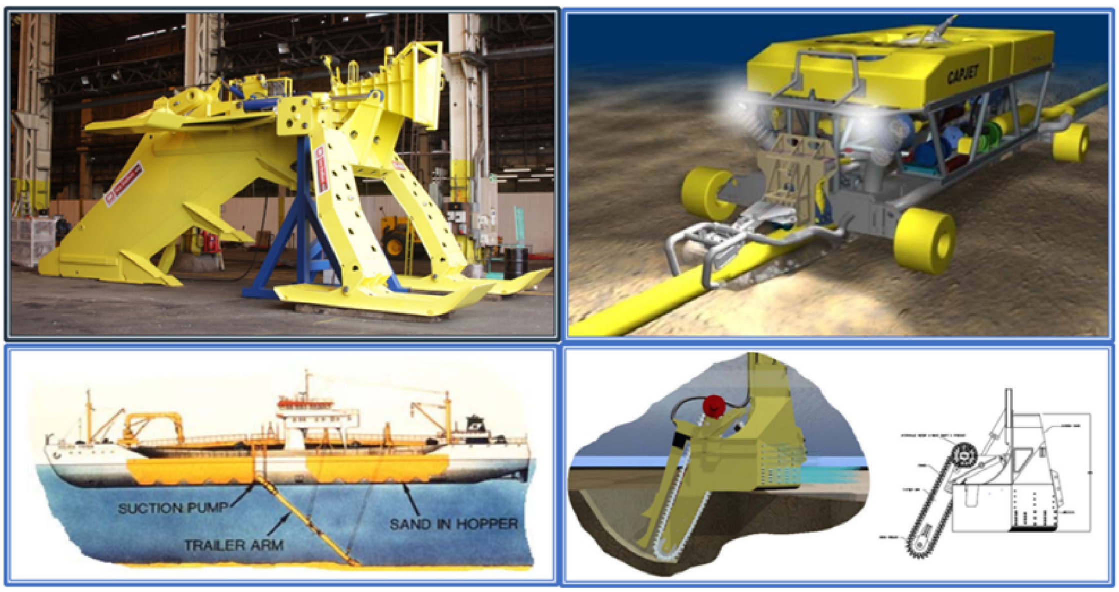
e/ Direct disturbance for bundled cable installation will be up to approximately 13 ft (4 m) wide based on the use of a jet trencher which is the primary tool planned for the majority of the route. A jet plow may be required for harder seabed conditions and can generate disturbance as wide as approximately 33 ft (10m) which represents the maximum disturbance width.

f/ The area in which a submarine export cable installation vessel may anchor in support of installation activities; distance measured from the edge of the siting corridor. Corridor width may increase or decrease where site constraints exist. The extent of the anchor corridor will be limited to the area of survey coverage that has been cleared of constraints. Impacts from Project-related vessel anchoring are expected to be in up to 269 square feet (ft2) (25 square meters [m^2]) area, with a maximum penetration depth of 49 ft (15 m), in up to 1,400 locations.

g/ The area that has been surveyed, where the submarine export cable could be installed, and seabed impacts may occur. Corridor width may increase or decrease where site constraints exist, and survey coverage allows.

h/ Distance from centerline for the cable.

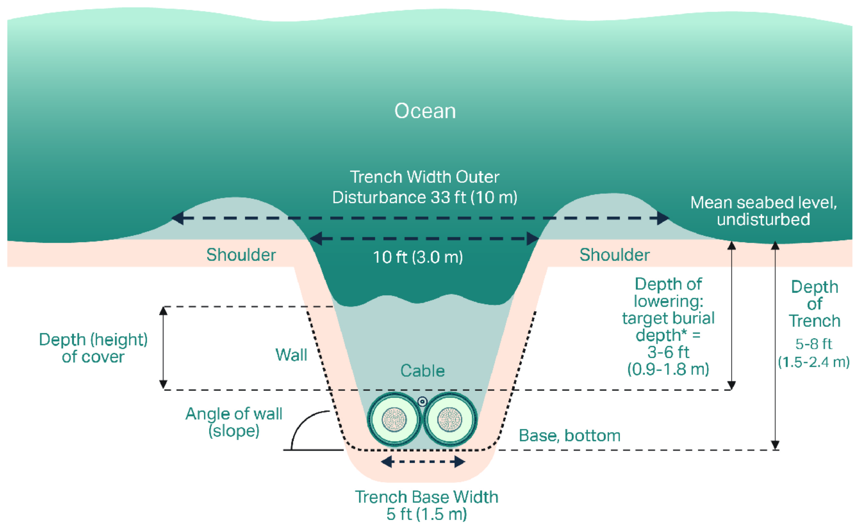
Figure E-3-3. Examples of Submarine Cable Installation Methods



