Appendix O. Alternatives Analysis for U.S. Army Corps of Engineers Joint Permit Applications (EW 1 and EW 2)

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Empire Wind 1

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U.S. Army Corps of Engineers
Joint Permit Application
Section 10/404 Individual Permit Application

Empire Wind 1 Project

Lease Area OCS-A 0512

Alternatives Analysis

Prepared for:

equinor

Equinor Wind US LLC
600 Washington Boulevard, Suite 800
Stamford, Connecticut 06901

Prepared by:

TETRA TECH

10 Post Office Square, Suite 1100
Boston, Massachusetts 02109

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TABLE OF CONTENTS

FIGURES

ACRONYMS AND ABBREVIATIONS

AIS	automatic identification system
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CLCPA	Climate Leadership and Community Project Act
CO_2	carbon dioxide
COP	Construction and Operations Plan
CSD	cutter suction dredge
Empire	Empire Offshore Wind LLC
EW 1	Empire Wind 1
ft	foot
GBS	gravity base structure
HDD	horizontal directional drilling
HRG	high-resolution geophysical
HVAC	high-voltage alternating-current
HVDC	high-voltage direct-current
km	kilometer
kV	kilovolt
Lease Area	The geographic area defined in Lease OCS-A 0512
LNYBL	Lower New York Bay Lateral
m	meter
mi	mile
MLLW	mean lower low water
MTBM	microtunnel boring machine
MW	megawatt
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NYCDEP	New York City Department of Environmental Protection
NYCDPR	New York City Department of Parks and Recreation
NYCEDC	New York City Economic Development Corporation
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research & Development Authority
O&M	Operations and Maintenance
PANYNJ	Port Authority of New York and New Jersey
POI	Point of Interconnection
Project	Empire Wind 1 Project
PSA	Purchase and Sale Agreement
ROW	right-of-way
SBMT	South Brooklyn Marine Terminal
SSBMT	Sustainable South Brooklyn Marine Terminal
TSHD	trailing suction hopper dredging
TSS	traffic separation scheme
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
UXO	unexploded ordnance
Wall-LI	Wall, New Jersey to Long Island telecommunications cable system

WTG	wind turbine generator

1. INTRODUCTION

Empire Offshore Wind LLC (Empire) proposes to construct and operate an offshore wind farm located in the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). Empire proposes to develop the Lease Area in two individual projects, to be known as the Empire Wind 1 (EW 1) and Empire Wind 2 projects. These individual projects will connect to separate offshore substations and onshore Points of Interconnection (POIs) by way of separate export cable routes and onshore substations. Empire is submitting this Alternatives Assessment as part of the Application to the U.S. Army Corps of Engineers (USACE) for an Individual Permit for jurisdictional activities pursuant to Section 404 of the Clean Water Act (Section 404) and Section 10 of the Rivers and Harbors Act (Section 10) for EW 1 (referred to hereafter as the Project).

As part of the design development of the EW 1 Project (Project), Empire conducted a detailed analysis of potential POIs to the existing grid and Project alternatives to connect the offshore Lease Area to the POI. Empire evaluated siting alternatives for the submarine export cable route from federal waters, onshore substation location, export cable landfall, and onshore cable route to interconnect with the POI relative to constructability, reliability, environmental resources, and stakeholder impact criteria. Although each component was assessed separately, the siting process was completed holistically relative to submarine and terrestrial constraints to identify the most feasible and reasonable overall solution to deliver energy from the Lease Area to the electric grid, with the fewest negative impacts. The evaluation is informed by several factors, including desktop assessments, site-specific surveys, supply chain capacity, commercial availability, and engagement with regulators and stakeholders. Additional discussion of the selection of the POI for the Project is provided in **Attachment D** (Project Narrative).

An initial high-level assessment of offshore constraints was conducted based on geographic information system data to identify the most feasible potential submarine export cable routes between the Lease Area and the area of Gowanus Bay, New York. A siting comparison of the potential submarine export cable routes was then conducted. Section 2.1 summarizes the constraints analysis and results for the identified submarine export cable alternatives within federal waters. Empire conducted more detailed site assessment, including geophysical and geotechnical surveys, along the proposed route (see **Attachment D** [Project Narrative]).

Once the submarine export cables make landfall, they either extend directly to the onshore substation or they transition to onshore export cables to transport power from the cable landfall to the onshore substation[1] (in the case of most evaluated alternatives). Interconnection cables leave the onshore substation underground to deliver power to the POI. The onshore cable route refers to the complete route traversed by the onshore export and interconnection cables between the submarine cable landfall and the POI.

In addition to evaluating Project siting alternatives, Empire also considered the use of alternative technologies. This analysis considered alternative submarine export cable current type, cable landfall installation, submarine asset crossing methodologies, and pre-sweeping and dredging methodologies, as discussed in Section 3.4. These alternative technologies were assessed relative to feasibility of existing technology and logistics, cost, and environmental impact, where applicable, in light of the overall project purpose.

[1] The final configuration is still under evaluation, but Empire anticipates that the design for cable landfall and onshore transition will be consistent with the methods and environmental impacts described herein.

2. PROJECT DESIGN DEVELOPMENT

This section provides an overview of the design development of the Project, including portions of the Project in federal waters. **Section 3** provides the detailed Alternatives Analysis[2] in accordance with the Clean Water Act's 404(b)(1) Guidelines, 40 Code of Federal Regulations (CFR) Part 230, for the discharge of dredge or fill material associated with the submarine export cable alternatives, cable landfall alternatives and onshore cable route alternatives, and alternative technologies.

2.1 Submarine Export Cable Route Alternatives – Federal Waters

Based on the location of the POI, an analysis of offshore routing constraints was the first step in submarine export cable route assessment to identify potential submarine export cable routes between the Lease Area and the POI, to assess feasibility, and to understand potentially significant challenges along each route. In considering submarine export cable routes between the Lease Area and the area of Brooklyn, New York, the most direct submarine export cable route served as the starting point in developing the export cable route. This was also driven by technical constraints and costs, including cable costs, installation time, and limits associated with efficient high-voltage alternating-current (HVAC) transmission. Detail on the offshore routing constraints considered in the offshore routing constraints analysis is provided in Volume 1, Section 2 of the Construction and Operations Plan (COP, provided in **Appendix D-1** of **Attachment D** [Project Narrative]).

Three submarine cable route alternatives were considered for the submarine export cable route in federal waters, which are presented in **Figure 1** and **Figure 2**.

Both regional bathymetry datasets (NOAA 2015) and project-specific high-resolution geophysical (HRG) survey data were collected to analyze general seabed conditions and specific seabed-related risks along the potential submarine export cable routes. These data have allowed for routing to minimize traversing steeper seabed slopes and areas of complex seabed due to scour, mobile seabed, potential hardgrounds, or anthropogenic dredged channels. Steep slopes and abrupt changes in depth can pose a risk to cable installation and burial, as seabed cable burial tools are susceptible to stability issues and decreased burial potential as slopes increase. Areas of very shallow water also pose a challenge to the installation because a cable vessel suitable to install this type of cable requires an adequate draft to safely maneuver.

Existing utilities and other assets pose several challenges and risks with respect to the submarine export cables and may limit the methods and depth of burial available for cable installation at the crossing. This may add cost and complexity to the installation, as well as residual risks to the installed cable from reduced burial in the area, the installation of external protection, and/or from maintenance activities for the existing asset. As such, cable crossings and close parallels are avoided to the extent feasible by the routing.

[2] Alternatives for the development of the Lease Area and associated facilities are also considered as part of the Empire COP filed in January 2020 and subsequent revisions in response to agency comments. The COP became publicly available following the Bureau of Ocean Energy Management issuance of a Notice of Intent to prepare an Environmental Impact Statement in June 2021. Additional information on the Project design development is provided in Section 2 of the COP (**Attachment D**, **Appendix D-1**).

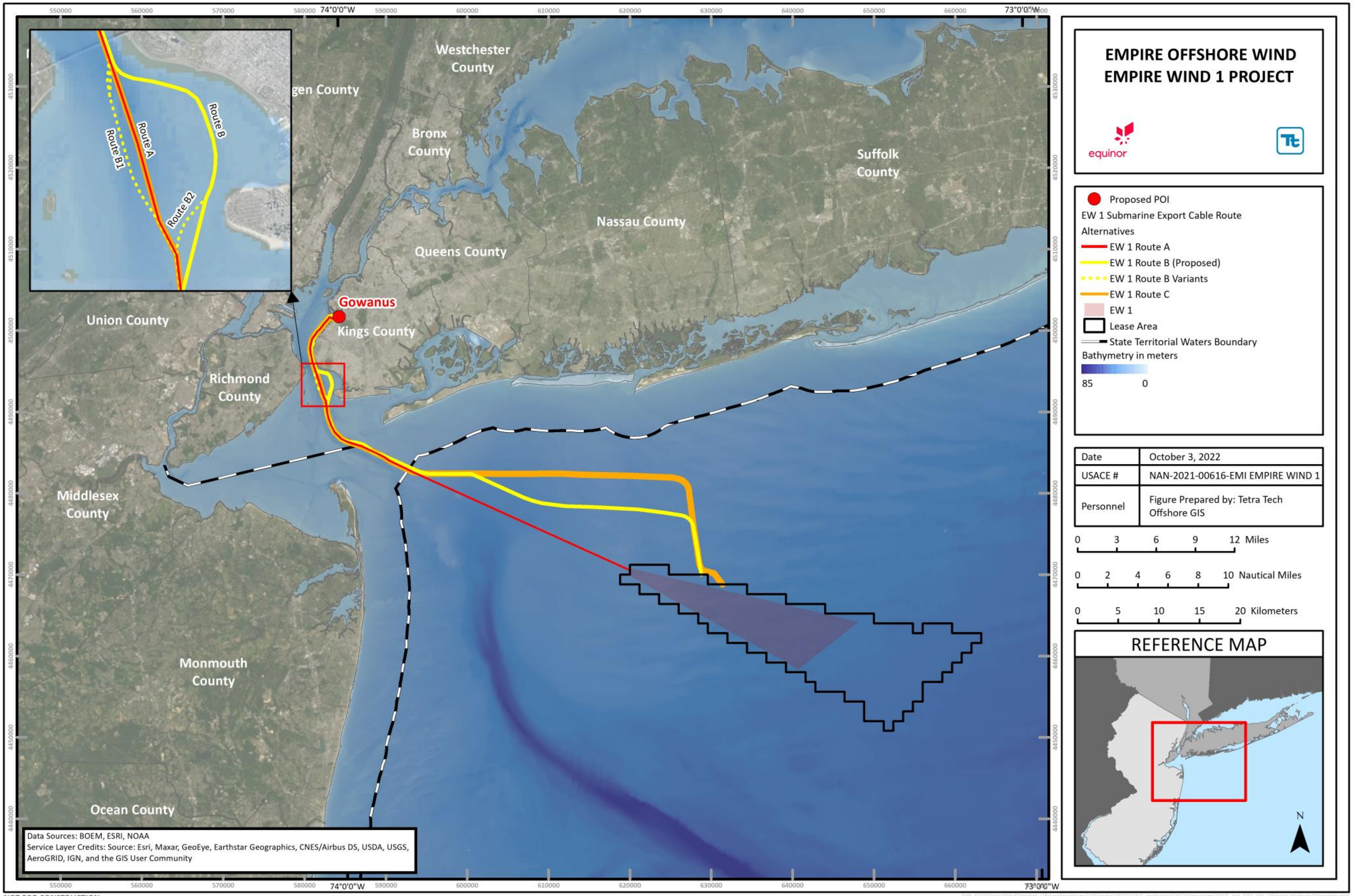

Figure 1 **Submarine Export Cable Route Alternatives – Federal Waters**

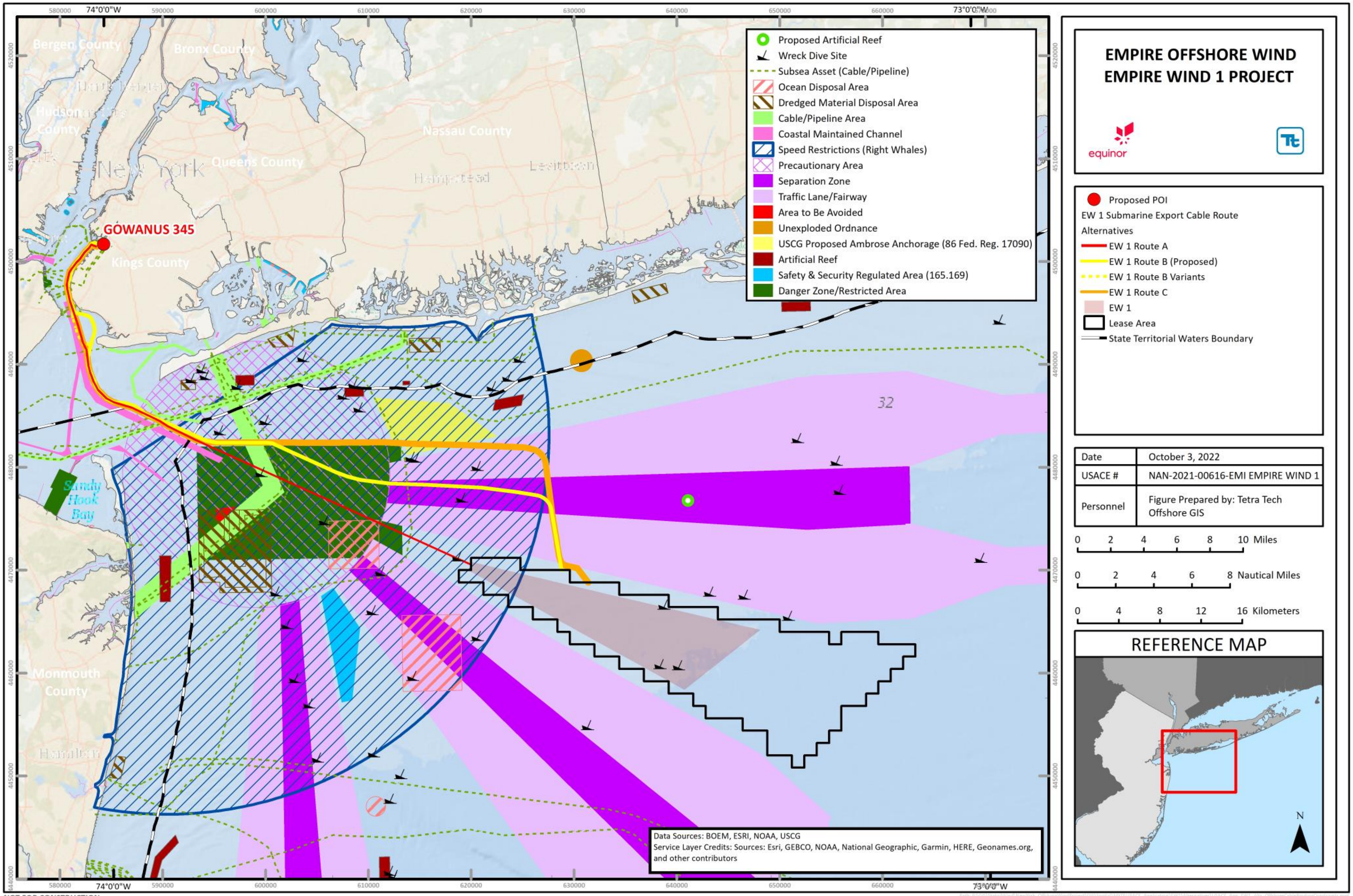

Figure 2 Submarine Export Cable Route Offshore Constraints – Federal Waters

Dredged and maintained channels are under the purview of the USACE. The location and depths of navigation channels are authorized by the federal government, and the USACE periodically performs condition surveys to identify when maintenance dredging may be needed to keep the channels available at the authorized depth. Should a cable route cross a maintained channel, the cable must be buried deep enough below the authorized depth to ensure that the channel can be safely maintained and to ensure that there is no risk to the cable; therefore, installation within dredged and maintained channels is minimized to the extent practicable.

Traffic separation schemes (TSS) are commonly used to identify and constrain inbound and outbound traffic lanes, typically with a separation zone between these lanes to minimize the likelihood of vessel collisions. Two of the evaluated submarine export cable routes must cross the TSS located to the north of the Lease Area.

Charted danger zones, restricted areas, and warning areas exist for a variety of reasons and serve to advise mariners and other users of the risks of navigating an area or conducting some type of bottom contacting activity, such as fishing or cable laying. For these reasons, traversing charted danger zones is avoided to the extent practicable. Similarly, charted disposal areas warn mariners and other users of the risks associated with traversing an area of disturbed seabed. While some areas may contain relatively harmless material, such as dredged spoils from maintained channels, others may contain acid wastes (an industrial byproduct), municipal waste (a sewage treatment product), or munitions.

Shipwrecks and other obstructions are cataloged in the National Oceanic and Atmospheric Administration (NOAA) Nautical Charts and within the NOAA Automated Wreck and Obstruction Information System database. These features may represent physical hazards to installation and may be historically or culturally significant. These features are avoided to the extent practicable by the submarine export cable routing. Where such features must be closely approached, the HRG survey provides insight into the location and nature of the feature through acoustic and magnetic datasets. Known and suspected shipwrecks and obstructions were avoided to the extent practicable during pre-survey routing and the routing was further refined following the acquisition of HRG survey data. Identified features and recommended buffer distances is in the process of being defined through review of the HRG survey and diver data by a qualified marine archaeologist.

All route alternatives also cross a seasonal management area for Right Whales, where vessel speed restrictions are in place. Project-related vessels will comply with NOAA National Marine Fisheries Service speed restrictions in this area.

2.1.1 EW 1 Route A

The EW 1 Route A Alternative represents approximately the shortest and most direct route from the offshore Lease Area to export cable landfall alternatives near the POI (36 nautical miles [nm, 42 miles {mi}, 67 kilometers {km}]). Minimizing route length was a primary driver in route selection, as it directly impacts project costs, electrical transmission, and environmental and stakeholder impacts of cable installation. EW 1 Route A, the first alternative considered, traversed northwest from the westernmost portion the Lease Area. This route then crossed a bathymetric high exhibiting increased seabed complexity and higher backscatter in regional seabed studies. Known as Cholera Bank, this feature has an increased potential as valuable seabed habitat and is targeted by fishing efforts. EW 1 Route A avoids interactions with the TSS lanes (**Figure 2**) but crosses a dump site with a usage status of “discontinued” and previously used for “municipal sewage sludge.” EW 1 Route A enters the Precautionary Area associated with the entrance to Ambrose Channel. Prior to reaching the Precautionary Area, the route enters a charted danger area. EW 1 Route A then follows the same alignment as Route B to landfall.

2.1.2 EW 1 Route B (Proposed Project Alternative)

EW 1 Route B Alternative (40 nm [46 mi, 74 km]) from the Lease Area to the export cable landfall is a route designed to mitigate the impacts to Cholera Bank. EW 1 Route B departs the Lease Area along its northern boundary and continues north-northwest across the outbound lane of the Ambrose to Nantucket TSS (**Figure 2**) and then enters the separation zone between the traffic lanes before turning to the west. The route continues through the traffic separation zone towards New York Harbor reaching the Precautionary Area at the end of the traffic lanes. Prior to reaching the Precautionary Area, the route enters a charted danger area. Risks of encountering UXO in this area have been and will continue to be studied to evaluate what mitigation measures may be necessary. This routing avoids the shallower and more complex seabed areas associated with Cholera Bank while minimizing impacts to the TSS lanes.

To minimize the traverse of the charted danger area, the route turns to the northwest and crosses the planned path of the Wall, New Jersey to Long Island (Wall-LI) telecommunications cable system (personal communications). The route passes approximately 2.0 nm (2.3 mi, 3.8 km) north of the Ambrose Channel Pilots Buoy, where it resumes a westerly direction after exiting the danger area.

North of the Red "4" Ambrose Channel buoy, the route turns to the northwest to stay north of the Ambrose Channel, a dredged and maintained shipping channel under the authority of the USACE. Ambrose Channel is authorized to a depth of 53 feet (ft, 16.2 meters [m]), with a width of 2,000 ft (610 m).[3] The route maintains an approximately 1,250 to 1,300-ft (380 to 400-m) offset from the designated channel boundary and is over 980 ft (300 m) outside of the boundaries of the areas dredged to maintain the channel.

Empire is proposing EW 1 Route B due to its minimization or avoidance of interaction with key constraints including Cholera Bank, TSS lanes, and a charted danger area.

2.1.3 EW 1 Route C

EW 1 Route C Alternative (41.8 nm [77.4 km]) from the Lease Area to the export cable landfall was designed to minimize potential risks from UXO by avoiding the charted danger area (**Figure 2**). EW 1 Route C follows Route B out of the Lease Area and then continues across both the inbound and outbound traffic lanes of the TSS before turning west to stay north of the danger area. This route increases the distance within the inbound TSS traffic lane and also traverses a large but not formally defined de facto anchorage just north of the danger area. As anchoring here is less regulated and more dispersed, protection via deeper cable burial would need to occur over a larger area, increasing costs and impacts. As such, EW 1 Route B has been evaluated as the best approach. West of this area, EW 1 Route C follows the same alignment as EW 1 Route B.

3. ALTERNATIVES ANALYSIS

Except in certain cases, 40 CFR Part 230 prohibits discharge of dredge or fill material where a practicable alternative exists to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. An alternative is considered practicable if it is available and could be implemented considering cost, existing technology and logistics in light of the overall project purpose. The overall project purpose is the construction and operation of a commercial scale offshore wind energy project for renewable energy generation and distribution to New York State's energy grid in support of New York's renewable energy mandates. This alternatives assessment is

[3] Additional correspondence with the USACE dated August 20, 2020 indicates that that the USACE has received approvals to evaluate and report on the feasibility of improving Ambrose Channel from 53 ft (16 m) to 58 ft+ (18 m) mean lower low water (MLLW).

provided in accordance with the 404(b)(1) Guidelines for the Specification of Disposal Sites for Dredged or Fill Material.

Under the 404(b)(1) Guidelines, if a proposed activity is to be located in a special aquatic site but is not water dependent, practicable alternatives not involving special aquatic sites are presumed to be available unless the applicant demonstrates otherwise. Offshore wind farms are generally considered not to require access or proximity to or siting within a special aquatic site to fulfill their basic project purpose (wind energy generation), and therefore are not water dependent. Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs and riffle and pool complexes. The proposed Project does not cross any identified special aquatic sites, and Empire has not identified any special aquatic sites that would be affected by the proposed Project. As a result, the presumption does not apply to EW 1.

3.1 Purpose and Need

The purpose and need for the Project is to develop a commercial-scale offshore wind energy facility in Lease Area OCS-A 0512 with wind turbine generators, an offshore substation, and electric transmission cables making landfall in Brooklyn, New York to support the achievement of New York's renewable energy mandates.