From top left, clockwise: plowing[1], jetting[2], trenching (cutting)[3], and suction hopper dredging[4].
[1] https://www.royalihc.com/en/products/offshore/subsea-equipment/subsea-cable-ploughs
[2] http://docplayer.nl/58313179-Aanvraaggegevens-aanvraagnummer-net-op-zee-hollandse-kust-zuid-ingediend-op-gefaseerd-blokkerende-onderdelen-weglaten.html
[3] http://www.miahtrenchers.com/page6.html
[4] https://www.epd.gov.hk/eia/register/report/eiareport/eia_2512017/html/Ch%2006%20Hazard%20to%20Life%20Assessment.htm

Figure E-3-4. Proposed Bundled and Unbundled Submarine Cable Burial Methodology

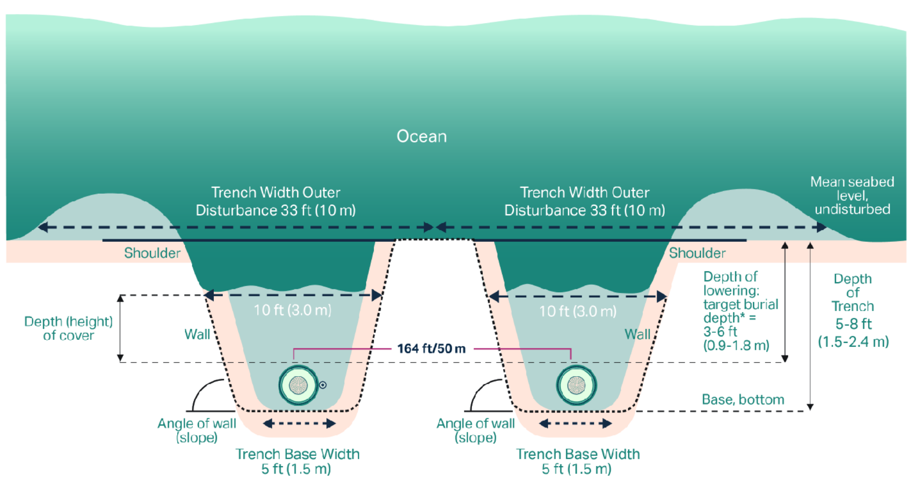
Bundled Submarine Cable Burial Methodology



*Note: Target burial depth will be 15ft (4.7m) below the current (and future) authorized depth or depth of existing seabed (whichever is deeper) in federally maintained navigation features (e.g., anchorages and shipping channels).

*Note: The trench width outer disturbance of 33 ft (10 m) represents the potential maximum disturbance generated by the jet plow required for harder seabed conditions. It is anticipated that along the majority of the submarine export cable route, a jet trencher tool will be used which is expected to generate an outer disturbance width of approximately 13 ft (4 m).

Unbundled Submarine Cable Burial Methodology



*Note: Target burial depth will be 15ft (4.7m) below the current (and future) authorized depth or depth of existing seabed (whichever is deeper) in federally maintained navigation features (e.g., anchorages and shipping channels).

*Note: The trench width outer disturbance of 33 ft (10 m) represents the potential maximum disturbance generated by the jet plow required for harder seabed conditions. It is anticipated that along the majority of the submarine export cable route, a jet trencher tool will be used which is expected to generate an outer disturbance width of approximately 13 ft (4 m).

Cable and Pipeline Crossings

There are existing cables and pipelines, both in and out of service, located along the submarine export cable route proposed for the NY Project. While the submarine export cable route has been sited to avoid cables and pipelines, crossings will still be required. Where cable and/or pipeline crossings along the submarine export cable route are necessary, the specific crossing methodologies to be used will be developed and engineered as the submarine export cable route is finalized. Cable crossing methodologies will be based on the type of asset to be crossed (i.e., material); depth of the existing buried cable or pipeline; and whether the assets are in service or out of service. Crossing methods will be determined through asset owner crossing agreements or by PSC approval of the segment EM&CP.