In August 2016, the Commission adopted the Clean Energy Standard.[4] Under this standard, 50 percent of New York State's electricity must come from renewable sources of energy by 2030. In 2017, New York set a goal of having 2.4 gigawatts of energy generated by offshore wind by 2030, which the Commission adopted as a supplementary goal for its Clean Energy Standard by order dated July 12, 2018.[5] On November 8, 2018, the New York State Energy Research and Development Authority (NYSERDA) issued its first competitive solicitation for 800 megawatts (MW) or more of new offshore wind projects. On July 18, 2019, Empire and the 816-MW EW 1 Project was announced as a winner of that first state solicitation. On the same day, the Climate Leadership and Community Protection Act (CLCPA) was signed into law. The CLCPA requires that the State obtain 70 percent of its electricity from renewable sources by 2030 and 100 percent by 2040, and that New York has 9,000 MW of offshore wind capacity by 2035. Equinor Wind US LLC and NYSERDA entered into the Offshore Wind Renewable Energy Certificate Purchase and Sale Agreement (PSA) on October 23, 2019. Equinor Wind US LLC subsequently entered a 50-50 partnership with bp plc in 2021 and assigned Lease OCS-A 0512 to Empire Offshore Wind LLC. The PSA requires Empire to design, obtain permitting/approvals for, build and operate the Project and to sell the Offshore Renewable Energy Certificates generated to NYSERDA.

The Project is needed to meet the Empire's obligation to NYSERDA to generate approximately 816 MW of clean, renewable electricity from an offshore wind farm located in the Lease Area for delivery into the New York State power grid via ConEdison's existing Gowanus 345-kilovolt (kV) Substation. The Project is an essential element in addressing the need identified by the State for renewable energy and will help the State achieve its CLCPA mandate and other renewable energy goals.

3.2 No Action Alternative

Under the No Action Alternative, the Project would not be built, the PSA contract between Empire and NYSERDA would not be fulfilled, and the Project's purpose to generate and deliver to New York renewable energy from the offshore wind farm in the Lease Area in furtherance of New York's renewable energy mandates and goals would not be met. The No Action Alternative does not meet the criteria to generate renewable energy

[4] Case 15-E-0302, *Large-Scale Renewable Program and Clean Energy Standard*, Order Adopting a Clean Energy Standard (Issued and Effective August 1, 2016).
[5] Case 18-E-0071, *In the Matter of Offshore Wind Energy*, Order Establishing Offshore Wind Standard and Framework For Phase 1 Procurement (Issued and Effective July 12, 2018).

through a commercial-scale offshore wind energy facility within the area defined by Lease OCS-A 0512 to meet the PSA to provide approximately 800 MW of energy to the New York State energy grid.

The No Action Alternative would result in no construction and operation of a commercial scale wind energy project, and therefore does not meet the Project's overall purpose. Because it does not meet the Project's purpose, the No Action Alternative is not a practicable alternative and is eliminated from further consideration.

3.3 Cable Landfall Alternatives

To identify the preferred cable landfall site, Empire conducted coastal and waterfront engineering analyses of the risks and benefits of potential cable landfall locations at multiple sites in New York. Depending on the distance to the onshore substation, the submarine export cables may transition to onshore export cables between the cable landfall and the onshore substation, or in the case of the EW 1 Cable Landfall Alternative at the South Brooklyn Marine Terminal (SBMT), the submarine export cables may be pulled directly into the onshore substation (hereafter, EW 1 onshore export cables). Interconnection cables leave the onshore substation to deliver power to the POI. The onshore cable route refers to the complete route traversed by the onshore export and interconnection cables between the submarine cable landfall and the POI. The locations of potential cable landfalls were also informed based on the submarine export cable routing analysis (Section 3.3.3), and the onshore substation site selection (see Section 2.1.3.2 of the COP in **Appendix D-1** of **Attachment D**).

Based on the location of the POI, the study area for a potential submarine export cable landfall includes the Brooklyn shoreline between Coney Island to the south, and the Sunset Park and Red Hook neighborhoods to the north. For much of this highly developed area, which borders the upper part of the Lower Bay of New York Harbor, Gravesend Bay, and Upper Bay, the shoreline typically consists of bulkheads, steel sheet piles, seawalls, wood piles, riprap, concrete and other debris, or a combination thereof. In some areas, relic structures and marine debris remain from former shoreline developments. Cable and other asset crossings are present across the navigation channels. Potential shoreline locations of adequate size for the submarine export cables to make landfall are limited, due to the highly developed nature of the area.

Cable landfalls to the north of SBMT and ConEdison's Gowanus 345-kV Substation were eliminated. Potential landfall sites further north would lengthen the overall transmission system from the offshore substation to the POI (thereby increasing cost, time and potential environmental impacts) and would need to represent substantial benefit to offset these undesirable attributes. Furthermore, routes making landfall north of the Gowanus 345-kV Substation add significant complexity due to challenges of constructing within or across the Gowanus Canal, currently a U.S. Environmental Protection Agency Superfund site. Therefore, the concept of landfall north of the Gowanus 345-kV Substation was not explored further. The concept of a direct landfall to the Gowanus 345-kV Substation was also eliminated, due to the potential complexities associated with an existing cable landfall (Bayonne Transmission) at that location. It was also recognized that the need to construct an onshore substation on a separate parcel would negate potential benefits of direct landfall to the Gowanus 345-kV Substation, because a land route would still be required to connect to the proposed onshore substation site.

In response to feedback from USACE and other stakeholders, Empire evaluated cable landfall alternatives as far south as Coney Island and within Gravesend Bay and associated onshore routes to the POI. The remaining conceptual landfall alternatives selected for detailed evaluation were located along the Brooklyn waterfront to the north of the Verrazzano-Narrows Bridge.

From each cable landfall alternative, the goal of the onshore cable routing was to develop a constructible route that is largely sited within public rights-of-way (ROWs) and minimizes impacts to the environment and the public. Siting the onshore cable routes to use public ROWs, where possible, is advantageous because the area is congested and highly developed, and is generally made up of small, privately owned lots with insufficient space for constructing the Project. Public ROWs limit the number of stakeholders directly impacted and the number of new landowner easements that must be acquired for the onshore cable route. However, minimizing in-street work reduces impacts on traffic, enhances safety during construction, and typically shortens the duration of installation. Roadways also typically contain gas, sewer, water, telecommunications, and electric utilities, which add routing and workspace constraints, construction logistics and complexity.

During conceptual routing, the route alternatives that had some construction flexibility for siting refinement were preferred. For example, roadway corridors with available shoulders or space on both sides of the roadway were preferred. Wide corridors are needed to allow for adequate construction workspace and access for installation of the Project and to minimize the potential need for road closures. By routing the Project along wider ROW corridors, constraints during the route assessment and development process can more easily be avoided with minor modification of the route alignment and/or construction workspace.

3.3.1 Cable Landfall Evaluation Criteria

The evaluation of cable landfall, submarine and onshore cable route alternatives was conducted as an iterative process that involved multiple steps of evaluation of the offshore and onshore cables routes, constraints on potential landfall locations, and the feasibility of landfall installation methodologies at potentially suitable landfall sites. Each of these Project components, although described as separate evaluations, were considered in concert for the selection of the overall proposed solution for the Project.

Cable landfall alternatives that were evaluated in detail are shown in **Figure 3**. Each landfall was evaluated relative to the following existing technology, cost, logistical, environmental, and stakeholder considerations:

- Proximity to the preferred POI (e.g., onshore route length);
- Prior subsea cable landfall success in nearby areas;
- Staging area size/options (e.g., preferably land without permanent structures, with a minimum size to allow for adequate staging);
- Hydrodynamics and sediment dynamics (e.g., erosion);
- Artificial interferences (e.g., fish trap area, pipelines, dredging);
- Environmental, wildlife habitat, and cultural considerations (e.g., eelgrass, dunes, wetlands, buried and/or submerged cultural resources);
- Technological and logistical constructability complexities (e.g., utility congestion); and
- Land use (consistency of existing uses, minimizing impacts to public lands).

Cable landfalls were evaluated relative to the use of horizontal directional drilling (HDD) installation methodology, as well as open cut methodology. These methods are briefly described below and evaluated for the proposed cable landfall in Section 3.4.5.

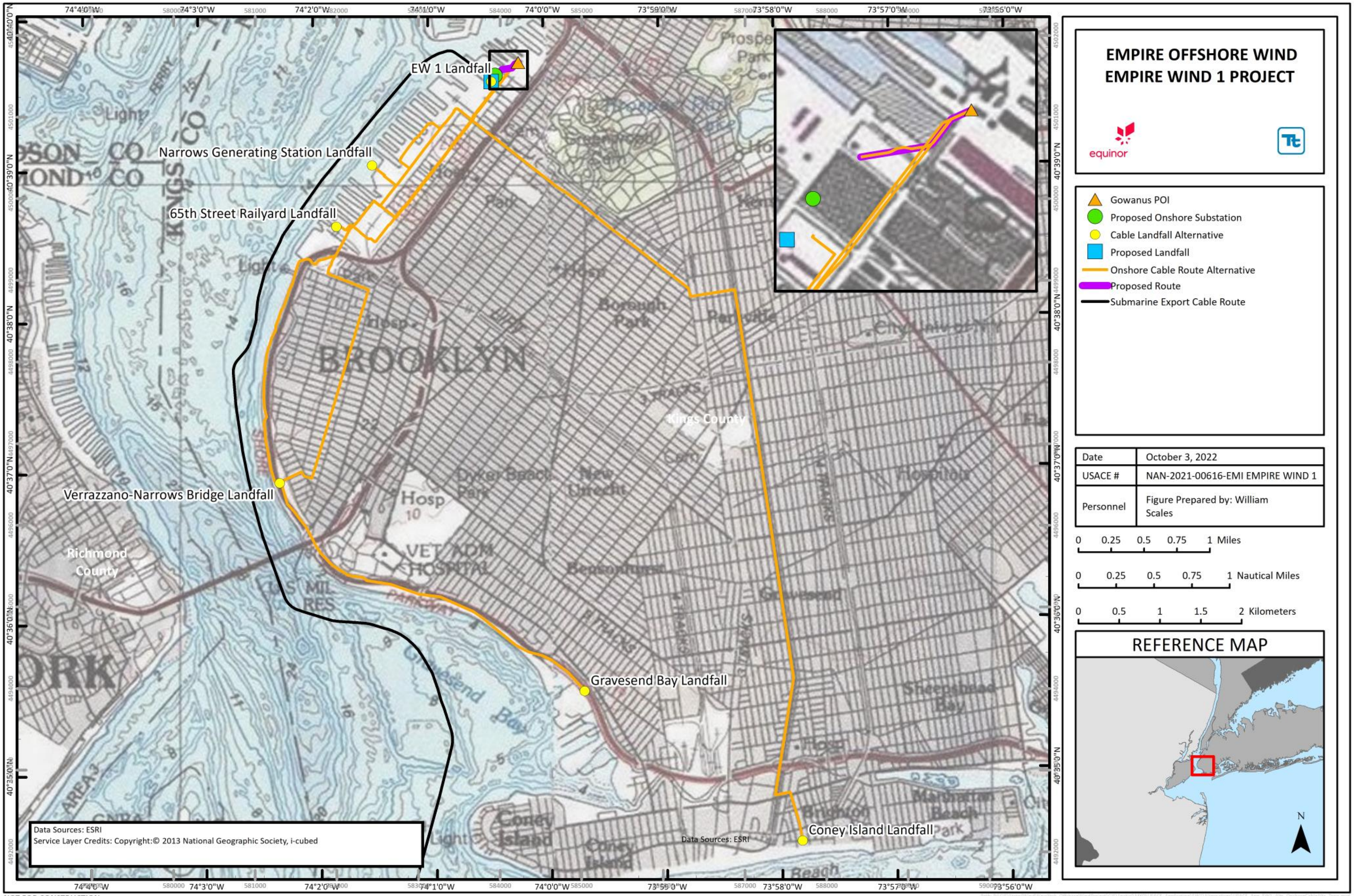

Figure 3 **Cable Landfall and Onshore Cable Route Alternatives**

3.3.1.1 HDD Installation

Horizontal directional drilling is a trenchless installation method often used to install cables in ducts under sensitive coastal and nearshore habitats, such as dunes, beaches, waterways, and submerged aquatic vegetation. HDD can also be used to cross under major infrastructure, including railroads and highways. Typically, HDD operations for an export cable landfall originate from an onshore landfall location and exit a certain distance offshore, determined by the water depth contour and total HDD length considerations. To support this installation, both onshore and offshore work areas are required.

The onshore work areas are typically located within the cable landfall parcel, supporting a drilling rig containment pit for drilling mud, a drill control cab, and staging of the drill stem and drilling mud production/recycling. Once the onshore work area is set up, the HDD activities commence using a rig that drills a borehole underground. The drill begins with a pilot bore that consists of advancing a steerable, rotary drill bit along the design alignment from the drill rig entry location to the exit location. Once the pilot bore is completed, the drilling assembly is removed and replaced with a reaming assembly. Reaming involves enlarging the pilot bore to a larger diameter to accommodate the conduits. Depending upon the required diameter, multiple passes with reamers of increasing diameter may be required to incrementally enlarge the pilot bore to its final diameter.

Upon completion of the reaming pass(es), the condition of the HDD bore is assessed by completing a swab pass through the bore. This pass consists of pushing or pulling a slightly smaller diameter barrel or ball reamer through the fully reamed bore from start to finish. When the reaming operation is completed, the conduit (steel or high-density polyethylene) in which the submarine cable will be installed, is pulled back onshore within the drilled borehole from the offshore exit side.

The offshore exit location requires some seafloor preparation in order to collect any drilling fluids that localize during HDD completion. Depending on the seabed conditions, a temporary steel casing may be installed on the exit side from a jack-up barge to below the mudline. This jack-up barge would also house a drill rig. Seabed preparation may also be completed with the installation of a cofferdam for each HDD and excavation to remove material from the cofferdam. A pit would be excavated or material within the cofferdam would be dredged prior to installation of the conductor casing. The offshore work area for HDD installation requires approximately 10,000 square feet (930 square meters), and siting consideration is needed to avoid impact to marine traffic.

Onshore, the entry side of the HDD installation requires an approximate workspace of 246 by 246 ft (75 by 75 m). The entry side staging area is required to locate equipment necessary for the installation, which includes the drill rig, stacks of drill pipe, operator control cabin, tooling trailers, crane or excavator, separation plant, mud tanks, mud pumps, water storage tanks, office trailer, and support trailers.

In addition to the entry and exit staging areas, a conduit staging area is also required for fabricating each conduit (or pipe) string. Each conduit string is fully fabricated into a single string with a length equivalent to the approximate length of the HDD installation (additional length may be necessary to account for geometry). This results in a conduit staging area requirement for a single conduit string that is typically 20 to 25 ft (6.1 to 8.2 m) wide by the length of the conduit string (approximately 2,460 ft [750 m]). The conduit string is floated out to the offshore HDD exit location, where it is installed using the drill string to pull it back through the drill hole.

HDD installations also require the overlying soils to possess sufficient strength to resist the required drilling fluid pressures during the installation and to allow the fluids to flow through the bore path created by the drilling equipment and back to the drill rig location. Sands, silts, and clays, when in a very soft or very loose state, may not provide sufficient strength to resist the required fluid pressures necessary to complete an HDD installation. It is important to note that longer installations typically require greater depths of cover to allow for sufficient overlying strength to resist the drilling fluid pressures.

Inadvertent returns occur when drilling fluid pressures exceed the strength of the overlying geotechnical material, and pressure causes the drilling fluids to follow a path that flows upwards and outwards until the pressure is relieved. Drilling fluids reaching the sediment surface may pond on the ground surface in uplands or be released on the seabed as inadvertent returns. All HDD installations carry some risk of an inadvertent drilling fluid return, especially during the exit curve and exit tangent, as the drill bit is steered upwards toward the ground surface or seabed. Inadvertent return risks can be reduced along the majority of an HDD alignment by selecting an appropriate depth of cover that provides sufficient overlying strength to resist the required fluid pressures; however, near the entry and exit points an HDD will need to cross shallow sediments.

Geotechnical conditions, HDD geometry, and bending radii dictate HDD installation depth, which may be driven by a combination of factors, including sediment characteristics, the required HDD entry angle, avoidance of existing shoreline infrastructure, limitations on the length of the drill, and potential impacts on maritime traffic at the location of the HDD exit point.

3.3.1.2 Open Cut Installation

Open cut alternatives and other non-trenchless installation methods would use standard submarine cable installation methods to facilitate installation at target burial for approach to landside. Open cut methods may include open cut trenching/dredging or jetting to bury the cables up to the landfall conduits. Jetting involves the use of pressurized water jets into the seabed, creating a trench. As the trench is created, the submarine export cable is able to sink into the seabed. The displaced sediment then resettles, naturally backfilling the trench.

Dredging is used to excavate, remove, and/or relocate sediment from the seabed/waterway in order to allow for the cable to make landfall at the target installation depth. Dredging can be completed through clamshell dredging, suction hopper dredging, and/or hydraulic dredging. During dredging activities, the material is collected in an appropriate manner for either re-use or disposal (depending on the nature of the material) and in accordance with applicable regulations.

A typical open cut method would involve installation of a sheet pile cofferdam to isolate the area of the shoreline at the landfall, dewatering within the area of the cofferdam, and excavating a trench for each cable within the dry cofferdam(s). Cable conduits would then be installed within the trench and the trench would be backfilled. Following installation of the conduits across the shoreline, the cables would be pulled through the conduits for final installation.

Additional non-trenchless installation methodologies are also considered at the interface of a developed shoreline for landfall (e.g., rip rap, bulkhead or sheet pile) and include installation "through the bulkhead" or "over the bulkhead," which would involve trenching/dredging or jet plowing the submarine export cables to the target burial depth along the approach to landside (see Section 3.4.5). These methods use conduits to install the cables over or through the developed shoreline feature, rather than trenching across such features.

3.3.2 Cable Landfall Alternatives

The cable landfall analysis is described in this section. Empire considered potential landfall alternatives in Coney Island and along Gravesend Bay, as well as four sites to the north of the Verrazzano-Narrows Bridge. Three of these northern landfall alternatives are immediately adjacent to the onshore substation alternatives (see Section

2.1.3.2 in the COP **Appendix D-1** of **Attachment D**). Cable landfall and onshore cable route alternatives were evaluated relative to the criteria listed in Section 3.3.1. The cable landfall and associated onshore cable route alternatives are considered together, since they are interdependent (i.e., a viable onshore cable route alternative needs a viable cable landfall alternative and vice versa).

3.3.2.1 Coney Island Alternative

Coney Island Cable Landfall

Empire evaluated a large public parking area on the north side of Brighton Beach as a potential Coney Island Cable Landfall Alternative. The Brighton Beach public parking area is located immediately to the south of Brightwater Circuit, opposite Brighton 3rd Street. The parking area covers approximately 2 acres (ac, 0.8 hectares [ha]), and it is bounded by the Rieglemann Boardwalk to the south and Brighton Beach Playground to the west. Otherwise, the surrounding area consists largely of high-rise buildings with mixed residential and commercial developments.

This parking lot represents one of relatively few large parcels without structures directly adjacent to the beach, with a relatively unobstructed approach for cable landfall. Other open parcels along the south side of Coney Island are generally more obstructed and/or consist of public parkland in recreational use, with the exception of similar large parking areas associated with Steeplechase Park and the Abe Stark Sports Center to the west, or Manhattan Beach parking towards the eastern end of Coney Island. In general, the waters to the south of Coney Island are shallow, and geophysical and geotechnical characteristics (i.e., non-cohesive soils) adjacent to other potential cable landfall parcels on the south side of Coney Island are expected to be similar.

Water depths in the vicinity of a south shore Coney Island cable landfall alternative are expected to present a significant challenge for construction of an HDD cable landfall. Nearshore waters are predominantly less than 16 ft (5 m) deep at 3,000 ft (914 m) from the shoreline, which is the approximate practicable limit of HDD installation and subsea cable pulling for EW 1. This does not achieve the 33 ft (10 m) depth that is required for the typical submarine export cable installation vessel. The result is that an HDD cable landfall to the southern shore of Coney Island would result in a long, risky, and significantly costly HDD, due to the additional cost and complexity of using specialized vessels and techniques required for a cable landfall installation in shallower water. The relatively shallow water depth at the HDD exit offshore would also mean potential concern for seabed mobility, since there would be increased risk of the cable becoming unburied or requiring burial mitigation in these shallow water areas during operations of the cable system.

Because Coney Island was formed during the last period of glaciation, its soils are expected to be underlain by glacial tills (unconsolidated material from boulders sand pebbles to sand and clays) and outwash deposits, which would present a significant challenge to HDD installation and result in a high likelihood of inadvertent returns (unintended discharges of drilling fluids). Empire could not find any record of successful HDD installation or operations in the vicinity of the south shore of Coney Island.

While an HDD cable landfall is likely to prove challenging, it is also unlikely that an open cut would be feasible or permitted, because Coney Island's shoreline is regulated as a Coastal Erosion Hazard Area. It is also a potential area of significant erosion risk in New York City (NYC Emergency Management 2019), due to the area's exposure to wave action from the Atlantic Ocean, which would require the cable landfall to be installed deep enough to avoid impacts from coastal processes. Empire met with the New York City Department of Parks and Recreation (NYCDPR) on November 20, 2020; NYCDPR indicated that a longstanding relationship exists between New York City, New York State Department of Conservation and the USACE regarding the nourishment of Coney Island's shoreline, as it is an area that provides important shoreline protection.

NYCDPR indicated that this obligation and function as shoreline protection, and the known erosion risk, would need to be considered for any installation activities.

Unlike the other cable landfall alternatives considered, a cable landfall at Brighton Beach with either HDD or open cut would cross sandy beach and intertidal habitat. Although surface impacts would be avoided by an HDD, if feasible, noise and disturbance adjacent to the beach could impact the use of the area by wildlife such as shorebirds, as well as public users of the beach, which is heavily used for recreation. Based on the U.S. Fish and Wildlife Service's Information for Planning and Consultation tool (USFWS 2021), Coney Island beaches may serve as potential habitat for federally listed species, specifically Red Knot, Piping Plover, Roseate Tern and Seabeach Amaranth.

Per NYCDPR, an easement across Brighton Beach would require pursuit of New York State parkland alienation legislation, which would also add regulatory challenges and schedule risk. Because Brighton Beach has also received federal grant money through the Land and Water Conservation Fund (e.g., Project # 36-00618 [1978]), any easement across such lands may trigger a separate parkland conversion review process; that process requires additional time to complete and is governed by the National Park Service (NYSOPRHP 2012). National Park Service rules require consideration of practicable alternatives to the conversion, which is likely to be a significant hurdle to overcome given the existence of identified practicable alternatives for the EW 1 Project (e.g., the proposed alternative).

Coney Island Onshore Cable Route

From the cable landfall alternative on the south shore of Coney Island, the onshore export cable route alternative maximizes use of Ocean Parkway, which is the widest north-south roadway corridor, to reduce space-related constraints for construction and utility congestion along the narrower north-south corridors in the vicinity. Ocean Parkway is a divided 6-lane road, edged by trees, and with additional carriage lanes on either side. From the cable landfall at the Brighton Beach public parking area, this route alternative proceeds north up Brighton 3rd Street to Neptune Avenue, and then north along Ocean Parkway. After entering the Kensington neighborhood, the route turns west along Ditmas Avenue, briefly north along Dahill Road and then continues northwest along 39th Street to the south of the Green-Wood Cemetery until it reaches 2nd Avenue at the southeast corner of the SBMT. This route is approximately 7.4 mi (11.9 km) long.

The Coney Island Onshore Cable Route Alternative was the longest onshore cable route considered and was determined to be unreasonably challenging, disruptive, and expensive in light of existing utilities, traffic diversions, development density, and space constraints. The route would involve extensive in-street work within densely developed areas of Brooklyn where street corridors already have significant existing utility congestion.

On December 11, 2020, Empire met with the New York City Department of Environmental Protection (NYCDEP) to better understand the potential in-street constraints and the presence of existing infrastructure. According to information provided, at minimum, the Coney Island Onshore Cable Route Alternative would encounter a water main and sewer main on every block, with additional considerations needed for storm sewers as well. Water mains typically are located at 4 ft (1.2 m) depth, which means special crossing methods would need to be employed on each block. Additionally, a NYCDEP interceptor main runs east-west along the length of Coney Island, along with the New York Metropolitan Transit Authority subway lines. Given the busy, developed nature of the area, it would be necessary to maintain traffic flow during cable installation, which would increase the number of trenchless crossings required along the route and the associated installation complexity.

This existing utility and infrastructure congestion limits the available space for routing duct banks for the cables, and the number of infrastructure crossings along the roadway corridor adds significant cost. The construction duration associated with the need for additional geotechnical work; cable splice and transition vaults; HDD, jack-and-bore and other trenchless infrastructure crossings; utility relocations; and soil and water management, decontamination, and disposal is a significant factor. Extended in-street construction and multiple trenchless crossings will exacerbate the potential for noise impacts to local residents during construction, as well as traffic and transportation impacts.

In addition to these considerations, Ocean Parkway, which was selected as the widest potential north-south corridor, affording the most potential space and flexibility to deal with the infrastructure-related challenges along the route, is designated as New York City Scenic Landmark. Disruptions from construction noise, traffic, and recreational use along a parkway with this status are likely to preclude the use of this route.

Coney Island Summary

The Coney Island Cable Landfall Alternative is not a practicable alternative for the Project. The cable landfall on Coney Island would reduce the length of the submarine export cable route (and associated disturbance to the marine environment for installation) by approximately 9.6 mi (15.4. km) relative to the proposed alternative, and it would avoid submarine pipeline and cable asset crossings in the vicinity of the Narrows. However, the technical and regulatory challenges associated with the cable landfall and the onshore cable routing render it impracticable relative to cost, existing technology and logistics. The cable landfall and associated onshore cable route have significant logistical constraints that include vehicular traffic, pedestrian foot traffic, residential and commercial development density, noise impacts, business impacts, constructability, workspace constraints due to existing infrastructure, a designated landmark and regulatory challenges.

3.3.2.2 Gravesend Bay Alternative

Gravesend Bay Cable Landfall

Empire considered a route that would make cable landfall to the north of Coney Island, within the southern portion of Gravesend Bay. Similar to Coney Island, there are a number of constraints for selecting potential cable landfalls within Gravesend Bay. There are very few parcels of sufficient-sized, open land areas that are not already dedicated as public parklands. For the Gravesend Bay Cable Landfall Alternative, Empire evaluated a private car lot located to the north of the New York City Sanitation Department BK11 garage along 25th Avenue, adjacent to Shore Parkway. The lot occupies approximately 3 ac (1.2 ha).

To the south of this location, cable landfalls are constrained by shallow waters, public open space and/or piers and other obstructions. Another similar parking lot space, and a park/open space area exist immediately to the north. These are not described separately in detail because considerations for the cable landfall and associated onshore cable route would be highly similar to those discussed for the evaluated Gravesend Bay Cable Landfall Alternative. Due to the Shore Parkway and adjacent high-rise development, no potential sites for cable landfall exist farther north until the area near the area of Fort Hamilton, at the northern end of Gravesend Bay.

Similar to the Coney Island Cable Landfall Alternative, water depths in the vicinity of the Gravesend Bay Cable Landfall Alternative are expected to present a significant challenge for an HDD cable landfall construction. Nearshore waters are mostly shallow, with depths of 13.1 ft (4 m) or less in much of the area out to 3,000 ft (914 m), which is the approximate technical limit of HDD installation. However, bathymetry shows a deeper channel at 26 ft (8 m) depth that runs near the Gravesend Bay shoreline from the north, presumably providing pier access. This does not achieve the 33-ft (10-m) depth that is typically required, but it could provide enough water depth for operation and staging of HDD cable landfall equipment.

The cable landfall approach and shoreline show evidence of old piers and shallow riprap along the shoreline, and a seawall to the north and west of the cable landfall would need to be avoided by an HDD cable landfall. Assessment of a potential HDD also indicated a potential high risk for inadvertent returns of drilling fluid. Based on the fact that Coney Island and Long Island were formed during the last period of glaciation, the soils throughout the area are likely to be underlain by glacial tills. The sediment in the area is therefore expected to be loose, unconsolidated material from boulders and pebbles to sands and clays. These highly variable soil conditions are not conducive to HDD operations, as stated above, because they make it difficult to maintain the borehole, and if large grain content (i.e., gravel, cobbles, till) is present, this may limit the technical feasibility of HDD operations and increase risks of inadvertent returns.

Because of the greater area and duration of construction within shallow waters associated with this cable landfall alternative, it is also expected to result in somewhat greater impact to habitats for species such as winter flounder and horseshoe crab than other cable landfall alternatives considered. Beaches in this area are considered locally important for horseshoe crab spawning (including Calvert Vaux and Dyker Beach Parks, NYC 2021a), and impacts to horseshoe crab spawning have been raised as a concern by environmental stakeholders for other area projects such as the New York City Economic Development Corporation (NYCEDC) ferry terminal project at Coney Island Creek (USACE 2021). Since the cable landfall would be installed underground to a paved parking area, however, these impacts for Empire's Project would be limited to temporary impacts during construction.

Gravesend Bay Onshore Cable Route

Empire evaluated a route from the Gravesend Bay Cable Landfall Alternative that follows 25th Avenue to Shore Parkway, and then turns northwest, following along a relatively narrow vegetated margin on the west side of Shore Parkway, crossing Bensonhurst Park and continuing along the narrow shoreline to Dyker Beach Park. At that point, the route crosses Shore Parkway and continues along the northeast side of Shore Parkway adjacent to Fort Hamilton, due to the very limited space between the Shore Parkway and the seawall along the shoreline. Crossing under the Verrazzano-Narrows Bridge, this onshore cable route alternative continues along the north side of Shore Parkway to Shore Road Park. From there, this route can either continue along Shore Road Park or follow an inland along the 3rd Avenue Onshore Cable Route Alternative, as described in Section 3.3.2.3 for the Verrazzano-Narrows Bridge Onshore Cable Route Alternatives. Routes from the Gravesend Bay Cable Landfall Alternative are approximately 7.3 mi (11.7 km) long.

This Gravesend Bay Onshore Cable Route Alternative follows approximately along the shoreline of Gravesend Bay to the Verrazzano-Narrows Bridge crossing several municipal parklands, including Bensonhurst Park, Dyker Beach Park, Shore Road Park, and Owl's Head Park. Empire met with the NYCDPR on November 20, 2020, to discuss considerations for onshore route alternatives crossing parklands. These crossings are likely to require easements, which would include certain development restrictions. Based on information provided, easements across these parks are expected to require parkland alienation legislation. Although it may be possible for Empire to obtain the parkland alienation required, the process would add significant time, complexity and risk to the Project; the existence of alternatives for the Project that reduce or eliminate impacts to parkland (e.g., the proposed alternative) may be challenging to overcome within the process (NYSOPRHP 2012), and the process may face stakeholder opposition, particularly given the length and number of parks that would need to be crossed.

In addition to municipal parkland, the Gravesend Bay Onshore Cable Route Alternative would also need to cross federal land associated with Fort Hamilton, which would require coordination and easement rights obtained through the Department of the Army. Review of mapping provided by NYCDPR indicates that there would not be sufficient space to stay on municipal land through this area. Obtaining easement rights through federal lands that are under the Department of Defense, if possible, is expected to be challenging and add further risk associated with land acquisition.

Construction along portions of this route is expected to be technically challenging due to space constraints between Shore Parkway and the seawall, access, and existing infrastructure. During a meeting with the NYCDEP, Empire verified the density of outfall infrastructure that would need to be crossed along the Gravesend Bay shoreline. Based on mapping from the NYCDEP (Open Sewer Atlas NYC 2019a, 2019b), it appears more than 100 outfalls are located along the shoreline adjacent to this route.

It is also likely that one or more additional on-land HDD segments would be required to avoid existing roadway infrastructure and potentially deep foundations/piles, such as the on/off ramps in the area of the Verrazzano-Narrows Bridge. The Metropolitan Transit Authority included a deck reconstruction project associated with the Verrazzano-Narrows Bridge as part of its 2020-2024 capital program (MTA 2020). In 2020, MTA completed improvements including an expansion of the Fort Hamilton Parkway exit to two lanes, and the addition of a fourth eastbound lane from the Verrazzano-Narrows Bridge to the Fort Hamilton Parkway exit (MTA 2020).

To the north of the Verrazzano-Narrows Bridge, this route is as described in Section 3.3.2.3 for the Verrazzano-Narrows Bridge Alternatives.

Gravesend Bay Summary

The Gravesend Bay Cable Landfall Alternative would reduce the submarine export cable route length (and associated disturbance to the marine environment) by approximately 6.1 mi (9.9 km) relative to the proposed alternative and would avoid pipeline and cable asset crossings in the vicinity of the Narrows. However, the Gravesend Bay Cable Landfall Alternative is not practicable, due to the logistical considerations of HDD cable landfall constraints, including shallow water, shoreline obstructions, the risk of inadvertent returns during HDD installation and the onshore cable routing. An open cut landfall would not be used at this location due to the existing shoreline bulkheading and additional environmental impacts associated with trenching across the intertidal zone (see Section 3.3.2.1). Significant logistical constraints along the onshore export cable route include disruption of recreational use of Shore Road Park, noise impacts, business impacts, constructability, existing infrastructure density, and workspace constraints. Additionally, the Gravesend Bay Onshore Route Alternative has technical and regulatory challenges associated with federal and municipal lands.

3.3.2.3 Verrazzano-Narrows Alternative

Verrazzano-Narrows Bridge Cable Landfall

The parcel at the Verrazzano-Narrows Bridge Cable Landfall Alternative consists of open park space (Shore Road Park) under the control of NYCDPR adjacent to Shore Road and the Belt Parkway, on the northwest side of the Verrazzano-Narrows Bridge. This site represents one of the few areas of open space available along the waterfront with adequate space for staging cable landfall installation equipment (e.g., HDD rig). Within Shore Road Park, the Verrazzano-Narrows Cable Landfall Alternative is located in an area consisting of playing fields and a baseball diamond, identified as Bobby Bello Field, located immediately south of the Shore Road Field House. The Bay Ridge Promenade runs south to north along New York Harbor on the opposite side of Shore Parkway from this location.

Given the need to cross an existing seawall, the Bay Ridge Promenade, and Shore Parkway/Belt Parkway in order to reach the start of the onshore cable route at this location, the Verrazzano-Narrows Cable Landfall

Alternative would need to be installed via HDD (see Section 3.4.5 for evaluation of cable landfall installation methodologies), since trenching across any of these features is impracticable.

Construction of the submarine export cable landfall by HDD would be complicated by the existing seawall, which is assumed to extend 23 to 26 ft (7 to 8 m) below the mudline, built on a timber crib wall or timber piles, with riprap extending to the shoreline. Water depths adjacent to the cable landfall site are shallow (approximately 4 to 6 ft [1.5 to 2 m]) nearshore and extend to approximately 98+ ft (30+ m) deep in the channel. No UXO are noted, but other unidentified obstructions are present in the area on National Oceanic and Atmospheric Administration (NOAA) charts, including a cable area south of the bridge. Strong currents may be present in the area, but coastal processes do not appear to be a limiting constraint for a cable landfall.

Assessment of potential HDD alignments and water depths at this location determined that the drill exit on the water side, where a cofferdam and conductor casing would likely be required, would be near medium to high levels of vessel traffic on the north side of the Verrazzano-Narrows Bridge. Given the duration of HDD installation (estimated at approximately two months per drill [with one drill per circuit]), this could result in a significant duration of impact to marine users. Impacts to marine traffic through the Narrows from the HDD would require additional coordination with the United States Coast Guard (USCG) to determine whether impact minimization or mitigation would be possible for this alternative.

The entry side of the HDD would be located within the playing fields in Shore Road Park. Since there is no direct access from public roadways adjacent to the site, and there are slopes immediately to the east of the playing fields, temporary construction access would be required within the park for vehicles and equipment. An offsite staging area for fabrication is also expected to be required.

Use of this cable landfall is expected to raise stakeholder concerns, due to potential disruptions affecting open space users, noise from HDD activities, and traffic for local residents. Local road closures are not anticipated, but some tree removal within the park would likely be required for staging and access. Use of the playing fields would result in conflict with recreational use of the area for the duration of cable landfall construction activities. To the north and west of the Verrazzano-Narrows Bridge Cable Landfall Alternative, dense residential development, high-rises and sensitive noise receptors are present on the west side of Shore Road. Given the topography and absence of tree screening along portions of Shore Road to the west of the cable landfall area, temporary noise impacts during construction would occur during HDD activities. Temporary visual impacts during construction due to tree clearing, staging, and construction equipment are also a potential stakeholder concern. Because this site is not already developed for industrial use, temporary impacts to vegetation, land use, and terrestrial habitats would be greater than at other cable landfall alternatives considered.

Cable landfall and onshore routing (discussed below) for the Verrazzano-Narrows Bridge Cable Landfall Alternative is also expected to require parkland alienation legislation. Parkland alienation in New York State applies to dedicated municipal parklands. Although it may be possible to obtain alienation legislation, it represents a significant additional procedural requirement that would be needed to use this cable landfall alternative, requiring additional time and support from both the local and State legislative bodies, which introduces additional risk. As described above, the existence of practicable alternatives for the Project that reduce impacts to parkland (e.g., the proposed alternative) likely would be challenging to overcome within the alienation process.

Verrazzano-Narrows Onshore Cable Route

Empire evaluated two onshore export cable routes from the Verrazzano-Narrows Cable Landfall Alternative:

- The Shore Road Park Onshore Cable Route Alternative: from the Verrazzano-Narrows Bridge Cable Landfall Alternative would run north and slightly west from the cable landfall through Shore Road Park and along the Belt Parkway to Owl's Head Park. From there, the route would require an HDD crossing of the Belt Parkway and the 65th Street Railyard. To the north of the 65th Street Railyard, this alternative would continue north along the west side of the Brooklyn Army Terminal and then turn east along 58th Street. The Shore Road Park Onshore Cable Route Alternative would then turn north along 2nd Avenue to SBMT and eventually to the POI, similar to other route alternatives described in this section. This route is approximately 4.4 mi (7.1 km) long.

- The 3rd Avenue Onshore Cable Route Alternative: from the Verrazzano-Narrows Bridge Cable Landfall Alternative. From the cable landfall in Shore Road Park, this route goes directly north across Shore Road and follows 96th Street to the northeast. The route cuts over to the 3rd Avenue corridor with a jog to the south along Marine Avenue and then east on 97th Street. After continuing north along 3rd Avenue, it turns west along Bay Ridge Avenue to Owl's Head Park, then crosses the Belt Parkway and 65th Street Railyard, following a similar alignment to the Shore Road Park Onshore Cable Route Alternative described above. This route is approximately 4.5 mi (7.2 km) long. The 3rd Avenue Onshore Cable Route Alternative was selected for the evaluation of a north-south corridor that substantially avoids a significant portion (but not all) of the parkland impacts along the waterfront, but instead it requires extensive in-street work in the densely developed Bay Ridge neighborhood.

In the area of the Shore Road Park Onshore Cable Route Alternative, Shore Road Park varies in width from an approximately 75-ft (23-m)-wide north-south strip, to up to 525 ft (160 m) wide in areas with fields, tennis courts, and other recreational infrastructure. HDDs would both reduce surface disturbance to the parkland and avoid areas of steep side slopes that are present along the route. Trenchless construction would also be needed to cross the Belt Parkway/Shore Parkway on the north side of Owl's Head Park, ramps and railroad tracks associated with the 65th Street Railyard. These HDDs would be technically challenging and require additional study for feasibility based on soils data, calculations for the cables, and railroad crossing requirements. Overall, the number of HDDs required along this route adds logistical and construction complexity that would increase installation cost and duration.

The Shore Road Park Onshore Cable Route Alternative would also cross the Narrows Botanical Garden, a volunteer-run garden, along Shore Road Park on the east side of the Belt Parkway. Based on a nominal corridor width of 50 ft (15 m), along with the additional temporary workspace at HDDs, bores, and temporary access roads, tree clearing would be required during construction. While much of the cable corridor could be restored post-construction, some tree clearing directly over the cable corridor may be permanent. Infrastructure may also be present along this route; based on mapping from the NYCDEP (Open Sewer Atlas NYC 2019a, 2019b), it appears more than 30 outfalls are located along the shoreline in the vicinity of this route, although it is unknown how many would cross the onshore cable route.

The 3rd Avenue Onshore Cable Route Alternative would avoid much of the routing within Shore Road Park and the Narrows Botanical Garden but is expected to encounter significant utility congestion within the relatively narrow roadway corridors found throughout the densely developed Bay Ridge neighborhood of Brooklyn. Although 3rd Avenue is relatively large compared to other north-south corridors in this area, it is only approximately 45 ft (14 m) between sidewalks and flanked largely by multi-story and high-rise apartment buildings, with commercial development at ground level. Considerations and logistical constraints include vehicular traffic, pedestrian foot traffic, residential and commercial development density, noise impacts, business impacts, constructability, and workspace constraints due to existing infrastructure. Significant stakeholder opposition may be present due to construction disruptions along this route.

Many of the considerations for the 3rd Avenue Cable Route Alternative are similar to those described in Section 3.3.2.1 for the Coney Island Onshore Cable Route Alternative. Investigation of utilities indicated significant utility congestion along this route, and per NYCDEP, this route would also encounter a water main and sewer main on every block. The need to maintain traffic flow is also expected to drive the number and complexity of trenchless crossing installations along this route. Additionally, there is a mapped NYCDEP interceptor main that runs to the north and south along from the Owl's Head Wastewater Treatment Plant that would need to be crossed by either the Shore Park Road or 3rd Avenue Onshore Cable Route Alternatives. Assessment of the space available for the 3rd Avenue Onshore Cable Route Alternative indicated that joint bays may be especially difficult to locate in the city street for this route.

Both the 3rd Avenue and Shore Park Road Onshore Route Alternatives cross Owl's Head Park to the south of the 65th Street Railyard. During a meeting with Empire, the NYCPDR indicated that there is significant local concern about preserving Owl's Head Park, and that there has been opposition to previous plans for construction of improvements in the park. Owl's Head Park is the site of the former estate of Brooklyn politician Henry C. Murphy in the 19th Century (NYC 2021b). It was later sold to New York City with the stipulation that it remain parkland, and the estate buildings were eventually demolished. Owl's Head Park therefore has potential historic significance. The vicinity of Owl's Head Park is also mapped as an area of potential cultural significance and is notable compared to much of the surrounding area as being on a natural terminal moraine (NYC 2021b) instead of urban filled soils. The NYCDPR indicated that if a crossing of Owl's Head Park is needed, it would be preferable to route around the outer edge of the park, adjacent to Belt Parkway, however it may not be possible to entirely limit impacts to the park edge due to the need to cross the Belt Parkway and the 65th Street Railyard via HDD or trenchless methods.

Verrazzano-Narrows Summary

The Verrazzano-Narrows Cable Landfall Alternative reduces the submarine export cable route length (and associated disturbance to the marine environment) by approximately 4.3 mi (6.9. km) relative to the proposed alternative and avoids pipeline and cable asset crossings in the vicinity of the Narrows. However, the Verrazzano-Narrows Bridge Cable Landfall Alternative is not practicable due to logistical constraints associated with the HDD cable landfall and potential for conflict with marine traffic, disruption of recreational use of Shore Road Park, noise, constructability challenges, and additional potential regulatory challenges compared to the proposed alternative. The Verrazzano-Narrows Onshore Cable Route Alternative is also impracticable due to logistics associated with parkland alienation legislation, added cost and complexity of several HDDs, utility congestion along 3rd Avenue and the potential for public stakeholder opposition along both routes. Moreover, the route across Owl's Head Park, an area of cultural sensitivity in the vicinity, has the potential to result in other adverse environmental impacts.

3.3.2.4 65th Street Railyard Alternative

65th Street Railyard Cable Landfall

The parcel at the 65th Street Railyard Cable Landfall Alternative consists of rail tracks and open industrial land adjacent to the Owls Head Wastewater Treatment Plant and north of the Belt Parkway. This site is adjacent to the 65th Street Railyard substation site that was considered by Empire (see Volume 1, Section 2.1.3.2 in the COP **Appendix D-1** of **Attachment D**).

The 65th Street Railyard is being developed as a significant transportation hub along the Brooklyn waterfront. In 2014, the Port Authority of New York and New Jersey (PANYNJ) published a draft Tier I Environmental Impact Statement (EIS) for the Cross Harbor Freight Program to study cross harbor transportation options to alleviate truck traffic. A Record of Decision was issued in 2016, which included a rail tunnel alternative crossing the 65th Street Railyard as one of the preferred alternatives advanced for further study. Under all operating scenarios for the rail tunnel, the 65th Street Railyard would process carload freight moving to and from Brooklyn, parts of Queens, and southern Long Island (FHWA and PANYNJ 2014). Enhanced waterborne transportation alternatives from the 65th Street Railyard were also part of this study. On May 5, 2017, the PANYNJ issued a request for proposals for a Tier II EIS of the preferred alternatives for the Cross Harbor Freight Program. In February, 2022, Governor Hochul announced that the Port Authority of New York and New Jersey is resuming work on the Tier II EIS. A FASTLANE grant from the Federal Highway Administration for 65th Street Railyard funds additional improvements beyond those contemplated in the Tier II study (FHWA and PANYNJ 2014).

Empire's discussions with New York City stakeholders indicated that plans for the 65th Street Railyard, including improvements associated with the Cross Harbor Freight Program, would not be compatible with siting Project facilities due to the likelihood of conflict with other potential uses, which could make obtaining an easement agreement for the cable landfall difficult.