A typical pre-lay and burial installation sequence for a submarine export cable crossing of other cable and pipeline assets is as follows:

- Once the precise crossing location and separation distance are determined, a layer of protection may be installed over the asset. Localized dredging using equipment described in **Section E-3.3.1.2** may be used in order to minimize or eliminate shoaling on the seabed before cable protection is installed;
- The submarine export cable will be laid over the first layer of protection. The submarine export cable may have a casing installed prior to placement, as an additional layer of protection;
- At a pre-determined distance away from the crossing location, cable burial will be suspended in accordance with a crossing agreement or approved EM&CP, cable route, water depth, and seabed conditions;
- Burial of the cable will resume at a pre-determined distance after the crossing;
- A second layer of protection will be installed over the submarine export cable; and
- Subject to burial depth, a final layer of protection will be installed over the crossing for stabilization and additional scour protection; any remaining voids in the seabed at the installation site will be allowed to backfill naturally.

Examples of cable crossings are shown in **Figure E-3-5** and **Figure E-3-6**.

Figure E-3-5. Representative Option for Locally Dredged Asset Crossing Methodology

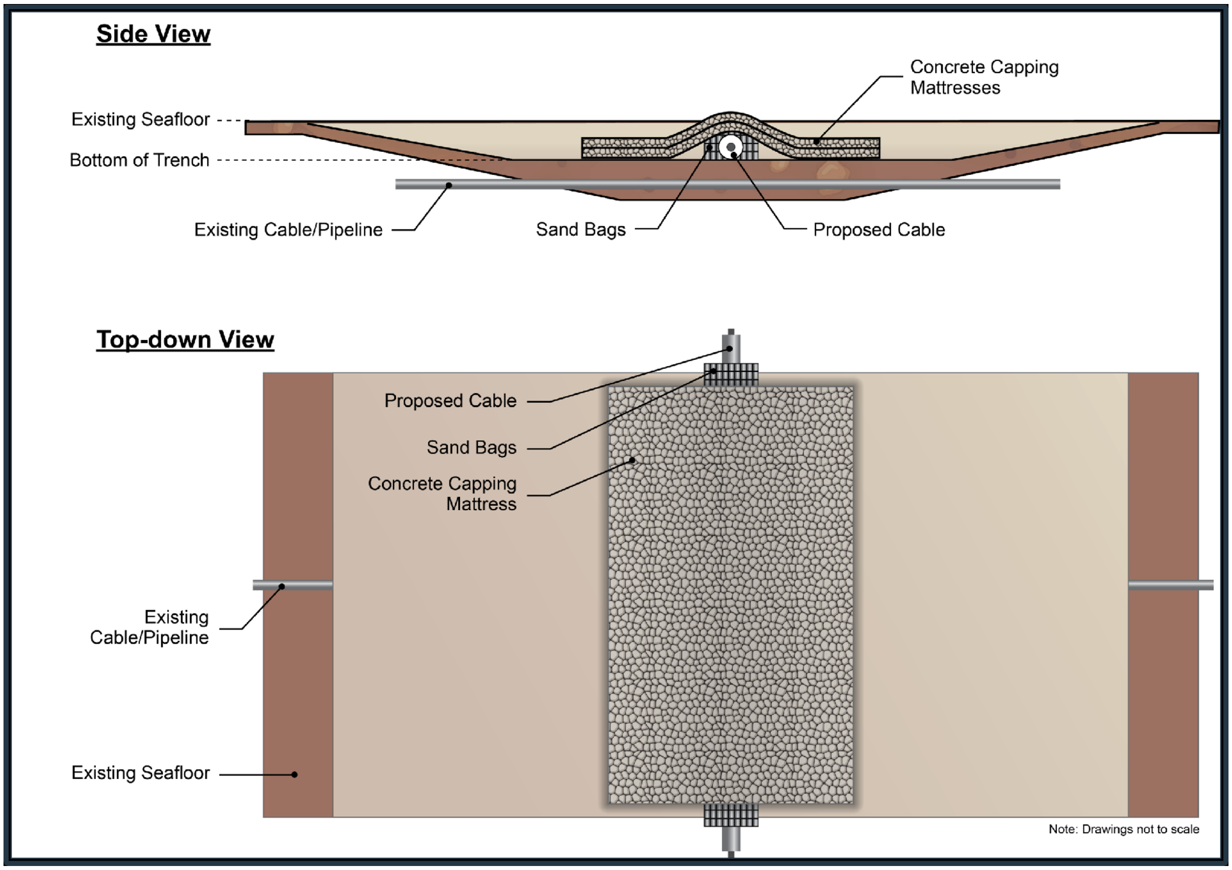
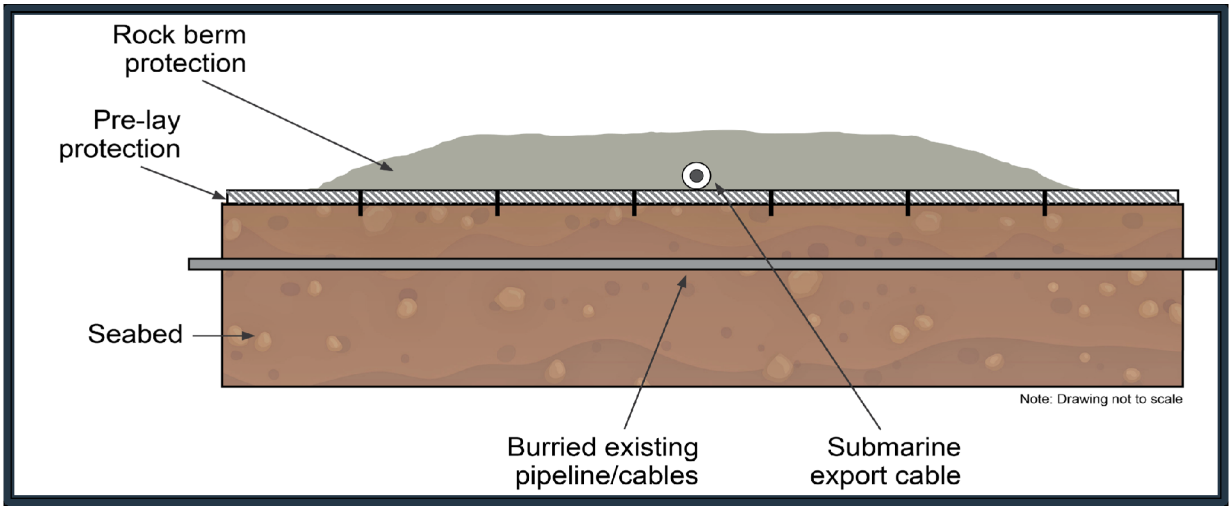
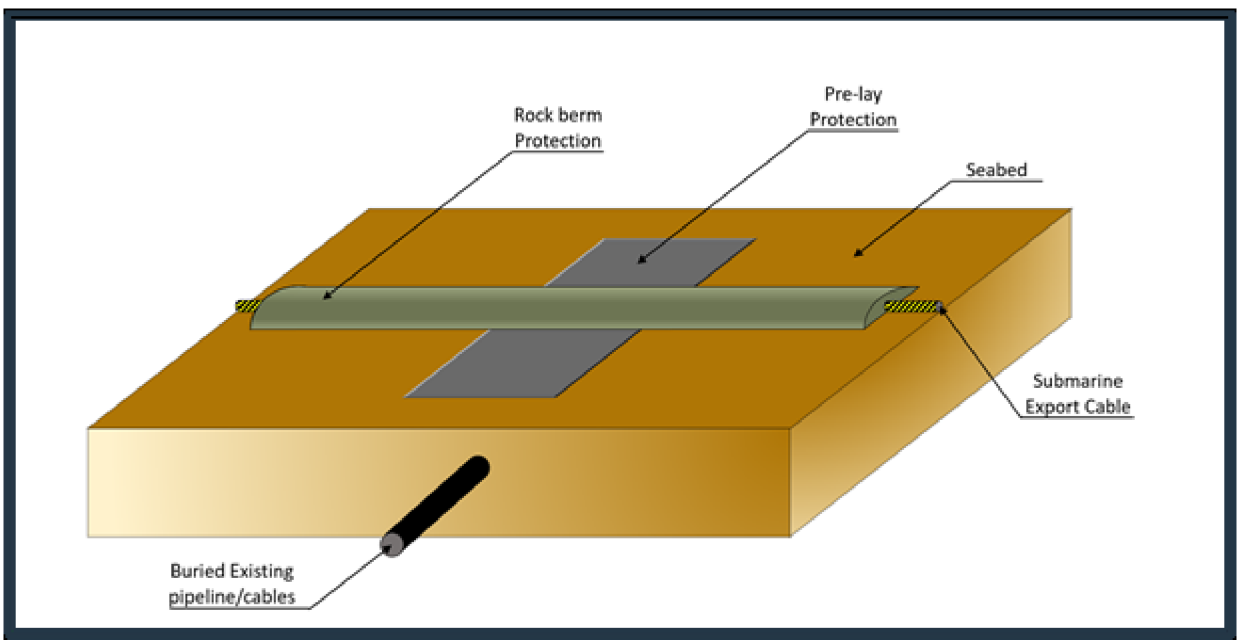