In addition, this site also presents challenges for either HDD or open cut cable landfall installation, due to shoreline infrastructure and cable burial depth limitations. Interferences and obstruction are present at the shoreline. Although as-builts of the seawall were not available, it is assumed to have deteriorated riprap that likely extends below the mudline. Other unidentified obstructions are also present on NOAA charts with only a narrow unobstructed corridor for a potential cable landfall alignment. Water depths immediately adjacent to the cable landfall are very shallow, however, coastal processes in this location do not appear to be a limiting constraint. Similar to other sites considered, the in-water HDD exit would be in deeper waters, which correspond to areas of higher marine traffic offshore. Also similar to other sites, there is a potential high risk for inadvertent returns of drilling fluid during HDD construction. The required depth of an HDD cable landfall may exceed the maximum allowable depth of the cable installation due to thermal resistivity concerns (see Section 3.4.5). Initial feasibility analysis indicated that an open cut solution may be possible at this location, but additional geotechnical assessment would be required to confirm this; however, this assessment was not done because it was determined this site would be unavailable and therefore not practicable.

65th Street Railyard Onshore Cable Route

Two onshore cable route alternatives were assessed from the 65th Street Railyard Cable Landfall Alternative. From the 65th Street Railyard, one onshore cable route alternative would exit the site to 2nd Avenue and travel northeast to 28th Street, following it to the entrance of the substation at the Gowanus POI. Empire also evaluated a route from the 65th Street Railyard that follows 1st Avenue to 39th Street, traveling east along 39th Street to 2nd Avenue, and continuing to the Gowanus POI along routes previously described from there. These routes are approximately 2.2 to 2.3 mi (3.5 to 3.7 km).

Of the two routes, the 2nd Avenue corridor was determined to be less risky than the 1st Avenue corridor, although neither route is practicable, due to site constraints within the 65th Street Railyard cable landfall (see above).

The 1st Avenue corridor is a two-lane street with an approximate roadway width of 40 ft (12 m) that runs north to south to 39th Street, where it ends at the SBMT. An existing rail line, and large diameter sewer interceptor run along this corridor to the north of the Owl's Head Wastewater Treatment Plant. These features constrain the available space for the onshore cable ducts along this corridor. The 1st Avenue alternative also crosses the parcel and parking lot associated with the Brooklyn Army Terminal, an industrial manufacturing and commercial business complex managed by NYCEDC, immediately north of the 65th Street Railyard, before entering the southern end of 1st Avenue. The Brooklyn Military Ocean Terminal, located at what is now the

Brooklyn Army Terminal, is a listed Formerly Used Defense Site property that staged chemicals for several decades, housing aboveground storage tanks, cask oil storage, and machine shops.

The 2nd Avenue corridor is a two-lane city street that runs north-south between 63rd and 28th Street, which also has an approximate roadway width of 40 ft (12 m); however, some of the large infrastructure that is present along 1st Avenue is absent. The street is mostly commercial/industrial development, while the side streets to the east of 2nd Avenue are mostly residential. The 2nd Avenue corridor generally runs closer to areas of commercial and residential development than the 1st Avenue corridor, which passes predominantly through areas of industrial land use. The 2nd Avenue corridor is a main route for transportation through Brooklyn and has several bus routes and stops; this corridor also has higher daily average traffic, with annual average daily traffic counts (8,500) that are nearly twice the volume along 1st Avenue (3,400). Utilities along this route are known to include a sanitary sewer transmission line, a water line, a high-pressure natural gas line, and storm drainage inlets. However, the risk caused by utility congestion along 2nd Avenue was estimated to be less than the risks associated with 1st Avenue.

65th Street Railyard Summary

The 65th Street Railyard Cable Landfall Alternative has the advantage of reducing the submarine export cable route length (and associated disturbance to the marine environment) by approximately 1.7 mi (2.7 km) relative to the proposed alternative. Due to planned development conflicts associated with the 65th Street Railyard, the 65th Street Railyard Cable Landfall Alternative is not practicable alternative for the Project due to its expected unavailability. Construction along either the 1st or the 2nd Avenue corridors would also be associated with additional logistical constraints due to infrastructure density, increased impacts due to construction noise and traffic, and disruption to adjacent residential and commercial neighborhoods compared with an in-water route. Empire has not identified any special aquatic sites that would be avoided with this cable landfall alternative.

3.3.2.5 Narrows Generating Station Alternative

Narrows Generating Station Cable Landfall

The Narrows Generating Station Cable Landfall Alternative is located at Astoria Generating Company, LP's Narrows Generating Station parcel, which was also considered by Empire for locating the new onshore substation (see **Attachment D, Appendix D-1** [COP Volume 1, Section 2.1.3.2]). The existing site contains floating platforms for the generation facility extending into the bay. The cable landfall would be located on the pier with a deep bulkhead sheet pile wall, which would require cable burial depths of 30 to 50 ft (10 to 15 m).

The generation float and other upland surface obstructions would have to be removed for the site to be used. Space availability is constrained by the presence of existing structures as well as the presence of existing rights-of-way. The removal of those existing structures in turn is dependent upon the decommissioning and remediation of the facility prior to the start of Project construction. Decommissioning of the Narrows facilities was proposed as part of the Gowanus Repowering Project; on December 15, 2021, Astoria Generating Company, LP, filed a notice discontinuance for the Gowanus Repowering Project with the New York State Department of Public Service (NYSDPS Case # 18-F-0758), stating that it is no longer pursing a Certificate of Environmental Compatibility and Public Need pursuant to Article 10 of New York Public Service Law. Whether and when decommissioning plans may be proceeding are currently unclear.

Empire considered both HDD and open cut cable landfall alternatives for the Narrows Generating Station Cable Landfall Alternative. Obstructions and interferences are present near the shoreline and include submarine dolphin piles and ruins of a historical pier to the south. The main obstacle at the site is a deep bulkhead that extends to an elevation of -39 ft (-12 m) mean lower low water (MLLW), with tie rods connected to this bulkhead and sheet pile anchor walls installed on the land side of the bulkhead. Detailed assessment determined that an HDD cable landfall would not be feasible for the Narrows Generating Station Cable Landfall Alternative, for reasons similar to those that eliminated HDD at the preferred site, including the required HDD depth, thermal resistivity limits, the presence of loose sediments, and inadvertent return risk (see Section 3.4.5). Additionally, the available right-of-way width between the two existing buildings onsite is only 42 ft (13 m). Allowing for horizontal tolerances and the necessary setback distance from the edge of the right-of-way, the available horizontal separation distance is only approximately 7.8 ft (2.4 m), not considering existing utilities that may further constrain this corridor. This is significantly less than industry standard separation for an HDD installation and may not allow sufficient separation of the two cables. Furthermore, the HDD at this location requires drilling next to the foundations/piles of an existing large office building, which is strongly not recommended due to the risk of foundation settlement and damage to the building. Additionally, vessel traffic around this site is expected to be heavy, with the potential for marine traffic impacts at the HDD exit location offshore.

Narrows Generating Station Onshore Cable Route

From the Narrows Generating Station Cable Landfall Alternative, two major route alternatives were considered:

1. The Bush Pier Terminal Park Onshore Cable Route Alternative runs northwest from Narrows Generating Station site along 1st Avenue from the intersection with 54th Street to the intersection of 51st Street. The route heads west then north, along a right-of-way adjacent to the Bush Pier Terminal Park, until reaching 43rd Street. Here the route runs southeast along 43rd Street to 2nd Avenue. From there, the route continues along the same path as the route from the EW 1 cable landfall, travelling northeast along 2nd Avenue to 28th Street where it enters the existing substation at the Gowanus POI. This route is approximately 2.0 mi (3.2 km).
2. The 1st Avenue Onshore Cable Route Alternative runs north from the Narrows Generating Station Cable Landfall Alternative at the intersection of 54th Street and 1st Avenue to the intersection at 43rd Street. The route then turns southeast on 43rd Street to 2nd Avenue. From here, the route continues along the same path as the route from the EW 1 Cable Landfall Alternative (Section 3.7.3.6), travelling northeast along 2nd Avenue to 28th Street where it enters the existing substation at the Gowanus POI. This route is approximately 1.8 mi (2.9 km).

Of the two onshore cable route alternatives from the Narrows Generating Station, Empire determined the Bush Pier Terminal Park Onshore Cable Route Alternative is not practicable, due to the portion of the routing along Bush Pier Terminal Park. Empire determined that this portion of the route would result in additional potential impacts to recreational resources. Empire also received feedback during a meeting on August 23, 2019 with NYCEDC and NYCDPR, that the location of any facilities within the Bush Terminal Park fence line would be discouraged due to the nature of the site as a former landfill. Landfill facilities, including leachate lines and groundwater monitoring wells, are located subsurface.

Considerations for routing along 1st Avenue from the Narrows Generating Station are similar to those described for the 65th Street Railyard Alternative along 1st Avenue. Two trenchless (jack-and-bore) crossings would be required for active railroad lines. This would result in additional onshore disturbance to commercial and residential neighborhoods in comparison to the proposed, shorter onshore cable route alternative, and would add risks, cost, and construction duration associated with utility congestion along a longer route.

Narrows Generating Station Summary

The Narrows Generating Station Cable Landfall Alternative would reduce the length of the submarine export cable route (and associated disturbance to the marine environment) by approximately 1.3 mi (2.1 km). However, it is expected that a cable landfall at this location would also require installation with an open cut cable landfall method and would not materially decrease in-water impacts as compared to the proposed alternative. Moreover, the Narrows Generating Station Cable Landfall is not practicable for the Project, due to the existing site constraints, commercial availability, and scheduling risks associated with the uncertainly of the decommissioning of the existing station.

3.3.2.6 EW 1 Proposed Project Alternative

EW 1 Proposed Project Cable Landfall

The proposed EW 1 Cable Landfall Alternative is located at SBMT. The SBMT is a New York City-owned parcel under lease by NYCEDC, which subleases to Sustainable South Brooklyn Marine Terminal (SSBMT). This site is Empire's proposed site for the onshore substation (see **Attachment D**, **Appendix D-1,** COP [Volume 1, Section 2.1.3.2]).

The EW 1 Cable Landfall Alternative is located immediately adjacent to the proposed onshore substation site at SBMT. For this export cable landfall alternative, Empire assessed both open cut and HDD cable landfall installation and determined that HDD cable landfall would not be feasible (see Section 3.4.5.1). The pier[6] at the EW 1 cable landfall location consists of deep, concrete-filled caisson bulkhead at the pier tip. The north side of the pier appears to be constructed of a steel sheet pile and riprap shoreline. Both in water and under the riprap are buried timber piles, cut off at the mudline. The piles are assumed to extend to 26 ft to 33 ft (8 to 10 m) below the mudline.

Other unidentified obstructions noted on NOAA charts include an obstruction near the seaward entry of the waterway. Based on water and sewer data from the NYCDEP, there is a combined sewer easement in this area that discharges to the harbor and approximately in line with 32nd Street. Empire is coordinating with the property owner and NYCDEP regarding the outlet. Depths adjacent to and between the piers at EW 1 vary and may be as shallow as 6.5 ft (2 m) below MLLW, increasing towards the bay.

Empire also assessed installing the submarine export cables through or over the bulkhead at the shoreline at SBMT. This cable landfall installation would require dredging between the 35th Street and 29th Street Piers to allow for sufficient depth for access by the cable lay vessel; installation through the bulkhead was determined to be a practicable option for cable installation at this location (see Section 3.4.5.1). The existing bulkhead between the 35th Street and 29th Street Piers requires replacement due to its condition.

EW 1 Proposed Project Onshore Cable Route

The proposed onshore cable route from the EW 1 Proposed Cable Landfall Alternative at SBMT to the Gowanus POI is approximately 0.2 mi (0.3 km) long. This route runs northeast from the proposed EW 1 onshore substation site to a parking lot along the northwestern side of 2nd Avenue. It then continues north along 2nd Avenue to 28th Street and turns east along 28th Street where it enters the existing substation at the Gowanus POI.

Because the EW 1 Cable Landfall Alternative is directly adjacent to the onshore substation, the EW 1 Onshore Cable Route Alternative consists only of the interconnection cable route traversing SBMT and 2nd Avenue to the POI. This cable route would be required for any project alternative that incorporates the onshore substation at SBMT (i.e., all other cable landfall/onshore cable route combinations under consideration). This onshore cable route eliminates onshore impacts to public open space, and greatly minimizes disturbance within densely

[6] Note that SBMT includes two areas of bulkheaded landfill that resemble and are referred to as "piers," (herein, the 29th Street and 35th Street Piers), despite being landfill instead of pile-supported structures over water.

developed areas of Brooklyn associated with the other onshore cable route alternatives, including reducing impacts to vehicular traffic, pedestrian foot traffic, residential and commercial development, business disruption, noise impacts, and traversing potentially contaminated soils. This route also minimizes the onshore cable route constructability risks associated with existing utilities, infrastructure, and in-street work.

EW 1 Proposed Project Summary

Based on the assessment of construction feasibility of an open cut cable landfall methodology, consistency with existing land use and future development, commercial availability, costs, logistical concerns, and minimization of impacts to local stakeholders, Empire has identified EW 1 Cable Landfall Alternative as the proposed alternative for the Project. The EW 1 Cable Landfall Alternative results in a longer submarine export cable route (and associated length of in-water/marine disturbance), and would require dredging, which represents a greater aquatic impact than other alternatives considered. However, other cable landfall alternatives considered are not practicable, for reasons of logistics, costs, and/or constraints of existing technology. Empire has not identified any impacts to special aquatic sites associated with the EW 1 Cable Landfall Alternative. Moreover, since the area around and between the 35th Street and 29th Street Piers is expected to need modification associated with SBMT's separate port upgrade activities (e.g., dredging, replacement of deteriorated bulkheads), siting disturbances associated with the cable landfall activities in the same area will help minimize overall environmental impacts relative to the use of another, relatively undisturbed site. Onshore disturbance and other environmental impacts will be minimized with the EW 1 Cable Landfall Alternative and the associated onshore cable routing, due to the location of activities in an area of existing industrial development, and the short length (0.2 mi [0.3 km]) of the onshore cable route.

3.3.3 Submarine Export Cable Route Alternatives – State Waters

The submarine export cable route begins where the route crosses into state waters 3 nm (5.6 km) offshore, approximately 3.9 mi (6.2 km) southeast of Rockaway Point at the southwestern corner of Long Island, and 5.5 mi (8.8 km) east of the tip of Sandy Hook in New Jersey.

For each submarine export cable route alternative, Empire evaluated several alternative methods for cable installation offshore, including cable burial and direct placement on the seafloor. Empire is proposing to bury the submarine export cables using jetting, mechanical plow, trenching/cutting, and dredging. Dredging and mass flow excavation are not proposed for cable burial in general, but may be required in certain locations, such as for pre-sweeping and seabed preparation activities prior to cable lay, at certain asset crossings, and for trench excavation and cable burial along the submarine export cable corridor between the 35th Street and 29th Street Piers, approaching the cable landfall. The evaluation of these installation methods is detailed in Section 3.4.3.

Based on results of the offshore constraints analysis, Empire evaluated four submarine cable route alternatives in New York State waters for the Project (**Figure 4, Figure 5**). Each of the routes is described relative to the cable landfall at the proposed EW 1 cable landfall at SBMT. The offshore routing constraints considered in the identification of potential Project submarine export cable route alternatives include:

- Segment length;
- Installation constraints and complexity, including water depth, slopes, and seabed features;
- Ability to adequately bury and protect the cable;
- Avoidance or minimization of anthropogenic hazards to cable installation and operations, and use conflicts (e.g., existing utility crossings, dredged and maintained channels, anchorages and de facto

anchoring areas, vessel TSSs, precautionary areas, safety and security regulated areas, charted danger zones, disposal areas, sand borrow areas);

- Avoidance of biological and cultural resources (e.g., eelgrass, shipwrecks); and
- Avoidance of high-use commercial and recreational fishing grounds.

Fairways and UXO areas were also considered in the offshore constraints analysis, although these are not present as mapped areas along the route alternatives in **Figure 5**.

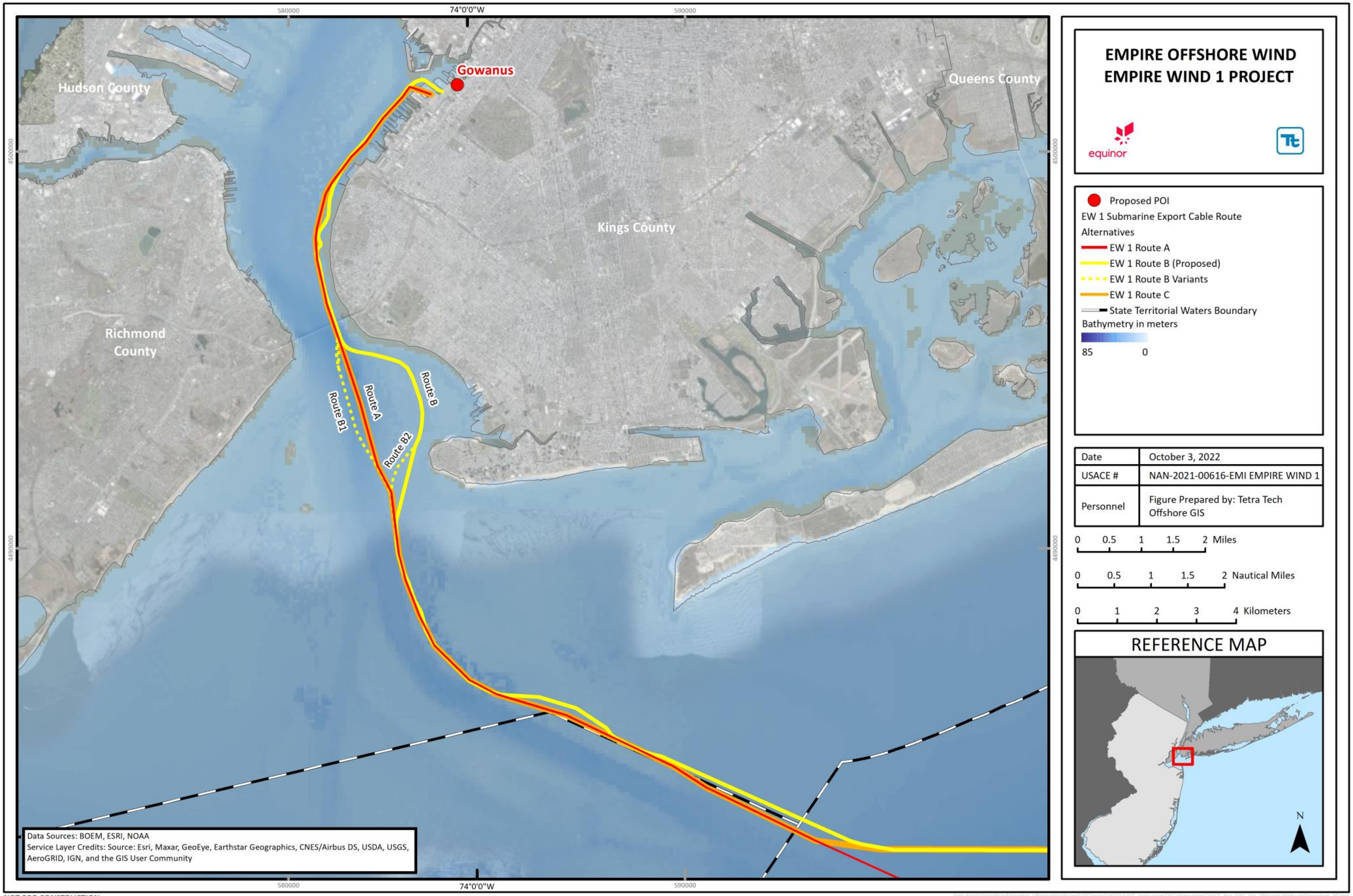

Figure 4 Submarine Export Cable Route Alternatives – State Waters

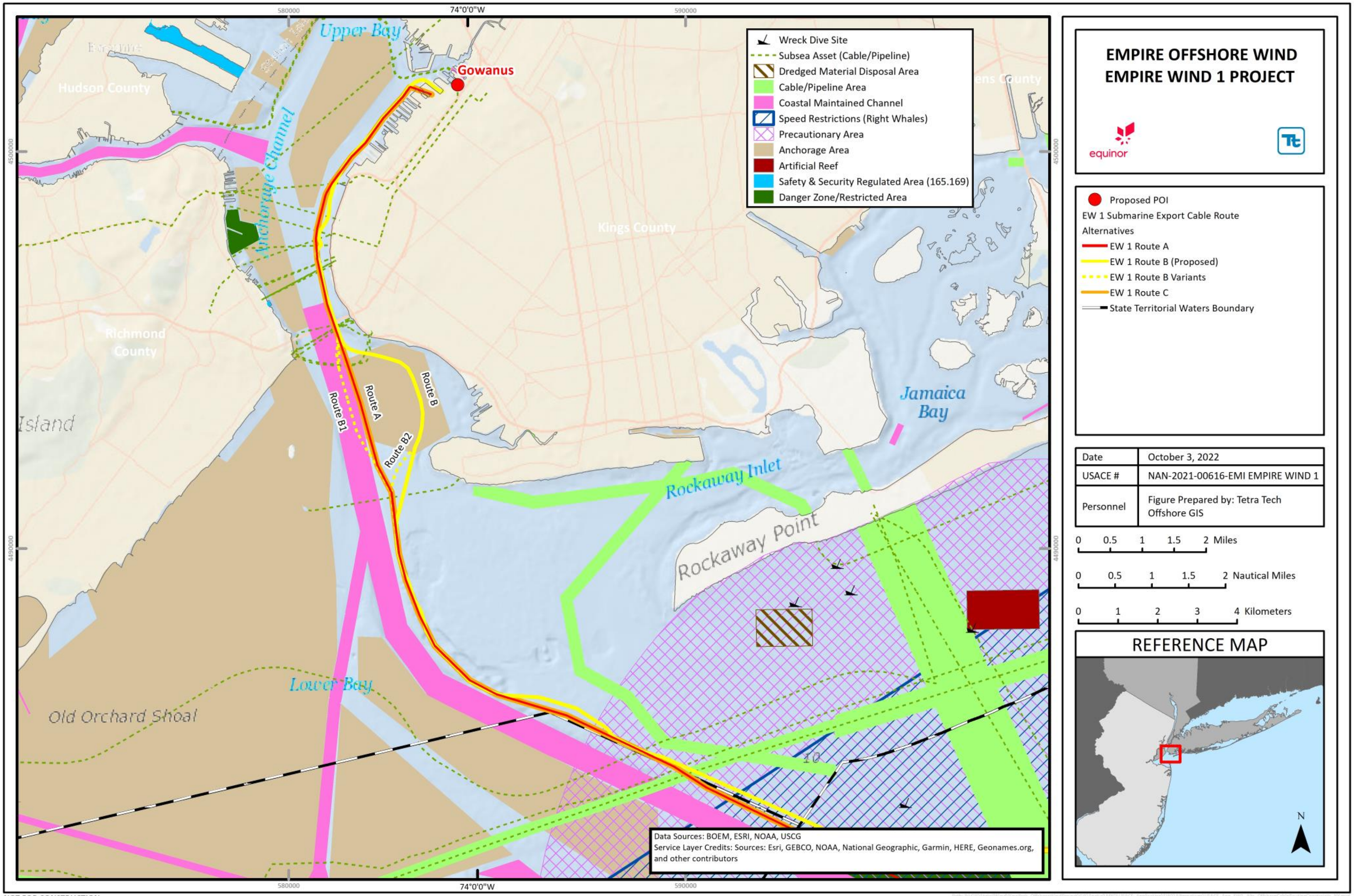

Figure 5 Submarine Export Cable Routing Constraints Analysis – State Waters

3.3.3.1 Submarine Export Cable Route Alternative A

From where the submarine export cable route crosses the New York State boundary 3 nm (5.6 km) offshore from federal waters, this route alternative continues parallel to the east of the maintained Ambrose Channel and then crosses the Transco Lower New York Bay Lateral (LNYBL) gas pipeline, which is buried in this area. Approximately 1,060 ft (323 m) northwest of the Transco LNYBL pipeline crossing is the high-voltage direct-current (HVDC) Neptune Regional Transmission System (Neptune cable), which is also indicated as buried in this area. The proposed Poseidon Transmission (Poseidon) cable is documented to closely follow the Neptune cable route and would also be crossed in a similar orientation, if the Poseidon cable is installed before the Project's submarine export cables. Approximately 0.4 nm (0.7 km) to the northwest, the route crosses the location of the planned Transco Raritan Bay Loop natural gas pipeline project. The route will then traverse a retired communications cable running from Coney Island to Swinburne Island.