Figure E-3-6. Typical Submarine Cable Crossing Design





E-3.3.1.4 Post-Installation Survey

After cable burial, a post-installation survey will be completed to determine the as-built conditions of the submarine export cable and the levels of burial achieved. The survey will also identify areas requiring remedial cable protection.

E-3.3.1.5 Post-Crossing or Remedial Cable Protection (if needed)

In areas where adequate burial of the cable is not possible, such as cable or pipeline crossings, or sufficient burial depth is not achieved, remedial cable protection may be installed as a secondary measure to protect the cables. Cable burial is the proposed protection technique, as it typically provides the best protection at the lowest cost in the shortest time. Therefore, the submarine export cable will be buried to the proposed burial depth wherever it is technically and commercially feasible to do so, with additional or alternative protection measures only applied if necessary and subject to outcomes of the CBRA and consultation with regulatory authorities and other users (e.g., commercial fishermen). Remedial cable protection measures may include the following:

- Rock – the installation of crushed boulders over a cable;
- Rock bags – pre-filled bags containing crushed rock to be placed over a cable; and
- Concrete mattresses – concrete blocks, or mats, connected via rope or cable.

In addition, at cable and pipeline crossings (**Section E-3.3.1.3**), a primary protection layer of rock or concrete mattresses may be installed over the existing asset prior to installation of the submarine export cable and placement of the previously described cable protection measures, dependent upon separation distance. Cable protection may also be placed around appropriate sections of exposed or at-risk cables, where the amount and type depend on the cable type/position and residual burial depth (if partially buried), and subject to the results of the geophysical and geotechnical surveys, hydrodynamic modeling and the CBRA. It is estimated that up to 10 percent of the length of the submarine export cables may require remedial surface cable protection.[4] **Table E-3-2** details the parameters for the proposed cable protection measures. Representative images of certain cable protection types are presented in **Figure E-3-7**.

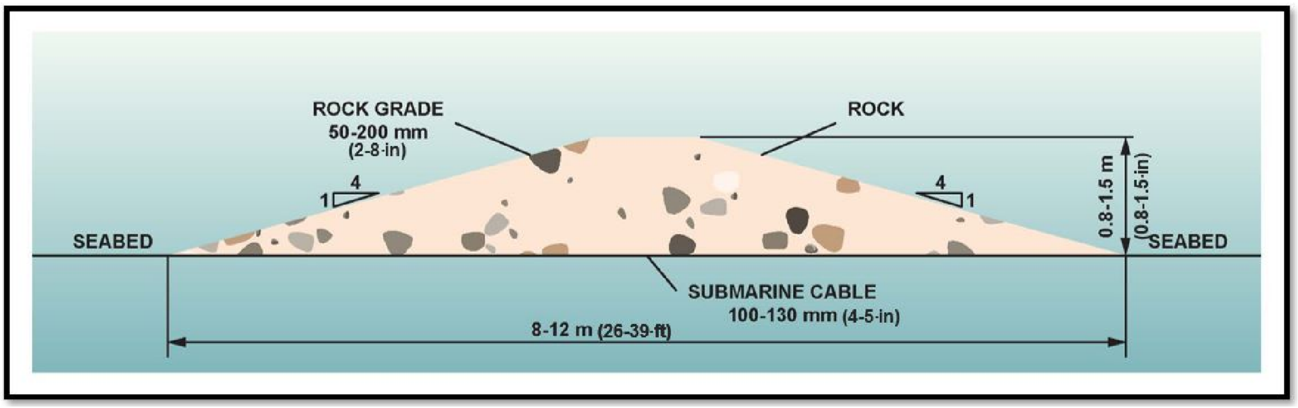
TABLE E-3-2. SUMMARY OF CABLE PROTECTION MAXIMUM PARAMETERS

Cable Protection Parameters	Dimensions a/
Submarine Export Cable	
Width at Base	36 ft (11 m)
Width at Top	5 ft (1.5 m)
Depth	5 ft (1.5 m)
Cable and Pipeline Crossings	
Width at Base	118 ft (36 m)
Width at Top	8.2 ft (2.5m)
Depth	9.8 ft (3 m)
Depth of Protection between Asset Crossed and Cable	18 in (0.5 m)

a/ Provided per cable within each installation corridor

[4] Actual extent of cable protection will be refined upon completion of the CBRA but shall not exceed 10 percent.

Figure E-3-7. Example of Cable Protection (Rock Dumping) for Use in Areas Where Burial Depths Cannot Be Achieved



E-3.3.2 Cable Landfall and Onshore Export Cable Installation

The submarine export cables will make landfall at the Astoria power complex at Lawrence Point in Queens, New York (see **Exhibit 2: Location of Facilities, Figure 2-6**). Once the submarine export cables reach the landfall, they are referred to as the onshore export cables. The onshore export cables will be brought directly into the onshore substation facility by trenchless (e.g., horizontal directional drilling, jack and bore, micro tunneling) installation methods described in **Sections E-3.3.2.1** and **E-3.3.2.2**. A representative example of submarine/onshore export cable transition components at the landfall is provided in **Exhibit 5**. If it is determined that trenchless techniques are not feasible, then an open cut trenching methodology at the landfall would be considered (see **Exhibit 3: Alternatives** for more detail).

E-3.3.2.1 HDD

HDD is used to install cables in ducts under sensitive coastal and nearshore habitats, such as shorelines as well as man-made infrastructure such as bulkheads and roadway crossings. HDD can also be used to cross under major infrastructure, including railroads and highways. **Table E-3-3** provides a summary of the HDD parameters proposed for the NY Project if HDD is the trenchless method used to install the onshore exports cables from the landfall to the onshore substation facility. A representative drawing of this installation methodology is provided in **Exhibit 5**.

TABLE E-3-3. SUMMARY OF HDD PARAMETERS

Parameter	Dimensions a/
Submarine Export Cable	
Onshore (entry) Work Area Footprint	328 ft × 164 ft (100 m × 50 m)
Offshore (exit) Work Area Footprint	328 ft × 328 ft (100 m × 100 m)
Onshore Export Cable/Interconnection Cable Crossing HDD	
Onshore Work Area Footprint	328 ft × 164 ft (100 m × 50 m) × 2 (entry/exit)

Typically, HDD operations for a cable landfall originate from an onshore landfall location and exit a certain distance offshore. The total distance of the HDD is influenced by many factors including, the water depth contour, geologic characteristics, and limitations of the HDD equipment. To support this installation, both onshore and offshore work areas are required. The onshore work areas are typically located within the landfall parcels. Work areas associated with the NY Project are shown in **Exhibit 2, Figure 2-6**.

Once the onshore work area is set up, the HDD activities commence using a rig which drills a borehole underneath the surface (a typical HDD schematic can be found in **Figure E-3-8**). Once the drill for the HDD exits onto the seafloor, the conduits in which the submarine/onshore export cables will be installed are floated out to the offshore exit location and then pulled back onshore within the drilled borehole. A single, larger HDD bore may be completed to install the entire cable bundle or individual, smaller HDD bores may be conducted to accommodate unbundled cables, which will depend on engineering and constructability factors.

The offshore exit location will require some seafloor preparation and construction of a workspace where the HDD drill can target the appropriate depth and location for the submarine export cable to start its landing. Typical offshore HDD exit pit preparations include the installation of a cofferdam or excavation pit that is either open to the sea (wet) or pumped clear of water (dry). This space not only marks the location the HDD drill will complete the borehole; it may be used to collect any drilling fluids that exit the borehole with the drill bit during HDD. Marine support is needed (e.g., vessels, barges, divers) to support HDD drilling operations.