At Gravesend Bay, Submarine Export Cable Alternative A continues straight along the east side of the Ambrose Channel, crossing the USACE Gravesend Anchorage and USCG Anchorage #25. Immediately north of Gravesend Bay, the route enters a charted cable area. The route encroaches to within approximately 82 ft (25 m) of the designated channel boundary due to the seabed constraints. A Safety Zone is depicted on NOAA Chart 12334 between the bridge footing and shore, which is understood to be related to a UXO area located on the seabed. This area is avoided by the routing. As the route turns to the north, it crosses a charted pipeline area. The route turns to the northeast and enters the Bay Ridge Channel, where it crosses a second charted pipeline area. These assets include additional retired communications cables, water siphons and oil pipelines, which cross from Staten Island to Brooklyn. A third charted pipeline area is crossed by the route and is understood to contain the second of two out of service water siphons. The route turns to the northeast and follows the eastern side of the Bay Ridge Channel to land at the EW 1 cable landfall at SBMT.

Alternative A lies east of and parallel to Ambrose Channel and lies partly within an anchorage planned for deepening and/or widening to allow additional anchorage of large vessels (USACE 2020). It is the shortest route alternative in the Gravesend Bay area, but closest route to the Ambrose Channel besides Alternative B1 (discussed in Section 3.3.3.3) and is close to the northbound movement of large ships (observed in 2019 to include up to approximately 180,000 deadweight tons). This area has exposure from large vessels both intentionally anchoring near the channel and transiting the channel itself. Therefore, Alternative A involves the most potential anchoring from large vessels. Compared to Alternative B1, cable burial along Alternative A would therefore need to mitigate for significantly more frequent and intentional anchoring by large vessels. Input from USACE and maritime stakeholders relative to Alternative A indicated concern over routing through this area.

If the proposed anchorage expansion results in dredging along the cable route prior to the installation of the Project, it could also result in more compacted sediments at the seabed at the time of cable installation, which could in turn make cable installation to the required burial depth more challenging. Alternative A is more sensitive to the ability to achieve target burial depth than the other considered routes, because installation of cable protection measures over the submarine export cables may not be considered acceptable in this area based on the existing and future additional anchorage use. In contrast, the use of cable protection along Alternative B1, if necessary, would be less problematic due to the greater water depths within the channel and lower frequency of anchoring. All of these factors result in increased submarine export cable installation time and complexity for Alternative A, in an area with a high level of maritime use and potential impacts to maritime stakeholders. Based on the complexity of installation, planned anchorage deepening/widening, potential marine stakeholder impacts, and stakeholder feedback received by Empire, Alternative A is not practicable.

3.3.3.2 Submarine Export Cable Route Alternative B (Proposed Project Alternative)

Submarine Export Cable Route Alternative B follows the same route as Alternative A. However, after passing around the end of Coney Island, the route traverses northeast closer to the shoreline of Coney Island and then enters into Gravesend Bay. Alternative B converges with Alternative A at the north end of Gravesend Bay and follows the same route to the north of the Verrazzano-Narrows Bridge.

Alternative B traverses the easternmost route in Gravesend Bay and the shallower water approximately 1,150 ft (350 m) eastward of Alternative A. It is designed to avoid the USACE Gravesend Anchorage, the potential anchorage expansion area, and the higher used area (informed by automatic identification system [AIS] data) of USCG Anchorage #25. Based on review of 2019 AIS records for all vessels travelling at less than 0.5 knots and a more general view of prior years, anchoring along Alternative B was infrequent in comparison to other alternatives considered, and such anchoring was mainly by pleasure craft and one USCG vessel. Anchor drag risk associated with transiting vessels would also be reduced along Alternative B, as very few vessels transit through the bay so far to the east.

Although there is some commercial and recreational fishing in the Gravesend Bay area, information from commercial fishing outreach indicates this mostly consists of small vessels using pots/traps for fish and crabs tied to lines laid along the seabed. Small dredges are also employed for crab harvesting in the Lower Bay during certain months. Both of these methods have minimal seabed penetration compared to ship anchors. Input from maritime users (see **Attachment D, Appendix D-1** [Appendix B Summary of Agency Engagement in the COP]) indicated a preference for route Alternative B.

In comparing the alternatives in the Gravesend Bay area, although Alternative B is slightly longer than Alternatives A and B1, there are no significant differences in environmental impacts expected between routes. The marine disturbance associated with the longer submarine export cable route is likely to be offset by the additional disturbance for deeper burial mitigation expected to be required along Alternatives A and B1 due to the anchoring activity. Alternative B does traverse closest to potential winter flounder spawning habitat, which consists of sandy bottom areas in water depths of 20 ft (6 m) or less. However, Empire will minimize potential impacts to winter flounder through implementation of appropriate timing windows during submarine cable installation. Thus, Empire is proposing Alternative B as the practicable alternative that minimizes environmental impacts and reduces potential conflicts with maintained channels, anchorages, and marine navigation.

3.3.3.3 Submarine Export Cable Route Alternative B1

Submarine Export Cable Route Alternative B1 also follows the same route as Alternative A; however, instead of turning east into Gravesend Bay like Alternative B, it turns slightly west into the eastern portion of Ambrose Channel. It then exits Ambrose Channel on the north end of Gravesend Bay.

Submarine Export Cable Route Alternative B1 enters the eastern portion of Ambrose Channel in order to avoid areas of anchoring activity in the USACE Gravesend Anchorage and USCG Anchorage #25, as well as future potential expansion of the USACE anchorage included in the New York and New Jersey Harbor Federal Navigation Project (USACE 2020). This routing avoids the anchorages (USACE 2020) and targets installation in deeper water but coincides with the highest level of transiting vessel traffic based on review of available AIS data. Few vessels have reason to intentionally deploy an anchor in the channel; vessel anchoring would typically only be associated with accidental deployment or intentional emergency anchoring. As such, anchoring along Alternative B1 is less frequent than that associated with Alternative A. However, during construction within Ambrose Channel, the channel would be partially to completely blocked for several days for the submarine export cable installation. Because the Alternative B1 route is within the maintained channel, it is also subject to potential future maintenance dredging during Project operations or deepening of the channel to allow use by larger vessels, which need to be considered for cable installation. However, this portion is naturally deeper than areas currently requiring maintenance, so it is not expected to require dredging in the near future.

Although Empire considers avoidance of installing the cable within Ambrose Channel to be a priority, the avoidance of crossing the anchorage area was determined to be an even greater priority when considering this route compared to Alternative A. Alternative B1 is considered a practicable alternative, but it may result in greater impacts to the marine environment due to the regulatory requirements for deep cable burial expected in this area, and has the potential for a high level of impact to marine navigation during construction.

3.3.3.4 Submarine Export Cable Route Alternative B2

Submarine Export Cable Route Alternative B2 is a variation of Alternative B that stays along Ambrose Channel further to the north before making a sharper turn east into Gravesend Bay, and then converging with the Alternative B route.

Submarine Export Cable Route Alternative B2 is slightly longer than Alternative B and has the same considerations as Alternative A relative to the proximity to the northbound movement of large ships along Ambrose Channel. Submarine export cable route Alternative B is optimized relative to Alternative B2, and therefore Alternative B2 may result in greater environmental impacts and potential conflicts with maintained channels, anchorages, and marine navigation. As such, Alternative B2 is a practicable alternative, but is not the proposed alternative.

3.4 Technology Alternatives

In addition to the siting and routing alternatives evaluated above, Empire also assessed technology alternatives, specifically cable landfall installation and foundation alternatives, to fulfill its energy requirements. A summary of the options evaluated is provided in this section.

3.4.1 Foundation Alternatives

Empire evaluated several potential types of foundations for wind turbines and offshore substation: monopile, piled jacket, gravity base structure (GBS), suction bucket jacket, suction bucket monopile, and floating. Over the past several years, Empire has been evaluating the use of a GBS as a potential foundation for wind turbines to be deployed in the Lease Area, recognizing the potential of a GBS to avoid certain impacts to marine life (specifically, acoustic impacts from pile driving) from other foundation alternatives, such as monopiles or piled jacket foundations. Empire's evaluation of the GBS foundation alternative included consultation with experts across a spectrum of specialties, including design and construction engineering, acoustic engineering, marine mammal science, manufacturing process engineering, transportation logistics, procurement, permitting, and commercial contracting. Based on the evaluation, Empire has concluded that the GBS is not a practicable alternative for any WTG foundations for EW 1, as stated in Section 3.4.1.1. Empire is instead proposing monopile foundations for the WTGs, and a piled jacket foundation for the offshore substation.

3.4.1.1 GBS

GBS foundations are strengthened concrete structures with a circular base fixed to a conical exterior and vertical concrete column. The vertical concrete column connects to a steel transition piece that holds secondary features (i.e. access platforms and boat landings) associated with deeper water sites. To support up to a 15-MW WTG, a GBS foundation would be approximately 118 ft (36 m) wide at the base, 210 ft (64 m) tall, and weigh up to 8,500 tons (7,711 metric tons). It would require approximately 10,000 tons (9,071 metric tons) of high-density aggregate to ballast down a GBS and would likely necessitate a considerable amount of scour protection when compared to a monopile foundation.

Structural integrity of the GBS foundation is dependent on stable and supportive seabed conditions. Weak horizontal seabed layers, which are commonly found in locations of sediment deposition (i.e., historic rivers and deltas), are not suitable for GBS foundations. Empire's geophysical and geotechnical survey campaigns of the Lease Area indicate much of the area contains thin layers of soft sediment and loose marine sand. The evaluation also indicates the Lease Area contains Glauconite, which is a highly friable sediment type that may degrade structural integrity under the cyclic loading (repeated application of a load) of a WTG and, therefore, cannot provide the necessary stability for GBS foundations.

Unsuitable seabed conditions necessitate seabed preparation prior to GBS installation. This process is necessary to ensure the wind turbine is adequately supported and involves a combination of dredging and backfilling with rock, adding an armor and filter layer above the mudline, and placing a gravel pad and scour protection on top of that. The dredging preparation would likely involve removing soft, uneven, or mobile sediments as well as a foundation bed of rock (or aggregate). By contrast, monopile foundations require no further seabed preparation after being piled into the ground and scour protection laid along the perimeter above the mudline. As such, GBS foundation installation involves seabed preparation and scour protection, which will disturb a larger area and result in greater impact to the marine environment and benthic resources when compared to impact from installation of the monopile foundation.

The primary advantage of the GBS foundations alternative is to avoid the pile driving into the sea floor that is required to install monopile foundation, and which generates acoustic energy potentially impactful to aquatic life. GBS foundations are transported and placed at the site without pile driving. However, the potential advantages of GBS foundations are offset by other negative environmental impacts. Empire's evaluation indicated there are higher overall carbon dioxide (CO_2) emissions associated with use of the GBS foundations (Empire's evaluation estimated approximately 4,500 [4,082 metric tons] tons per foundation for GBS, compared to approximately 2,300 tons [2,086 metric tons] per foundation for monopile foundations). This is mostly due to much higher emissions from installation of the GBS foundation. GBS foundation transportation would also result in more marine traffic impacts (GBS foundations must be transported individually, unlike other foundation types).

Logistical challenges are also a consideration for GBS foundations. Since there are currently no GBS manufacturers in the United States, a fabrication site for the foundations is required. Empire would also need to develop its own supply chain to fabricate, transport, and install the GBS foundations. Empire would be entirely responsible for establishing the supply chain, skilled workforce, and adequate quality control. Empire identified Port of Coeymans (near Albany, New York) as a potential fabrication site, but determined it is impracticable due to associated upgrade costs, transportation and staging requirements, and logistics due to bridge height restrictions along the Hudson River. No other commercially viable options for the fabrication and supply chain for GBS foundations were identified.

After evaluation, Empire determined that the costs, logistical challenges, and commercial risks of GBS foundations render the alternative impracticable and would restrict Empire's ability to meet contractual commitments with New York and achieve the Project purpose (see Section 3.1). Moreover, the GBS foundations would cause greater potential environmental impacts to the seafloor due to a larger footprint, to air emissions from increased CO_2 emissions, and to navigation/marine traffic, which outweigh the benefits of GBS foundations in reducing the potential temporary acoustic impacts to marine wildlife during construction.

3.4.1.2 Monopile

Monopile foundations consist of a single vertical, broadly cylindrical steel pile driven into the seabed. A steel transition piece, which contain secondary structural components, cable hang-offs and material handling equipment for the WTG (i.e., boat landings. internal access platforms with cable hang-offs, external work platform equipped with gates for W2W systems and crane for equipment transfer from CTV), will be connected to the monopile by bolting (see **Attachment B** Permit Drawings). The transition piece will also contain the Navaid equipment such as marine lanterns, foghorn and AIS

While a piled solution (monopile or piled jacket) for a wind turbine or offshore substation may not require the same level of ground preparation for installation as GBS, drivability relevant to geotechnical conditions need to be considered. Empire has completed an initial drivability assessment to confirm feasibility and has included contingent locations within the conceptual layout.

Empire's evaluation indicated that CO_2 emissions and seabed impacts are lower with installation of monopile foundations than GBS foundations, as discussed in Section 3.4.1.1. Based on the monopile foundation's previous use in the United States, known technology and existing supply chain, and Empire's obligation to meet contractual commitments with New York to achieve the Project purpose (see Section 3.1), monopile foundations were selected for the EW 1 wind turbine foundations.

3.4.1.3 Piled Jacket

A piled jacket is a vertical steel lattice structure consisting of three or four legs to support a wind turbine, or up to eight legs to support an offshore substation, from which piles are inserted and connected through cross-bracing (see **Attachment B** Permit Drawings).

The piled jacket foundation was selected for the offshore substation, since monopile foundations are not designed for and are not practicable to support the larger size/weight of the offshore substation (approximately 5,500 tons [5,000 metric tons]).

3.4.1.4 Suction Bucket Jacket

A suction bucket jacket is a vertical steel lattice structure consisting of three or four legs, which contain inverted bucket-like structures at the base, connected through cross-bracing. Suction bucket jackets were removed from additional consideration because the conditions in the Lease Area are not suitable. Suction bucket jackets are more typically appropriate for areas with characteristics that allow the buckets to achieve appropriate penetration and the proper soil-structure interaction for the jacket. Empire's geophysical and geotechnical survey data has demonstrated that the seabed sediment in most locations (0 to 33 ft [0 to 10 m] below surface) consists of loose marine sand, limiting the holding capacity of the buckets. As such, based on the technical constraints of suction bucket jacket foundations, they are not a practicable alternative to meet the Project purpose.

3.4.1.5 Suction Bucket Monopile

A suction bucket monopile is a single vertical, broadly cylindrical steel monopile, which contains a single inverted bucket-like structure at the base. Suction bucket monopiles were also deemed not to be technically or commercially feasible for the development timescales associated with this Project and are therefore not a practicable alternative to meet the Project purpose.

3.4.1.6 Floating

This alternative uses a floating structure, typically a spar or semi-submersible, which is tethered to the seafloor through a set of anchoring devices. Floating foundations are used for installations at much deeper water depths than are present in the Lease Area. Floating foundations are not considered practicable for the Project because the water is not deep enough to justify the additional costs and engineering considerations.

3.4.2 Submarine Export Cable Technology Alternative

Empire evaluated different transmission technologies for the submarine export cables against the following criteria:

- Transmission distances,
- Economic considerations, and
- Land required to support onshore electrical facilities.

The submarine export cables are designed to use HVAC rather than HVDC due to the considerably lower costs to interconnect HVAC into the alternating current terrestrial grid at the Gowanus 345-kV Substation. HVDC requires a considerably larger investment with greater complexity, significantly larger onshore space requirements, and higher maintenance needs than HVAC due to the need for converter stations onshore and offshore. HVDC becomes more cost-effective for wind farms with a larger nameplate capacity than is planned for the EW 1 Project, in part because HVDC may allow a reduction in the number of export cables for larger projects. This may also be preferable for long transmission lines carrying very large power capacities where HVDC reduces transmission losses relative to HVAC. The transmission distance and power rating of the EW 1 Project submarine export cables makes it suitable and more cost-effective to employ an HVAC system.

3.4.3 Submarine Export Cable Installation Alternatives

Empire also evaluated several alternative methods for cable installation offshore, including cable burial and direct placement on the seafloor. Empire is proposing to bury the submarine export cables using jetting, mechanical plow, trenching/cutting, and dredging. Dredging or mass flow excavation are not proposed for cable burial in general, but may be required in certain locations, such as for pre-sweeping and seabed preparation activities prior to cable lay, at certain asset crossings, and for trench excavation and cable burial along the submarine export cable corridor between the 35th Street and 29th Street Piers, approaching the cable landfall.

Placement of the submarine export cables directly on the seafloor as the primary installation method was determined to be not practicable due to the heightened risk of third-party damage to the cables and increased maintenance requirements from anchor or fishing gear snagging. Although direct seafloor disturbance from jetting or trenching during construction would be avoided with this method, the additional cable protection measures required to minimize third-party damage would result in a much larger footprint alteration of the seabed surface and long-term impact to the benthos. Additional cable protection requirements would also likely offset the installation time savings from placing cables on the seafloor instead of burying them. As such, Empire has retained placement of the cables directly on the seafloor, with cable protection (such as rock berm or matting) only for limited areas where sufficient burial depths cannot be achieved due to seabed conditions.

For cable burial, Empire assessed a variety of methods including jet plow, mechanical plow, trenching/cutting, and dredging. Both jetting and mechanical plowing may create a trench and lay the cable in a single pass. 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. The water sufficiently liquifies the sediments such that the cable can then settle down through the suspended sediments to the desired burial depth. Mechanical plowing uses a 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. Due to gravity, the displaced sediment returns to the furrow, covering the cable.

Jettting methods (including capjet, jet sled, jet plow and vertical injector equipment) are considered Empire's primary proposed method for cable installation. Jetting is the most efficient method of submarine cable installation that minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route. The majority of suspended sediments from jetting settle back in the trench naturally, reducing sedimentation impacts.

Empire also considered trenching, or cutting, which may be used on seabed containing hard materials not suitable for mechanical plowing or jetting, as the trenching machine is able to mechanically cut through the material using a chain or wheel cutter fitted with picks or teeth. Once the cutter creates a trench, the submarine export cable is laid into it, and typically backfill is mechanically returned to the trench using a backfill plow. This method is less preferred due to lower efficiency, longer installation duration, and greater potential impacts from the additional step of backfilling the trench. However, both mechanical plowing and trenching (cutting) are proposed as potential installation methods to be used in the event that Empire encounters seabed or depth conditions where jet plowing is not practicable or efficient. Pre-sweeping or pre-trenching may be associated with any of the considered cable burial methodologies.

Mechanical dredging was also assessed as a potential method for submarine cable installation. Dredging is used to excavate, remove, and/or relocate sediment from the seabed in order to increase water depth and alter existing conditions; this can be completed through clamshell dredging, suction dredging, and/or hydraulic dredging. Because of the greater duration and extent of sediment disturbance associated with dredging, this method is not practicable for the majority of the cable installation. Dredging, however, is proposed for cable installation along the submarine export cable corridor approaching the landfall at SBMT, between the 35th Street and 29th Street Piers. In this area, depths below the existing bathymetry are required because of cable installation vessel draft requirements and for cable landfall activities. Since dredging is proposed along this segment of the route, Empire is also proposing to dredge the submarine export cable trench to the target burial depth and backfill with suitable sand or other quarried material. Backfilling the material along this portion of the submarine export cable route will be required due the thermal resistivity properties of the existing sediments along this segment of the submarine export cable route.

3.4.4 Cable and Pipeline Crossing Alternatives

The submarine export cable route will cross existing in-service and out-of-service assets including existing transmission cables, natural gas and petroleum pipelines, and water siphons, especially as the route traverses the Narrows. Empire is proposing to install the submarine export cables across third-party assets using concrete or rock-filled mattresses or rock berm protection (see Section 2 of **Attachment D**).

A traditional asset crossing with crushed rock installation or a rock berm will consist of installation of rock at the base, cable lay, followed by another layer of rock protection over the top. Rock installation provides protection for the cable against anchor drags or other external impacts. This method results in approximately 6.5 ft (2 m) of shoaling on the seafloor. For certain crossings, Empire is also evaluating the use of traditional asset crossing measures protected with mattresses filled with either rock or concrete. Potential methods include either laying the cable directly on the seafloor with a protective mattress on top or laying the cable on top of a layer of protective mattress on the seafloor, and then adding a second protective mattress over the top of the cable. These solutions do not cause significant shoaling, resulting in a less than 3 ft (0.9 m) reduction in water depth. Removal of sediment at crossings of identified assets to facilitate installation may be conducted before the crossing installation to allow for sufficient burial of the submarine export cables and reduce the need for supplemental cable protection material or shoaling on the seabed. This method may not be feasible due to site-specific limitations on dredging in the vicinity of existing assets.

These asset crossing methods have been retained as practicable for use on a case-by-case basis at cable and pipeline crossings along the submarine export cable route. Where the submarine export cable route requires the crossing of assets, specific crossing designs will be developed and engineered. Cable crossing methodologies will be based on a variety of factors, including the type of asset to be crossed (i.e., material), the depth of the existing buried cable or pipeline, and whether the assets are in-service or out-of-service.