E-3.3.2.2 Non-HDD Trenchless Methods

The submarine/onshore export cables may also transition from the landfall to the onshore substation using micro-tunneling, jack and bore, or other non-HDD trenchless technologies. While each method has its own characteristics, micro-tunneling and jack and bore are generally completed by installing a steel pipe or casing under surface impediments or constraints such as existing roads or other infrastructure. This is completed by excavating a bore (entry) pit and receiving (exit) pit on either side of the crossing. An auger boring machine or tunneling boring machine installs the casing pipe through the earth between each pit. A conduit bundle will be installed within the bore hole, grouted and the onshore export or interconnection cable will then be pulled through the crossing. In general, the decision to use one method over the other will be a factor of the length and size of the pipe, but the construction layout, cable landing, and handling considerations will be similar.

Table E-3-4 provides a summary of the micro-tunnel or jack and bore parameters proposed for the Project. A representative drawing of this installation methodology is provided in **Exhibit 5**.

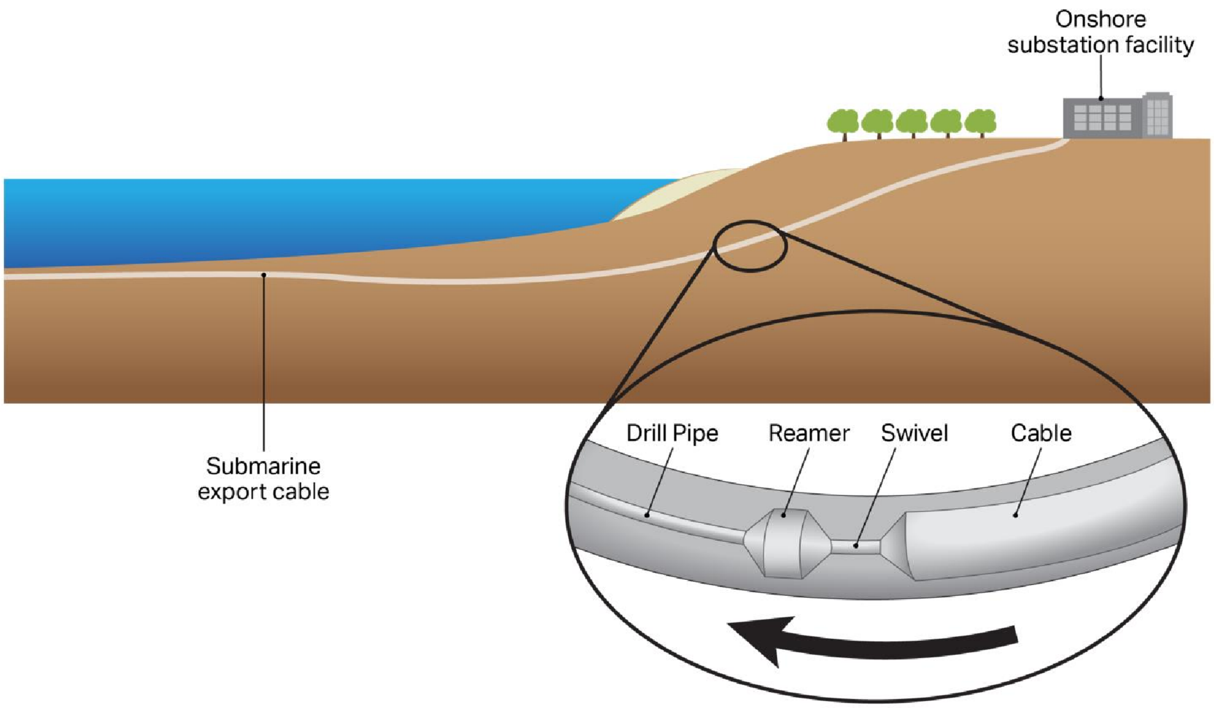
TABLE E-3-4. SUMMARY OF OTHER TRENCHLESS CROSSING (NON-HDD) PARAMETERS

Parameter	Dimensions a/
Work Area Footprint	300 ft × 300 ft (91 m × 91 m)
Bore Pit Footprint	50 ft × 50 ft (15 m × 15 m)
Receiving Pit Footprint	50 ft × 50 ft (15 m × 15 m)