In a meeting in June 2020, the USACE requested that Empire evaluate the possibility of using trenchless methods to install the submarine export cables under assets in New York Harbor, to avoid the need for shallower burial and surface protection at these crossings. As such, Empire assessed the potential to use HDD or microtunnel installation methods for several cable and pipeline crossings.

A water-to-water HDD installation would be similar to the method described for the land-to-water HDD in Section 3.4.5.1, except that it would be completed using barge support on both ends of the installations. In other words, these crossings would require a barge-to-barge installation for each crossing. Each barge would need to be a jack-up type to eliminate the impacts of waves and tides. It is expected that the soil conditions below the mudline of the harbor would require installation of a 24-inch (610-millimeter) outer diameter stainless steel conduit. Starter casings would be required on both ends of the HDD alignment to help manage and control drilling fluid loss. Potential HDD alignments assessed were 1,990 to 2,365 ft (606 to 720 m) in length.

The resulting depth of the HDD installation greatly exceeds the depth limitation for the electrical cables. Even if temporary casing pipes were not needed and the vertical curve could be started very close to the mudline, the resulting installation elevation would still exceed the depth limitation. Additionally, based on the available geotechnical information, soils consisting of extremely low to low strength clay and silt are anticipated from the mudline and extending down to depths of at least 22 ft (6.7 m) below mud line. These soils present significant risk of drilling fluid inadvertent return. Even with the casing pipe installation, the risk of a drilling fluid inadvertent return is considered extremely high and containing any drilling fluid inadvertent return would be difficult.

The extremely low to low strength clay and silt present additional challenges associated with steering to maintain the design alignment. To induce a steering deflection, the downhole tooling must be able to push off of the existing soil. Difficulty steering can result in a deeper and/or longer than anticipated installation. Designing the HDD alignment within more favorable soils with sufficient strength where the HDD bore curves are located can decrease this risk.

In addition, barge-to-barge crossings carry a unique set of risks in addition to typical HDD risks. Water levels and storms are significant variables that have effects on scheduling and site productivity. Underwater currents during violent storms can alter the casing pipe, in turn affecting the drill string. This is less likely once the casing has been fully placed into the soil but remains a strong possibility until the casing is set. Site logistics, including incoming and outgoing materials and products, including fluid and spoil removal from the site, can also be more difficult than land crossings due to the more isolated nature of the entry and exit points. Barges and/or ships used for the removal of the fluid returns must be adequately sized so as to not reduce the productivity of downhole operations, meaning larger vessels may be needed in areas of marine traffic. Given the risks and challenges associated with the site soils and the exceedance of the maximum depth of the electrical cables, an HDD construction alternative is not a practicable crossing method.

Microtunneling is a method of constructing a tunnel that involves underground installation of a casing pipe by jacking it into place from a jacking shaft, using hydraulic jacks. Excavation is carried out with a remotely controlled, closed face, fully shielded, steerable, laser-guided or similar articulated Microtunneling Boring Machine (MTBM). The MTBM can exert a continuous, controllable pressure at the tunnel heading, utilizing pressurized slurry to prevent groundwater inflows and soil movement into the heading. The MTBM is propelled by thrust from a continuous string of pipe that is advanced from a jacking shaft to a receiving shaft by hydraulic jacks. As the MTBM advances, the cutter head excavates the encountered material in front of the machine. The excavated material passes through a crushing/mixing chamber, where the spoils mix with the recycled slurry water that is pumped down from a slurry separation plant, which is located at the surface. The jacking pipe used for microtunnel installations can be either reinforced concrete jacking pipe or steel.

For a microtunnel, Empire assessed a 42- to 60-inch (1,067- to 1,524-millimeter) outer diameter reinforced concrete jacking pipe that would need to be installed. Similar to HDD, sands, silts and clays in a very soft to soft or very loose state may not provide sufficient bearing capacity to support the heavy MTBM, which would make maintaining the design alignment difficult. Based on Empire's geotechnical investigations in support of the cable routing, the anticipated sediments in the vicinity of potential crossings in New York Harbor are expected to include extremely low to low strength clay and silt, as explained above. These materials are unlikely to provide sufficient bearing capacity to resist the weight of the MTBM, which would impact steering, and increase the risk of a lost MTBM and the potential for significant ground disturbance. Advancement of the MTBM through the anticipated very soft soils may cause a stress redistribution within the soils leading to increased risk of settlement. Settlement, in turn, also has the potential to introduce risk to the existing assets above the microtunnel.

Microtunnel operations also require dry or watertight shafts. Constructing and sealing each of these shafts presents significant challenges. Given the extent of the very soft/extremely low strength soils, these shafts may require significant depth to provide a stable and watertight seal at the base of the shaft. Given the risks and challenges associated with the site soils, the low anticipated bearing capacity of the site soils, and difficulties laying the export cables through the casing pipe, a microtunnel construction alternative is not a practicable crossing method.

In addition to these trenchless crossing methods, Empire also evaluated artificial reef and pipe-supported bridge crossing methods. An artificial reef concept would use an artificial reef structure as cable protection in lieu of the mattress or rock protection that would be employed for a traditional trenched asset crossing. However, Empire did not find examples of artificial reefs having been previously used for cable protection at asset crossings; therefore, the effectiveness of these structures is unknown. Because of the soft soils present at the locations of the existing cable and pipeline crossings, it was determined that a mattress foundation would likely need to be employed in combination with the artificial reef structures for sufficient support. The reef units also carry the risk of creating anchor snag points. Therefore, Empire determined that the use of an artificial reef in conjunction with asset crossings was not a practicable option for the Project.

A pile-supported bridging crossing would require driving piles to either side of the asset crossing, and significant trench dredging. Seabed impacts, as well as potential underwater noise impacts, would be greater than with the preferred solutions. This method is also more labor-intensive and costly than traditional crossing methods. It was therefore determined that a pile-supported bridge crossing is not a practicable solution for the Project.

Rock-filled mattresses, concrete articulated mats, and rock berm protection were determined to be practicable options for asset crossings, considering factors such as hydraulics, scour, and anchor drag/impact. These methods therefore have been retained for case-by-case use at the cable and pipeline crossings along the submarine export cable route.

3.4.5 Cable Landfall Installation Alternatives

Empire considered several cable landfall installation alternatives, including installation of the submarine export cables through conduits in the bulkhead at the shoreline of SBMT, installation over the bulkhead, or HDD from offshore to onshore. Installation through the bulkhead is the proposed alternative, as described in Section 3.4.5.2.

3.4.5.1 HDD Cable Landfall Alternative

Empire considered multiple potential HDD alignments in evaluating potential HDD cable landfall alternatives at SBMT in the vicinity of the 35th Street Pier. The shoreline around the 35th Street Pier is as follows:

1. The end of the 35th Street Pier is understood to have a deep concrete-filled caisson bulkhead with cofferdam to a depth of approximately 50 ft (15 m) below MLLW. This cofferdam has two layers of sheet pile.
2. The southern edge of the pier consists of steel sheet pile bulkhead towards the tip of the pier, to a depth of approximately -14.9 ft (-4.5 m) MLLW, and rip rap armoring towards the base. The riprap was reported to extend approximately 28 ft (8.5 m) offshore to a depth of 10.5 ft (3.2 m). Wood fragments are also found in borings in this area.
3. Along the north side of the 35th Street Pier, the shoreline also consists of a combination of rip rap armoring and steel sheet pile. The rip-rap revetment extends from the southeast corner and out to the offshore face of the pier. Prior to the installation of the rip rap revetment, a timber pier was demolished, leaving timber piles cut off approximately 2 ft (0.6 m) below the mudline.

Empire conducted an HDD feasibility assessment of an alignment that makes landfall near the base of the southern side of the 35th Street pier. The specific information provided in this section refers to the assessment of that alignment; however, the consideration of other HDD alignments around the 35th Street pier indicated that similar constraints exist for other potential alignments. Empire determined that based on available geotechnical data that the geotechnical conditions, HDD geometry, and bending radii would require installing the export cables to depths of greater than 70 ft (21 m). This depth requirement is driven by a combination of factors, including sediment characteristics that are unfavorable to a shallower HDD installation, the required HDD entry angle, avoidance of existing shoreline infrastructure, limitations on the length of the drill, and location of the offshore HDD exit due to maritime traffic.

Based on review of previous geotechnical investigations in the vicinity of the Project, it appears that the deeper installation would be required due to the following conditions:

- In the vicinity of the HDD entry location onshore, the geotechnical materials are anticipated to include fill materials overlying sands, silts, and clays, extending from the ground surface to a depth of 22 to 30 ft (6.7 to 9.1 m) below ground surface. The fill materials are anticipated to include sands, gravel, silt, brick fragments and concrete fragments. The density of the fill materials ranged from medium dense in the upper 10 feet (3.3 meters) of the soil column, loose to medium dense to a depth of between 18.5 and 30 feet (5.6 and 9.1 meters) below ground surface. Below the fill, the soil is anticipated to include medium dense sand and silt with varying amount of gravel.
- Beyond the limits of the pier, the geotechnical materials are anticipated to include layers of very soft to soft silts with gravel and very loose to loose sand overlying medium dense sand and silts and medium stiff silt at depths of 50 to 59 ft (15.2 to 18.0 m) below ground surface; and
- In the vicinity of the HDD exit location offshore, the site soils are anticipated to include various layers of very soft to soft silt and very loose sand to a depth of approximately 45 ft (13.7 m) below

the mudline. These soils pose significant challenges with preventing drilling fluid inadvertent return events during pilot bore, reaming, swabbing, and product pipe installation.

Due to the presence of loose fill materials in the soil column in at the HDD entry, and the elevation difference between the HDD entry and exit location, a conductor casing would be needed to bridge and support the drill path from the point of entry. The entry angle of the HDD would have to allow the installation of the temporary conductor casing through the upper 26 ft (7.9 m) of the fill materials. The HDD alignment would also cross beneath the existing pier known to consist of a steel sheet pile bulkhead with riprap armor stone. Avoidance of these features is factored into the required HDD angle, length, and depth.

Soil thermal resistivity is a critical factor for the cable design and limits the burial depth for the installation. Due to the long cable routing and electrical parameters of this Project, cable landfall is the most critical location for the cable design, where burial depth poses most risk of derating the export cable due to the cable heat limitations. Derating is a reduction in the cable's rated capacity to carry current, to prevent degradation of the cable insulation due to heat. In case of an HDD, the maximum cover will be located on the shore side of the drill alignment. This maximum cover will typically be measured from ground level onshore to the safe distance below any existing structures or existing piles along the shoreline. The required depths of greater than 70 ft (21 m) for a cable landfall HDD on EW 1 would exceed the cable burial limitations and introduce thermal constraints on the submarine export cables resulting in cable derating.

Besides exceeding depths set by thermal resistivity limitations, the necessary HDD alignment would also place an HDD installation beyond the ends of the existing piers at the site and within the active vessel traffic area. Vessel tracking AIS data from December 2017 indicates that the landward boundary of heavy vessel traffic is approximately 164 ft (50 m) seawards of the end of 35th Street Pier. AIS data shows that the slips north (Sims Municipal Recycling Facility) and south of SBMT are both active with vessel traffic (including tug and barge traffic).

In addition to design limitations associated with the HDD installation depth in this location, geotechnical conditions indicate a high risk for inadvertent returns of drilling fluid. In the vicinity of a potential HDD cable landfall exit, the thickness of very soft silt and very loose sand is approximately 45 ft (13.7 m). The majority of the exit curves and exit tangents are within these low strength materials; therefore, inadvertent drilling fluid returns would be anticipated regularly and often during pilot bore, reaming, swabbing, and conduit installation. Within these soils at the exit location, a casing strategy to mitigate inadvertent returns cannot be developed without significantly deepening and lengthening the HDD installation.

In conclusion, Empire's assessment indicated that an HDD installation of the cable landfall at SBMT would not be practicable, because the depth required for installation would exceed the depth limitations of the export cables. Additionally, the HDD alignment would have a high risk of inadvertent returns and potential associated environmental impacts, especially near the HDD exit location. Moreover, the constraints and impacts were similar for any HDD alignment in the vicinity of the cable landfall. The use of the HDD method would reduce seafloor disturbance between the HDD entry and exit points; however, in this area the seafloor is already highly disturbed and future dredging activities are planned. The potential benefits of the reduced seafloor disturbance with HDD installation are also offset by the additional impacts from a larger cable landfall workspace and cofferdam required offshore for HDD, HDD noise, navigational impacts, and potential impacts form inadvertent returns.

3.4.5.2 Through the Bulkhead Alternative

The proposed installation for the cable landfall involves pulling the cables through conduits in the bulkhead at the shoreline at SBMT, aligned approximately with the end of 32nd Street, between the 35th Street and 29th Street Piers. Due to the condition of the existing relieving platform and bulkhead, replacement is needed to stabilize the site. A new pile-supported platform and bulkhead structure at the cable landfall will incorporate two straight, 30-inch outer diameter steel pipe conduits angled through the bulkhead for landfall of the submarine export cables.

Following installation of the sheet pile behind the existing bulkhead, a sheet pile wall will be hammered approximately 4 ft in front of the edge of the relieving platform. The sheet pile wall will extend only slightly above the seabed elevation, to support the lower end of the conduits and stabilize the seabed in front of the existing relieving platform. Slots will be cut into the sheet pile to allow for the conduit installation. Preparation will then begin on the land side support for the conduits behind the sheet pile.

Next, a dredge pit will be excavated at the pier face for each cable landfall. The dredge pit base will measure approximately 12 ft by 82 ft (3.7 m by 25 m) and excavated to an elevation of 19.1 ft (5.8 m) below MLLW (-22 ft [-6.7 m] elevation NAVD88). The dredge pit will be backfilled with clean stone/scour protection to create a foundation to support the lower, seaward end of the conduits. The conduits will be installed though the sheet pile mechanically.

Once the conduit is installed, stone fill will be placed around and above the lower, in-water opening for stabilization. Export cable installation will then commence by pulling the end of each cable from the cable-laying vessel through the conduits and temporarily anchoring them on shore. Additional stone/scour protection will be placed over the cables to approximately 100 ft (30 m) out from the edge of the relieving platform.

Prior to installation of the cables approaching the cable landfall, dredging will be conducted between the 35th Street and 29th Street Piers. This dredging is necessary to facilitate cable vessel access and install the submarine export cables between the two piers. Although this method of installing the submarine export cables would involve some additional seafloor disturbance associated with the dredging and burial of the cables to the shoreline, as compared to the HDD method alternative, this disturbance would be in an already highly disturbed area. This area between the piers provides a straight alignment at cable landfall.

Empire considered other alignments for this cable landfall method; however, compared to a cable landfall on the end or along the north or south sides of the 35th Street Pier, the proposed cable landfall alignment through the bulkhead in the area between the piers has a lower risk of conflict with jack-up vessel berthing. Jack-up vessel footings have the potential to pose a risk for third-party damage to the cables during operations; therefore, minimizing conflict with potential berthing areas is advantageous. The cable is also located within an area of SBMT that already has reduced bearing live load requirements. A cable landfall towards the seaward end of the 35th Street pier has potential impacts by creating future limitations on heavy loads at the SBMT site. Installing the submarine export cables into conduits through the bulkhead between the piers results in limited disturbance of the seabed at the exit point, minimal interference with marine traffic, and avoids the risk of inadvertent returns of drilling fluid that would be associated with the HDD installation method. As such, Empire is proposing this method and alignment for installation of the Project.

3.4.5.3 Over the Bulkhead Alternative

As an alternative method, Empire considered an installation that routes the export cables through a mildly sloped steel conduit that goes over the edge of the bulkhead down towards the mudline. Under this alternative, the conduit would remain on top of the bulkhead instead of routing through the bulkhead. Similar to the method of installing conduits through the bulkhead, the conduits may need to be supported by a steel structure between bulkhead and mudline, and a cofferdam may be installed to facilitate installation of the conduit underwater. Impacts for this method would be similar to installing a conduit through the bulkhead.

Empire assessed several alignments for an over the bulkhead cable landfall, including onto the 35th Street Pier. Nearshore conditions such as bathymetry, in-water obstructions, seabed conditions, and vessel traffic were investigated. For the alignment between the 35th Street and 29th Street Piers, installation over the bulkhead and relieving platform would result in projection of the conduits out beyond the edge of the relieving platform. In designing the cable landfall, minimizing new structures seaward of the existing edge was preferred. Keeping the cables underground/within the bulkhead and/or under the relieving platform provides greater safety and protection to the cables from external damage. Running the cables over the bulkhead also may introduce stress from a steeper approach angle.

Cable landfall directly onto the pier was determined to be challenging due to existing remnant pile structures, potential conflict with future site uses, the potential for jack-up vessels or barges berthing at the pier, cable alignment complexity and greater potential conflicts with high vessel-traffic areas, similar to considerations for alignments onto the pier with the "through the bulkhead" method (see Section 3.4.5.2). Routing the cables along the 35th Street Pier was also determined to have greater potential to conflict with future site uses, based on discussions with SSBMT. Based on these factors, a cable landfall over the bulkhead to the 35th Street Pier was determined not to be a practicable alternative for the Project.

3.4.6 Pre-Sweeping and Dredging Alternatives

In certain limited areas of the submarine export cable siting corridor, where underwater megaripples and sandwaves are present on the seafloor, pre-sweeping may be necessary prior to cable lay activities. Pre-sweeping involves smoothing the seafloor by removing ridges and edges, where present. For cable installation along the submarine export cable corridor approaching the landfall at SBMT, between the 35th Street and 29th Street Piers, Empire is also proposing to conduct localized dredging to install the submarine export cables due to cable installation vessel draft requirements, existing sediment thermal resistivity properties, and to conduct cable landfall operations. Empire evaluated a variety of pre-sweeping and dredging equipment for these activities. Dredging methods evaluated include trailing suction hopper dredging (TSHD), hydraulic dredging/cutter suction dredging, mechanical dredging, and mass flow excavation. Based on its evaluation, Empire is proposing mass flow excavation as the primary method for pre-sweeping, subject to regulatory approvals, and a mechanical clamshell dredge operation for localized dredging at SBMT.

3.4.6.1 Pre-Sweeping and Dredging Equipment Alternatives

The primary pre-sweeping method will involve using a mass flow excavator from a construction vessel to smooth excess sediment on the seafloor along the footprint of the cable lay. A mass flow excavator uses jets to disturb and displace the material below the excavator. This equipment is deployed from a self-propelled vessel, making excavation continuous and adaptable. This technology may also incorporate dynamic positioning, allowing the operator to set way points and plan sediment disturbance with a high degree of accuracy. This equipment often works in close proximity to existing subsea objects in support of cable burial operations.

A TSHD is a self-propelled vessel that digs, stores, and pumps dredged material. TSHDs are beneficial in long, spread out excavation areas since they can freely move with no wires or spuds. This equipment can cover miles of excavation each day, and returning to a dig area for a "clean up" or small touch ups to a profile is relatively easy. There is little to no support equipment needed for the dredge to dig, transport, and pump off/bottom dump material. However, active dig time may be reduced due to accommodate other activities, such as sailing or disposal of materials. A typical mid-sized hopper dredge in the United States would be expected to remove between 1 and 3 ft (0.3 and 0.9 m) of material vertically, across a width of 6-12 ft (1.8 to 3.7 m). After filling the hopper, which typically will hold between 2,300 to 6,000 cubic yards (1,760 to 4,590 cubic meters) of dredged material, the TSHD will transit to a disposal site and prepare for disposal.

A TSHD can be used for ocean placement of material; for bottom placement, the dredge opens several gates/doors or splits its hull on a central hinge to release all the material over 4 to 12 minutes, usually while moving slowly through the disposal area to clean out the hopper. If pumping a slurry (combined water and sediment) of the dredged material to an upland disposal or beach location, the vessel discharge pipe will be connected to a land-based pipe and the operator will pump the slurry until the hopper is reasonably cleaned out. On a beach, the water runs into the ocean as the sediment settles on the beach. During upland disposal, typically the sediment settles in planned cells and the excess water discharges through weir boxes. If dry aggregate is required, the dredge will overflow any excess water using skimmers in the hopper, and then will usually also require additional time to dry out the material. After it is adequately dried, cranes and/or conveyors can be used to offload the hopper. However, this dry aggregate method results in exceptionally long cycle times, and is often not selectedslected due to cost implications and significant duration. Once the material disposal is completed, the dredge will travel back to the excavation area and continue with the next load.

A hydraulichydralic dredge/cutter suction dredge (CSD) is a vessel with a large rotating cutter head that disturbs material then sucks it up and uses an onboard pump to pump it either through a pipeline directly to a disposal location or to a barge. A CSD can dig sand, clay, and rock in some cases, and can pump this material further than a hopper dredge due to the pump size. However, it is not self-propelled, so anchors and wires or spuds are used for small moves, and tugs are used for large moves or anchor resets. Because of this traveling limitation, CSDs are typically not used for narrow (less than 100 feet) and/or low-face (less than 5 feet) dig areas. They are exceptionally good at removing large amounts and can be expected to disturb and pump 8 ft (2.4 m) or more of vertical material in one swing. If the dredge is close enough to the pump out location, a long pipeline can be run directly from dredge to disposal. The length of this pipeline can be upwards of 6 mi (9.6 km) if additional boosters are brought in; boosters are barges (or land-based stations) with large pumps that are strategically put in line to increase the velocity through the pipe. If the disposal area is too far for a continuous pipeline, the CSD can pump to a spider barge which will fill scows for transport to disposal. A spider barge is an anchored barge connected to the pipeline from which the material is pumped; it has several "arms" that open, close, raise, and lower to load material in scows based on the scow's location. This method of CSD to spider barge allows the continuous pumping of material to scows, which are then sailed to an offshore disposal, location pumped to some type of upland disposal, or brought to a facility to be unloaded with a bucket or conveyors if dry aggregate is needed.

A mechanical or bucket dredge consists of a barge with a bucket to move material. The dredge moves itself a few hundred feet using spuds or wires, but ultimately requires several tugs for large moves or anchor resets. Therefore, this equipment is beneficial for protected waters with a wider dig area, to limit the amount of forward movement required. Mechanical dredges also require scows to move the material to a disposal site since there is no pump or material storage onboard. Each bucket of material, typically 12 to 30 cubic yards (9.2 to 22.9 cubic meters), is put in a scow alongside the dredge. When the scow is full, a tug brings that loaded scow to a disposal area and a different tug replaces an empty scow alongside the dredge, pausing digging for 20 to 60 minutes for each scow change. If bottom dumping the material to the ocean, the tug will sail the scow to the disposal area, the scow will open its bottom doors, release all material in 4 to 12 minutes (similar to the TSHD), then close and travel back to the dredge location. If material is to be pumped to an upland disposal or beach, each scow will have to be brought alongside an "unloader." An unloader is a stationary vessel with a piece that sucks from the scow, a large pump, and a connection to which a pipeline can run to a disposal cell or location on land. The unloader pumps slurry from the scow until it is relatively clean, then the scow makes its trip back to the dredging area. A less common, but available mechanical dredging method uses a high-powered backhoe to break up and load rock.

3.4.6.2 Pre-Sweeping and Dredging Equipment Alternatives Analysis

Use of a mass flow excavator for pre-sweeping activities (to smooth sandwaves) and at utility crossings is expected to be much shorter in duration than dredging using TSHD, CSD or mechanical dredging equipment. The shorter duration will result in less physical presence of work vessels in the cable corridor, less interference with other marine activities and navigation, and reduced overall duration of disturbance to the seabed and the marine enviornment. The reduction in duration will also increase the likelihood of being able to complete submarine export cable installaiton activities within one construction season, which greatly reduces the duration of construction-related disturbances to the marine environment, including disturbances to marine wildlife and fisheries.

Due to the efficiency of the operation, the mass flow excavator can be used immediately prior to the cable installation, minimizing the potential for sediment build up between the time of the pre-sweeping operation and the cable installation due to seabed sediment mobility. A dredging operation would likely need to be conducted significantly in advance of the cable lay and burial operation, which would necessitate overdredging additional volumes to account for the seabed mobility in the interim, in order to ensure the correct depths and seabed conditions are present at the time of cable installation and burial.

Once the pre-sweeping acivitity is completed and the mass flow excavator moved to a different location, the disturbed sediment is expected to settle out quickly. Dredging equipment may result in longer durations of suspended sediment, both due to the increased duration of operations at a given location along the submarine export cable route, and because of impacts associated with managing dredged material, such as barge overflow, hopper barge decanting, and/or onshore dewatering activities that may be necessary prior to disposal, as described in Section 3.4.6.1.

Use of mass flow excavation eliminates the dredged material disposal associated with this pre-sweeping methodology. With dredging, Empire would need to excavate, manage and dispose of material dredged from construction, including management of decanting and dewatering activities. Disposal of the volumes of dredged material anticipated for pre-sweeping will involve a significant cost to the Project, and introduce added logistical complexity associated with the management, sampling and transportation of the dredged material. Moreover, for pre-sweeping at utility crossings, dredging equipment is expected to be impracticable and/or prohibited in certain locations due to the potential risk of impact to existing assets. Mass flow excavation can remove material surrounding an existing asset with reduced risk of damage from contact with dredging equipment.

In the case that mass flow excavation cannot be used due to regulatory requirements , Empire would likely use a TSHD to pre-sweep sandwaves. Although not preferred, the TSHD allows more efficient production for pre-sweeping sandwaves than other dredging methods due to the independent mobility of the equipment and disposal options.

Empire is proposing to use mechanical dredging, with a clamshell bucket, for the dredge area and submarine export cable installation between the 35th Street and 29th Street Piers. In this area, mass flow excavation is not practicable, because the final seabed surface elevation needs to be lowered for vessel transit, excavation of and backfill of the cable trench (not just seabed smoothing) is required, and due to concerns related to existing sediment contamination in this area. As such, the mechanical dredge is the most practicable solution in this confined area to allow proper management, handling, and disposal of the dredged material.

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Empire Wind 2

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U.S. Army Corps of Engineers
Section 10/404 Individual Permit Application

Empire Wind 2 Project

Lease Area OCS-A 0512

Alternatives Analysis

Prepared for:

equinor

Equinor Wind US LLC
600 Washington Boulevard, Suite 800
Stamford, Connecticut 06901

Prepared by:

TETRA TECH

10 Post Office Square, Suite 1100
Boston, Massachusetts 02109

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TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ac	acre
AIS	automatic identification system
BOEM	Bureau of Ocean Energy Management
CBRA	cable burial risk assessment
CFR	Code of Federal Regulations
CLCPA	Climate Leadership and Community Project Act
CO_2	carbon dioxide
COP	Construction and Operations Plan
CSD	cutter suction dredge
CTV	crew transfer vessel
Empire	Empire Offshore Wind LLC
EW 1	Empire Wind 1
EW 2	Empire Wind 2
FLAG	Fiber-optic Link Around the Globe
ft	foot
GBS	gravity base structure
GIS	geographic information system
GW	gigawatt
ha	hectare
HDD	horizontal directional drilling
HRG	high-resolution geophysical
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
km	kilometer
kV	kilovolt
Lease Area	Lease Area OCS-A 0512
LIPA	Long Island Power Authority
LIRR	Long Island Rail Road
LWCF	Land and Water Conservation Fund
m	meter
m^3	cubic meter
MFE	mass flow excavation
mi	mile
MLLW	mean lower low water
MTBM	microtunnel boring machine
MW	megawatt
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NYISO	New York Independent System Operator
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research & Development Authority

NYOPRHP	New York State Office of Parks, Recreation and Historic Preservation
POI	Point of Interconnection
Project	Empire Wind 2 Project
PSA	Purchase and Sale Agreement
QMA	Qualified Marine Archaeologist
SDU	Subsea Distribution Unit
Transco LNYBL	Transco Lower New York Bay Lateral
TSS	traffic separation scheme
TSHD	trailing suction hopper dredging
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
Wall-LI	Wall, N.J. to Long Island telecommunications cable
WOTUS	Waters of the United States
WTG	wind turbine generator
yd^3	cubic yard

1. INTRODUCTION

Empire Offshore Wind LLC (Empire) proposes to construct and operate an offshore wind farm located in the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). Empire proposes to develop the Lease Area in two individual projects, to be known as the Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2) projects. These individual projects will connect to separate offshore substations and onshore Points of Interconnection (POIs) by way of separate export cable routes and onshore substations. Empire is submitting this Alternatives Analysis as part of the Application to the U.S. Army Corps of Engineers (USACE) for an Individual Permit for jurisdictional activities pursuant to Section 404 of the Clean Water Act (Section 404) and Section 10 of the Rivers and Harbors Act (Section 10) for EW 2 (referred to hereafter as the Project).

Empire conducted a detailed analysis of Project alternatives to connect the offshore Lease Area to the proposed POI in Oceanside, New York. Empire evaluated siting alternatives for the submarine export cable route from federal waters, export cable landfall, onshore export cable route, onshore substation location, and onshore cable route to interconnect with the POI relative to constructability, reliability, environmental resources, and stakeholder impact criteria. Although each component was assessed separately, the siting process was completed holistically relative to submarine and terrestrial constraints to identify the most feasible overall solution to deliver energy from the Lease Area to the electric grid, with the fewest negative impacts. The evaluation is informed by several factors, including desktop assessments, site-specific surveys, supply chain capacity, commercial availability, and engagement with both regulators and stakeholders. Additional discussion of the selection of the POI for the Project is provided in **Attachment D** (Project Narrative).

An initial high-level assessment of offshore constraints was conducted based on geographic information system (GIS) data to identify the most feasible potential submarine export cable routes between the Lease Area and the southern shore of Long Island in the vicinity of Long Beach, New York. A siting comparison of the potential submarine export cable routes was then conducted. Section 2.1 summarizes the constraints analysis and results for the identified submarine export cable route alternatives within federal waters. Empire conducted a more detailed site assessment, including geophysical and geotechnical surveys, along the proposed route (see **Attachment D** [Project Narrative]).

The submarine export cables exit the Lease Area, enter New York State waters, and continue to the export cable landfall. An overview of the submarine export cable routing in federal waters is provided in Section 2.1. A cable landfall alternatives analysis is discussed in Section 3.3, including cable installation method alternatives and landfall evaluation criteria. Once the submarine export cables make landfall, they transition to onshore export cables to transport power from the cable landfall to the onshore substation[1]. Onshore export cable alternatives are described in Section 3.5.1 and onshore substation alternatives are described in Section 3.4. Interconnection cables leave the onshore substation underground to deliver power to the POI; an alternatives analysis of the interconnection cable route is provided in Section 3.5.3. The onshore cable route refers to the complete route traversed by the onshore export and interconnection cables between the submarine cable landfall and the POI.

In addition to evaluating Project siting alternatives, Empire also considered the use of alternative technologies. This analysis considers wind turbine generator foundation types, alternative submarine export cable current type, cable landfall installation, submarine asset crossing methodologies, and pre-sweeping and dredging methodologies, as discussed in Section 3.6. These alternative technologies were assessed relative to feasibility

[1] The final configuration is still under evaluation, but Empire anticipates that the design for cable landfall and onshore transition will be consistent with the methods and environmental impacts described herein.

of existing technology and logistics, cost, and environmental impact, where applicable, in light of the overall project purpose.

2. PROJECT DESIGN DEVELOPMENT

This section provides an overview of the design development of the Project, including portions of the Project in federal waters. **Section 3** provides the detailed Alternatives Analysis[2] in accordance with the Clean Water Act's 404(b)(1) Guidelines, 40 CFR Part 230, for the discharge of dredge or fill material associated with cable landfall alternatives, submarine export cable alternatives, onshore export and interconnection cable alternatives, onshore substation alternatives, and alternative technologies.

2.1 Submarine Export Cable Route Alternatives: Federal Waters

Based on the location of the POI, an analysis of offshore routing constraints was the first step in submarine export cable route assessment to identify potential submarine export cable routes between the Lease Area and the POI, to assess feasibility, and to understand potentially significant challenges along each route. In considering submarine export cable routes between the Lease Area and the vicinity of Long Beach, New York, the most direct submarine export cable route served as the starting point in developing the export cable route. This was also driven by technical constraints and costs, including cable costs, installation time, and limits associated with efficient high-voltage alternating current (HVAC) transmission. Detail on the offshore routing constraints considered in the offshore routing constraints analysis is provided in Volume 1, Section 2 of the Construction and Operations Plan (COP, provided in **Appendix D-1** of **Attachment D** [Project Narrative]).

Three submarine export cable route alternatives were considered for the submarine export cable route in federal waters, which are presented in **Figure 2.1-1** and **Figure 2.1-2**.

Both regional bathymetry datasets (NOAA 2015) and project-specific high-resolution geophysical (HRG) survey data were collected to analyze general seabed conditions and specific seabed-related risks along the potential submarine export cable routes. These have allowed for routing to minimize traversing steeper seabed slopes and areas of complex seabed due to scour, mobile seabed, potential hardgrounds, or anthropogenic dredged channels. Steep slopes and abrupt changes in depth can pose a risk to cable installation and burial, as seabed cable burial tools are susceptible to stability issues and decreased burial potential as slopes increase. Areas of very shallow water also pose a challenge to the installation because a cable vessel suitable to install this type of cable requires an adequate draft to safely maneuver.

Existing utilities and other assets pose several challenges and risks with respect to the submarine export cables and may limit the methods and depth of burial available for cable installation at the crossing. This may add cost and complexity to the installation, as well as residual risks to the installed cable from reduced burial in the area, the installation of external protection, and/or from maintenance activities for the existing asset. As such, cable crossings and close parallels are minimized to the extent feasible by the routing.

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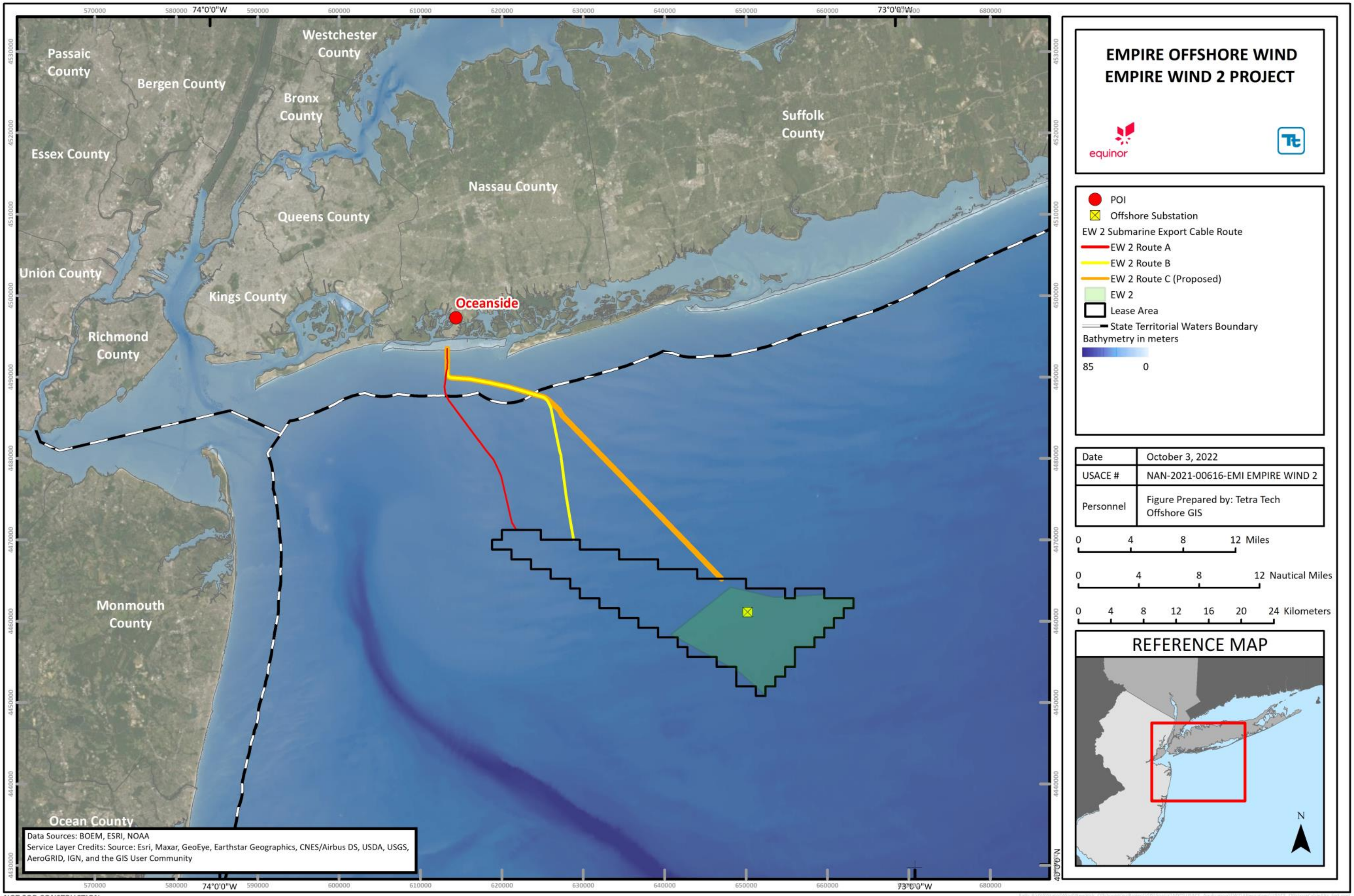
[2] Alternatives for the development of the Lease Area and associated facilities are also considered as part of the Empire COP that was filed in January 2020 with subsequent revisions in response to agency comments. The COP became publicly available following the Bureau of Ocean Energy Management's (BOEM) issuance of a Notice of Intent to prepare an Environmental Impact Statement in June 2021. Additional information on the Project design development is provided in Section 2 of the COP (**Attachment D**, **Appendix D-1**).



NOT FOR CONSTRUCTION

Figure 2.1-1 Submarine Export Cable Route Alternatives: Federal Waters

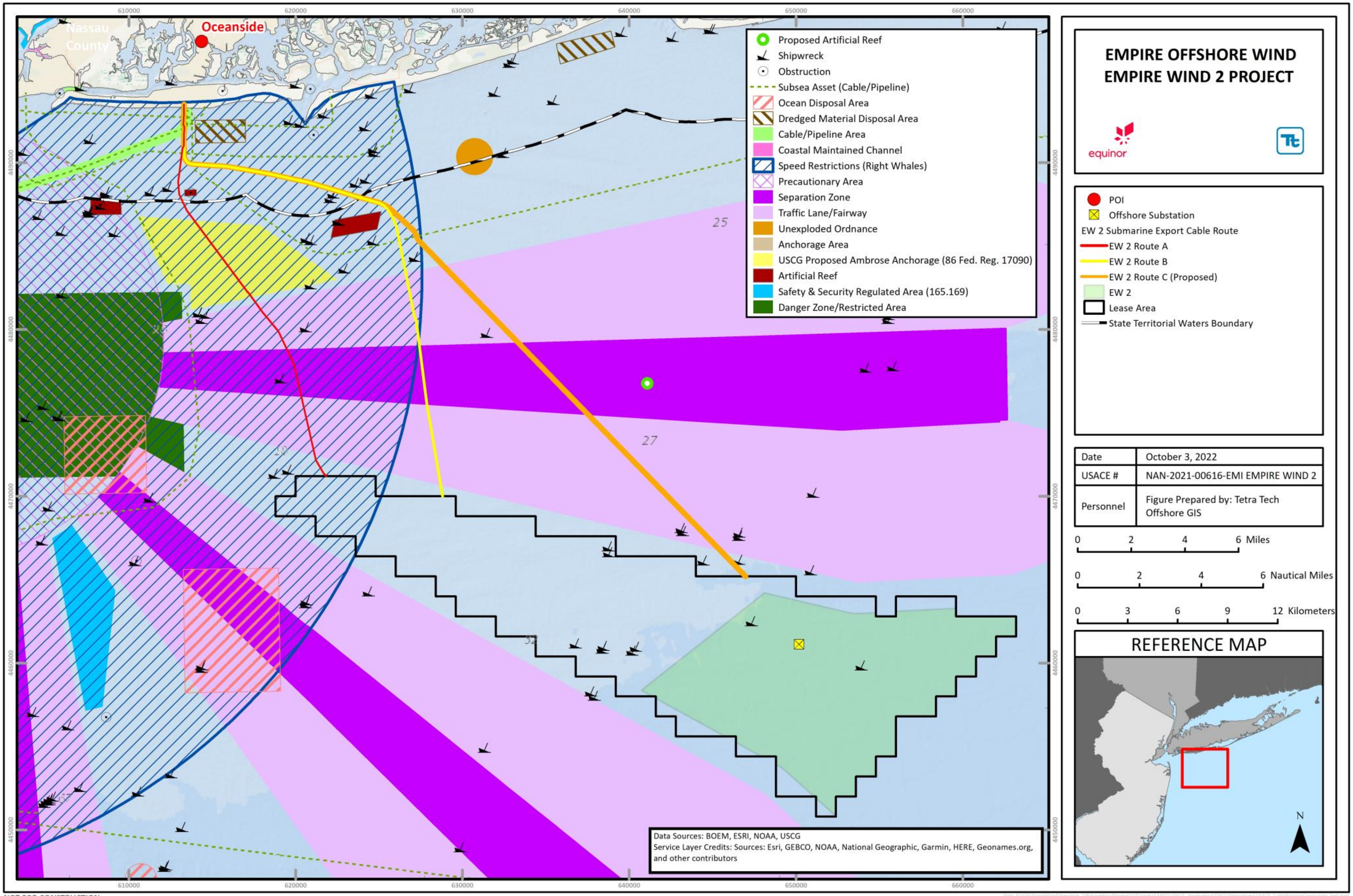


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Figure 2.1-2 Submarine Export Cable Route Offshore Constraints: Federal Waters

Dredged and maintained channels are under the purview of the USACE. The location and depths of navigation channels are authorized by the federal government, and the USACE periodically performs condition surveys to identify when maintenance dredging may be needed to keep the channel available at the authorized depth. Should a cable route cross a maintained channel, the cable must be buried deep enough below the authorized depth to ensure that the channel can be safely maintained and to ensure that there is no risk to the cable. The submarine export cable route alternatives for the Project all avoid dredged and maintained channels (with the exception of the cable route associated with the Shell Creek Park (Barnum Island) Landfall Alternative discussed in Section 3.3.5).

Traffic separation schemes (TSS) are commonly used to identify and constrain inbound and outbound traffic lanes, typically with a separation zone between these lanes, to minimize the likelihood of vessel collisions. All routes must cross the TSS located to the north of the Lease Area.

Charted danger zones, restricted areas, and warning areas exist for a variety of reasons and serve to advise mariners and other users of the risks of navigating an area or conducting some type of bottom contacting activity, such as fishing or cable laying. For these reasons, traversing charted danger zones is avoided to the extent practicable. Similarly, charted disposal areas warn mariners and other users of the risks associated with traversing an area of disturbed seabed. While some areas may contain relatively harmless material, such as dredged spoils from maintained channels, others may contain "acid wastes" (an industrial byproduct), "municipal waste" (a sewage treatment product), or munitions.

Shipwrecks and other obstructions are cataloged in the National Oceanic and Atmospheric Administration (NOAA) Nautical Charts and within the NOAA Automated Wreck and Obstruction Information System database. These features may represent physical hazards to installation and may be historically or culturally significant. These features are avoided to the extent practicable by the submarine export cable routing. Where such features must be closely approached, the HRG survey provides insight into the location and nature of the feature through acoustic and magnetic datasets. Known and suspected shipwrecks and obstructions were avoided to the extent practicable during pre-survey routing and the routing was further refined following the acquisition of HRG survey data. Identified features and recommended buffer distances are in the process of being defined through review of the HRG and diver survey data by a Qualified Marine Archaeologist (QMA).

All route alternatives also cross a Seasonal Management Area for Right Whales, where vessel speed restrictions are in place. Project-related vessels will comply with NOAA National Marine Fisheries Service speed restrictions in this area.

2.1.1 EW 2 Route A

Empire evaluated a submarine export cable route alternative from the northwestern corner of the Lease Area to Long Beach to minimize cable length. The total length of EW 2 Route A from the edge of the Lease Area to the cable landfall is approximately 18.6 nautical miles (nm) (34.5 kilometers (km)). The submarine export cable route length within the Lease Area adds another approximately 16.3 nm (30.2 km), while also introducing the difficulty of crossing multiple interarray cables. This route traverses north from the Lease Area to the New York State boundary, across the outbound and inbound traffic lanes of the TSS. EW 2 Route A also traverses closer to the higher grounds of Cholera Bank, potentially increasing the impacts to benthic habitat and areas of increased fishing.

Further north of the inbound traffic lane, the route crosses an area of increased anchoring by large vessels (de facto anchoring area) as identified by automatic identification system (AIS) vessel data. Establishment of an official regulated "Ambrose Anchorage Ground" in this area is being proposed by the US Coast Guard (USCG)

(USCG 2021) (**Figure 2.1-2**). To mitigate the potential risk of impact to the submarine export cables from anchor strike, target burial depth within anchorages is informed by the cable burial risk assessment (CBRA) considering anchor penetration depth. Although Empire can mitigate anchoring risk through the appropriate target burial depth, the increase in depth required in these areas by the CBRA typically results in greater installation complexity, duration, and cost. Anchorage areas may also be subject to potential future maintenance dredging or deepening to allow use by larger vessels. Therefore, crossing either designated anchorages or de facto anchoring areas is avoided to the extent feasible in siting the submarine export cable route. Anchoring within the de facto anchorage is currently less regulated and more dispersed than an official anchorage, so protection via deeper cable burial would need to occur over a larger area, increasing costs and seabed impacts for cable burial.

Empire determined that EW 2 Route A would result in additional challenges associated with crossing the proposed anchorage area and existing de facto anchoring area than the proposed alternative (EW 2 Route C), as well as challenges associated with multiple interarray cable crossings within the Lease Area.