E-3.3.3 Onshore Interconnection Cable Installation

The interconnection between the onshore substation facility and the Astoria West POI will consist of three 138-kV circuits. Each circuit will consist of nine HVAC single core XLPE solid dielectric cables with copper conductors enclosed in XLPE insulation. Three separate fiber optic cables will be used for communication and temperature measurements and will be installed alongside the interconnection cables. The onshore interconnection cables will be housed in three separate concrete duct banks, which will be buried to a target depth of between 3.0 ft and 16.4 ft (0.9 and 5 m) beneath the surface. Shallower burial may be required with the potential need for additional protection depending on subsurface obstructions encountered. Each of the concrete duct banks will be approximately 3 ft (1 m) high by 11 ft (3.4 m) wide, for a total width of 33 ft (10 m). Up to 4 joint pits (manholes) will be located along the interconnection cable corridor to provide access and the spacing between joint pits will vary due to site-specific and cable installation constraints. See **Exhibit 5** for profile and cross section drawings of the interconnection cable. Final locations and design of the onshore interconnection cables will be provided in the EM&CP.

Figure E-3-8. Typical Onshore HDD Landfall



The onshore interconnection cables will be installed in conduits utilizing open cut trench (except where trenchless methodologies are necessary such as if existing infrastructure is present), and will typically include the following main activities:

1. Prepare the construction corridor and excavate a trench;
2. Establish jointing bays;
3. Install ducting;
4. Pull interconnection cables through the ducts;
5. Join the cables; and
6. Restore the construction corridor.

Open cut trenching consists of excavating a trench along the onshore interconnection cable route. During excavation, the material is stockpiled next to the trench or hauled offsite based on the suitability of reuse. The onshore civil components, including the conduits, conduit spacers, and concrete encasement are then installed within the trench. Once installation is complete, the trench is backfilled with thermally acceptable backfill, which can include a combination of excavated soil, borrow soil, or low-strength flowable fills. Excavated soils will be used following engineering analysis and as approved for reuse by permitting authorities. Unsuitable or contaminated soils will be disposed of offsite in an approved manner and location, and suitable and/or uncontaminated soil will be brought in and used as backfill. The area is then restored. **Table E-3-5** provides the dimensions for the open cut trench, recognizing the potential for the corridor widths to increase (or become individual) if the distance between circuits has to increase due to other obstructions. An example of a typical open cut trench operation is provided in **Exhibit 5**.

TABLE E-3-5. SUMMARY OF ONSHORE DUCT BANK PARAMETERS

Parameter	Dimensions
Maximum Depth of Trench	16.4 ft (5 m)
Width of Trench	11.2 ft (3.4 m)
Number of Trenches	3
Construction Corridor Width	82 ft (25 m)
Operational Corridor Width	75 ft (22.9 m)

E-3.3.4 Cable System Maintenance

The NY Project will be designed to operate 24 hours a day with minimal day-to-day supervisory input, with key systems monitored remotely from a central location. During operations and maintenance (O&M), the NY 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. The Applicant will ensure that all components are maintained and operated in a safe and reliable manner, compliant with regulatory requirements, and in accordance with commercial objectives. Remote monitoring and maintenance activities will be based out of the Applicant's O&M facility for the offshore wind farm, on the SBMT site.

An O&M Plan will be developed and finalized prior to the commencement of construction. An Oil Spill Response Plan (for offshore facilities); Spill Prevention, Control and Countermeasures Plan (for onshore facilities); and Safety Management System will also be developed and implemented during O&M activities.

The submarine export cables will be monitored during operations through Distributed Temperature and Distributed Vibration Sensing equipment. The Distributed Temperature Sensing system will be able to provide real time monitoring of temperature along the submarine export cable route, alerting the Applicant should the temperature change, which often is the result of scouring of material and cable exposure. The Distributed Vibration Sensing system will provide real time vibration monitoring close to the cables indicating potential dredging activities or anchor drag occurring close to the cables. Upon receiving any such alert, the Applicant would investigate the cable condition and identify any needed corrective actions. Should one of the submarine export cables fault, the portion of the cable will be spliced and replaced with a new, working segment.

The onshore export cables and onshore interconnection cables should not require regular maintenance, but occasional repair activities may be required should there be a major electrical fault or damage caused by a third party.