2.1.2 EW 2 Route B

EW 2 Route B was designed to exit the Lease Area from a more centrally located position and stay east of both Cholera Bank and the de facto anchorage area/proposed Ambrose Anchorage Ground described in Section 2.1.1. The route from the Lease Area to the EW 2 landfall runs north-northwest, crossing the inbound and outbound lanes of the Ambrose-Nantucket TSS, to the New York State boundary This route is a total of approximately 19.6 nm (36.2 km) in length from the edge of the Lease Area to the cable landfall. The submarine export cable route length within the Lease Area adds another 12.9 nm (23.8 km), while also introducing the difficulty of crossing multiple interarray cables.

EW 2 Route B crosses the Fiber-optic Link Around the Globe (FLAG) Atlantic South telecommunications cable about 8.9 nm (16.5 km) offshore from the cable landfall in approximately 59 feet (ft, 18 meters [m]) of water, with the route crossing nearly perpendicularly to the fiber optic cable. The route then proceeds north, keeping over 1,148 ft (350 m) east of a charted artificial reef area containing multiple known wrecks, before turning to the west-northwest.

Empire determined that EW 2 Route B would result in additional challenges associated with multiple interarray cable crossings within the Lease Area compared to the proposed alternative (EW 2 Route C), which is better aligned with the offshore substation location.

2.1.3 EW 2 Route C (Proposed)

EW 2 Route C, the proposed alternative, was designed to better align with the anticipated location of the proposed EW 2 offshore substation and is located further southeast within the Lease Area. This route is a total of approximately 26 nm (48 km) in length from the edge of the Lease Area to the cable landfall. This route offers the shortest cable length within the Lease Area, adding only another approximately 3 nm (5.6 km).

EW 2 Route C exits the Lease Area from the central north edge of the Lease Area and travels in a northwestern direction in a relatively straight line. EW 2 Route C also crosses the FLAG Atlantic South telecommunications cable before turning west and joining the EW 2 Route B alignment seaward of the state water boundary. EW 2 Route C also stays to the east of the charted artificial reef area containing multiple known wrecks, before turning to the west-northwest.

Empire selected EW 2 Route C as the proposed option due to its avoidance of key constraints, such as Cholera Bank, and areas with demonstrated higher frequency anchoring activity. Furthermore, this submarine export cable route minimizes interarray cable crossings within the Lease Area, which can introduce significant challenges, as noted in Sections 2.1.1 and 2.1.2 above.

3. ALTERNATIVES ANALYSIS

Except in certain cases, 40 CFR Part 230 prohibits discharge of dredge or fill material where a practicable alternative exists to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. An alternative is considered practicable if it is available and could be implemented considering cost, existing technology, and logistics in light of the overall project purpose. This alternatives analysis is provided in accordance with the 404(b)(1) Guidelines for the Specification of Disposal Sites for Dredged or Fill Material.

Under the 404(b)(1) Guidelines, if a proposed activity is to be located in a special aquatic site but is not water dependent, practicable alternatives not involving special aquatic sites are presumed to be available unless the applicant demonstrates otherwise. Offshore wind farms are generally not considered to require access or proximity to, or siting within, a special aquatic site to fulfill their basic project purpose (wind energy generation), and therefore, are not water dependent. Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes.

Based upon wetland delineation efforts performed to date, the proposed Project is not anticipated to significantly affect any special aquatic sites. The Project does not cross any sanctuaries or refuges, vegetated shallows, coral reefs, and riffle and pool complexes. The Project crosses areas of mapped National Wetlands Inventory (NWI) and publicly available NYSDEC tidal wetlands mapping associated with open water areas (Atlantic Ocean, Reynolds Channel, and Barnum Channel). Based on NYSDEC tidal wetlands mapping and aerial photography, areas of mudflat and/or vegetated tidal wetlands may be present along the Project's interconnection cable corridor adjacent to Barnums Channel; however, Empire anticipates that these features, if present, can be avoided with the cable bridge crossing design (see Section 3.5.4).

Empire conducted reconnaissance and wetland delineations for the Project along the onshore export and interconnection cable route on November 4, 2021, June 28, 2022 and August 18, 2022; however, portions of the Project were not assessed due to lack of access permission from property owners. Survey methodologies incorporated the requirements detailed within the Northcentral and Northeast regional supplement to the U.S. Corps of Engineers Wetlands Delineation Manual (USACE 1987). A small palustrine emergent wetland was delineated within the Long Island Railroad (LIRR) corridor. The results of the November 4, 2021, June 28, 2022 and August 18, 2022 survey efforts are provided in the Wetland and Terrestrial Vegetation Report in **Attachment F**.

3.1 Purpose and Need

The overall purpose of the Project is to develop a commercial-scale offshore wind energy facility located in Lease Area OCS-A 0512 (Lease Area) with wind turbine generators, an offshore substation, and electric transmission cables making landfall in the City of Long Beach, New York, to support the achievement of New York's renewable energy mandates.

In August 2016, the State of New York Public Service Commission adopted the Clean Energy Standard.[3] Under this standard, 50 percent of New York State's electricity must come from renewable sources of energy by 2030, with 2.4 gigawatts (GW) of electricity generated by offshore wind. In 2017, New York set a goal of having 2.4

[3] Case 15-E-0302, *Large-Scale Renewable Program and Clean Energy Standard*, Order Adopting a Clean Energy Standard (Issued and Effective August 1, 2016).

gigawatts of energy generated by offshore wind by 2030, which the New York State Public Service Commission adopted as a supplementary goal for its Clean Energy Standard by order dated July 12, 2018.[4] In July 2019, the Climate Leadership and Community Project Act (CLCPA) was signed into law. The CLCPA adopts a comprehensive climate and clean energy legislation and requires that the State obtain 70 percent of its electricity from renewable sources by 2030 and 100 percent by 2040, and that New York has 9,000 megawatts (MW) of offshore wind capacity by 2035. On July 21, 2020, New York's second offshore wind procurement was announced, under which procurement the New York State Energy Research and Development Authority (NYSERDA) sought up to 2,500 MW of offshore wind. On January 13, 2021, Empire's 1,260-MW EW 2 Project was announced as a winning bidder in the State's competitive solicitation for Offshore Wind Renewable Energy Credits. Governor Hochul announced that Empire Offshore Wind LLC and NYSERDA entered into the Offshore Wind Renewable Energy Certificate Purchase and Sale Agreement (PSA) on January 14, 2022. The PSA requires Empire to design, obtain permits/approvals for, build and operate the Project and to sell the Offshore Renewable Energy Certificates generated to NYSERDA.

The Project is needed to meet Empire's obligation to NYSERDA to generate approximately 1,260 MW of clean, renewable electricity from an offshore wind farm located in the Lease Area for delivery into the New York State power grid via an expansion of Long Island Power Authority's Barrett 138-kilovolt (kV) Substation. The Project is an essential element in addressing the need identified by the State for renewable energy and will help the State achieve its CLCPA mandate and other renewable energy goals.

3.2 No Action Alternative

Under the No Action Alternative, the Project would not be built, the PSA contract between Empire and NYSERDA would not be fulfilled, and the Project's purpose to generate and deliver to New York renewable energy from the offshore wind farm in the Lease Area in furtherance of New York's renewable energy mandates and goals would not be met. The No Action Alternative does not meet the criteria to generate renewable energy through a commercial-scale offshore wind energy facility within the area defined by Lease OCS-A 0512 to meet the PSA to provide approximately 1,260 MW of energy to the New York State energy grid.

The No Action Alternative would result in no construction and operation of a commercial scale wind energy project, and therefore, does not meet the Project's overall purpose. Because it does not meet the Project's purpose, the No Action Alternative is not a practicable alternative and is eliminated from further consideration.

3.3 Cable Landfall Alternatives Analysis

The transition from submarine export cables to the onshore export cables will occur at the export cable landfall location. To identify the proposed cable landfall, Empire conducted coastal and waterfront engineering analyses of the risks and benefits of potential cable landfall locations at multiple sites along the southern shore of Long Island, as well as the submarine export cable routing and associated constraints approaching the cable landfall alternatives. The locations of potential cable landfalls, as discussed in Section 3.3, were also informed by the onshore export cable routing, which is discussed in Section 3.5.

Based on the location of the POI in Oceanside, New York, and the proposed onshore substation in Island Park, New York, the primary study area for a potential submarine export cable landfall included the shoreline of the barrier island of Long Beach, New York. Empire also evaluated a submarine export cable route that would make landfall directly into Barnum Island, as well as a landfall on the adjacent Jones Beach Island.

[4] Case 18-E-0071, *In the Matter of Offshore Wind Energy*, Order Establishing Offshore Wind Standard and Framework For Phase 1 Procurement (Issued and Effective July 12, 2018).

The shoreline adjacent to the export cable landfall locations along the southern shore of the Long Beach barrier island generally consists of sandy beaches, with a boardwalk along Long Beach, and beach and dune areas along Lido Beach. The boardwalk along Long Beach consists of sheet piling that would require a trenchless method for installation of the submarine export cable. Long Beach recently underwent a USACE renourishment project, which included the placement of new sand material and the repair of rock jetties. To the east, Jones Beach is a State Park, consisting of sand beaches and dunes along the shoreline. By contrast, most of the shoreline along Barnum Island consists of bulkhead or seawall. Due to the limited availability of any other undeveloped space on Barnum Island and/or in the Village of Island Park for the cable landfall, the only evaluated landfall area for the Barnum Island alternative is located within municipal parkland.

The offshore environment generally consists of sandy material with wave and current action typical of the region. Significant offshore constraints on the cable landfall include the presence of existing and proposed pipeline and cable assets along the shoreline, shoals and shallow water areas, the presence of known and potential shipwreck areas, and a sand resource area in the vicinity of the western shoreline of the Long Beach barrier island.

3.3.1 Cable Installation Method Alternatives

Empire is proposing to use the horizontal directional drill (HDD) installation method for the Project cable landfall. Cable landfall installation methods considered were assessed relative to technical feasibility, cost, logistics and minimization of environmental impacts.

Trenchless installation of the cable landfall consists of installation of the cables across the shoreline without direct disturbance of the areas between the entry and exit points, for example, by either HDD or Direct Pipe® installation methodologies. Both methods allow for the installation of conduits or ducts beneath sensitive coastal and nearshore habitats, such as dunes, beaches, waterways, submerged aquatic vegetation, etc. Trenchless installations can also be used to cross under major infrastructure, including railroads and highways. The Project will require three separate trenchless installations to complete the cable landfall, one for each of the submarine export cables.

Typically, trenchless installation operations for an export cable landfall originate from an onshore landfall location and exit a certain distance offshore, determined by the offshore water depth contour and total cable landfall length considerations. To support this installation, both onshore and offshore work areas are required.

Trenchless installation of the cable landfall is proposed due to the more extensive impacts to the marine and shoreline environments associated with installing an open cut cable landfall across the sandy beach (Section 3.3.1.2), which would include dredging and possible temporary suspension of sediment along the offshore portion of the submarine cables, excavation through the intertidal zone, and disturbance to beach and dune habitats on the upland side of the landfall that may include potential foraging and nesting areas for shorebirds. Seabed mobility and coastal shoreline erosion are also significant concerns in the vicinity of the cable landfall, and a trenchless installation will allow deeper installation across the shoreline than an open cut installation could, which will minimize potential for cable exposure during erosion events. Engineering evaluation concluded that the Direct Pipe® installation method is not feasible at Empire's proposed cable landfall (Alternative A) location due to deep foundation and sheet piles supporting the boardwalk and existing structures (Section 3.3.3). Furthermore, Direct Pipe® requires a fabricated steel pipe behind the launch pit that would extend 400 to 500 ft (122 to 152 m) for the duration of the installation, which would result in multiple road closures for several months. Due to the shallow installation angle, an entry pit 15 to 20 ft (4.6 to 6.1 m) is required and would also need to be staged farther north in the roadway than for the HDD installations. Therefore, HDD installation is proposed for the cable landfall installation.

3.3.1.1 Horizontal Directional Drill (HDD) (Proposed)

The onshore work area for HDD installations is typically located within the upland cable landfall parcel(s) at the HDD entry point. The evaluated cable landfall alternatives in Section 3.3.3 were sited to avoid vegetation, natural habitats, beach and wetlands, or other waters of the US (WOTUS). Once the onshore work area is set up, casings may be installed at the drill entry points and the HDD activities commence using a rig that drills a borehole underground. The drill begins with a pilot bore that consists of advancing a steerable, rotary drill bit along the design alignment from the drill rig entry location to the exit location. Once the pilot bore is completed, the drilling assembly is removed and replaced with a reaming assembly. Reaming involves enlarging the pilot bore to a larger diameter to accommodate the conduits. Depending upon the required diameter, multiple passes with reamers of increasing diameter may be required to incrementally enlarge the pilot bore to its final diameter.

Upon completion of the reaming pass(es), the condition of the HDD bore is assessed by completing a swab pass through the bore. This pass consists of pushing or pulling a slightly smaller diameter barrel or ball reamer through the fully reamed bore from start to finish. When the reaming operation is completed, the conduit (steel or high-density polyethylene), in which the submarine cable will be installed, is pulled back onshore within the drilled borehole from the offshore exit side. The process of drilling a borehole and conduit pull back will be completed three times for the Project, once for each submarine export cable circuit. The cable installation will be completed when all three submarine export cables are installed through these conduits.

The offshore exit location requires some seafloor preparation to collect any drilling fluids that localize during HDD completion. Preparation will include excavation of pits at each offshore exit location and may also include installation of temporary steel casings from a jack-up barge to below the mudline. Casings may, or may not, be supported by goal posts. The jack-up barge will also house a drill rig. Seabed preparation may also be completed with the installation of a cofferdam for each HDD and excavation to remove material from the cofferdam. The offshore work area for HDD installation requires approximately 22,500 square feet (2,090 square meters) per cable.

Onshore, the entry side of the HDD installation requires an approximate workspace of at least 246 by 246 ft (75 by 75 m) per cable. The entry side workspace area is required to locate equipment necessary for the installation, which includes the drill rig, stacks of drill pipe, operator control cabin, tooling trailers, crane or excavator, separation plant, mud tanks, mud pumps, water storage tanks, office trailer, and support trailers.

In addition to the entry and exit workspace areas, a conduit staging area is also required for fabricating each conduit (or pipe) string. Each conduit string is fully fabricated into a single string with a length equivalent to the approximate length of the HDD installation (additional length may be necessary to account for geometry). This results in a conduit staging area requirement for a single conduit string that is typically 20 to 25 ft (6.1 to 8.2 m) wide by the length of the conduit string (approximately 2,460 ft [750 m]). The conduit string is floated out to the offshore HDD exit location, where it is installed using the drill string to pull it back through the drill hole.

Empire is evaluating potential temporary offsite staging areas for fabricating the HDD conduit strings for the cable landfall. Empire is prioritizing potential temporary fabrication and conduit stringing areas that are existing paved or developed areas (e.g., parking areas or roadways) with existing access to the water. Once fabricated, each conduit string would be rolled across the land toward the water via pipe rollers in an approximately one-day operation (per HDD/conduit). From there, it would be towed by boat to the offshore HDD exit location for installation.

Target depths of the cable landfall HDDs vary by length, down to approximately 100 ft (33 m). Longer HDD installations typically require greater depths of cover to allow for sufficient overlying strength to resist the drilling fluid pressures. Inadvertent drilling fluid returns may occur when drilling fluid pressures exceed the strength of the overlying geotechnical material, and pressure causes the drilling fluids to follow a path that flows upwards and outwards until the pressure is relieved. Drilling fluids reaching the sediment surface may pond on the ground surface in uplands or be released on the seabed as inadvertent returns. All HDD installations carry some risk of an inadvertent drilling fluid return, especially during the exit curve and exit tangent, as the drill bit is steered upwards toward the ground surface or seabed. Inadvertent return risks can be reduced along the majority of an HDD alignment by selecting an appropriate depth of cover that provides sufficient overlying strength to resist the required fluid pressures.

Geotechnical conditions, HDD geometry, and bending radii dictate HDD installation depth, which may be driven by a combination of factors, including sediment characteristics, the required HDD entry angle, avoidance of existing shoreline infrastructure, limitations on the length of the drill, and potential impacts on maritime traffic at the location of the HDD exit point. Another consideration for the export cable landfall alternatives is the need to maintain required spacing (minimum 10 ft) between the submarine export cables, as well as offsets from other existing infrastructure.

3.3.1.2 Direct Pipe®

Direct Pipe® is a trenchless method that can be used when HDD methods present challenges for a particular crossing. Similar to HDD, Direct Pipe® operations will originate from an onshore cable landfall location and exit offshore, using both onshore and offshore work areas and requires approximately 260 by 680 ft (79 by 207 m) of onshore workspace per cable. The onshore work area is typically located within the export cable landfall parcel(s). Target depths of landfall paths vary by the length of the Direct Pipe®, up to approximately 80 ft (24 m); however, one advantage of the Direct Pipe® method is that it may allow for a shallower installation than the equivalent length HDD, while still reaching sufficient depths to minimize potential cable exposures from erosion or storm events.

Once the onshore work area is set up and a shallow launch pit has been excavated, Direct Pipe® activities commence. The method involves using a pipe thruster to grip and push a steel pipe with a microtunnel boring machine (MTBM) attached to the leading edge through a seal attached to the pit wall and along the alignment. The MTBM travels along the installation path from onshore to offshore. Once the MTBM exits onto the seafloor and is removed, the duct used to house the electrical cable can be fabricated into a pipe string one joint at a time within the same onshore entry workspace area and pushed into the casing pipe that was previously installed using the Direct Pipe® method. As with the HDD method in Section 3.3.1.1, this process is repeated three times, once for each submarine export cable circuit.

The offshore exit locations will require some seafloor preparation to retrieve the MTBM. Preparation may include completing a shallow excavation (wet) for the MTBM at each exit location. Marine support is needed (e.g., vessels, barges, divers) to excavate the exit pits and support retrieval of the MTBM.

The Direct Pipe® method avoids the need to fabricate a conduit string in a continuous length for each cable, as is required for the HDD installation method. As such, the Direct Pipe® installation does not require an offsite staging and fabrication area. The Direct Pipe® method also avoids the risk of inadvertent returns since drilling fluids are not required to maintain the borehole pressure. However, because the duct is fabricated one joint at a time within the onshore workspace, a larger cable landfall workspace is needed onshore, with greater space constraints for the cable landfall siting. As such, the Direct Pipe® method is only a feasible installation method at certain cable landfall location alternatives, described further in Section 3.3.3. The proposed cable landfall alternative (Alternative A) does not have sufficient space for installation using the Direct Pipe® method, and Direct Pipe® is not feasible due to existing infrastructure constraints. Moreover, a Direct Pipe® method at this location would result in greater impacts to traffic from road closures. Therefore, Empire is proposing the HDD method for installation of the cable landfall.

3.3.1.3 Open Cut

An open cut alternative uses standard submarine cable installation methods to facilitate installation at the target burial depth along the approach to landside. Open cut methods may include open cut trenching/dredging or jetting to bury the cables up to the landfall conduits. Jetting involves the use of pressurized water jets directed into the seabed, creating a trench. As the trench is created, the submarine export cable sinks into the seabed. The displaced sediment then resettles, naturally backfilling the trench.

Dredging is then needed to excavate, remove, and/or relocate sediment across the shoreline and intertidal area to allow the cables to make landfall at the target installation depth. Dredging can be completed through clamshell dredging, suction hopper dredging, and/or hydraulic dredging. During dredging activities, the dredged material is collected in an appropriate manner for either re-use or disposal (depending on the nature of the material) and in accordance with applicable regulations.

A typical open cut method involves installation of one or more sheet pile cofferdams to isolate the area of the shoreline at the cable landfall, dewatering within the area of the cofferdam, and excavating a trench for each cable within the dry cofferdam(s). Cable conduits would then be installed within each trench and the trench would be backfilled. Following installation of the conduits across the shoreline, the cables would be pulled through the conduits for their final installation. A traditional trenched installation then continues across the beach and dune area along the onshore export cable route.

An open cut cable landfall is unlikely to be either feasible or permitted. The shoreline along much of the southern coast of Long Island, including the export cable landfall area, is regulated by New York State as a Coastal Erosion Hazard Area due to the area's exposure to wave action from the Atlantic Ocean, which would require the export cable landfall to be installed deep enough to avoid impacts from coastal processes. Deep installation of the export cables with an open cut cable landfall, if feasible, would require extensive disturbance for dredging, excavation, and stockpiling across the shoreline and beach area. It would also result in direct disturbance to the beach and dune habitat for trench installation of the three export cables, and the associated potential wildlife impacts, including potential impacts to habitat for nesting shorebirds. Finally, direct disturbance and excavation of the shoreline and beach is likely to be viewed unfavorably by the local community and other stakeholders. Empire, therefore, determined that the open cut installation method is not a practicable alternative for the Project and would result in greater environmental impacts than a trenchless installation.

3.3.2 Cable Landfall Evaluation Criteria

The evaluation of cable landfall, submarine export, and onshore export cable route alternatives was conducted as an iterative process that involved multiple steps of evaluation of the offshore and onshore cables routes, constraints on potential landfall locations, and the feasibility of landfall installation methodologies at potentially suitable landfall sites. Each of these Project components, although described as separate evaluations, were considered in concert for the selection of the overall preferred solution for the Project. Each landfall was evaluated relative to the following existing technology, logistical, cost, environmental, and stakeholder criteria:

- Proximity to the preferred POI (e.g., route length);
- Prior subsea cable landfall success in nearby areas;

- Temporary staging area size/options (e.g., preferably land without permanent structures, with a minimum size to allow for adequate staging);
- Hydrodynamics and sediment dynamics (e.g., erosion, shoaling);
- Anthropogenic interferences (e.g., fish trap area, pipelines, dredging, sand resources, navigational impacts);
- Environmental, wildlife habitat, and cultural considerations (e.g., eelgrass, dunes, wetlands, sand resources, buried and/or submerged cultural resources);
- Technological and logistical constructability complexities (e.g., long additional water crossings, vessel access, asset crossings); and
- Land use (e.g., consistency of existing uses).

Cable landfalls were evaluated relative to the use of trenchless as well as open cut methodologies (see Section 3.6.5). The trenchless installation methodology was selected due to the avoidance of environmental impacts associated with the open cut methods. As such, the evaluation of cable landfall siting alternatives is based on the use of a trenchless installation. A summary table of the cable landfall alternatives and associated nearshore submarine export cable route alternatives within New York state waters is provided in **Table 3.3-1**.

Table 3.3-1 Cable Landfall and Submarine Export Cable Route Alternative Comparison

Assessment Criteria	Cable Landfall Alternative A (Proposed)	Cable Landfall Alternative B	Cable Landfall Alternative C					Cable Landfall Alternative D	Cable Landfall Alternative E	Cable Landfall A + Landfall E Alternative	Barnum Island Cable Landfall	Jones Beach Cable Landfall Alternative
			Alternative C1	Alternative C1 with Deep Burial (no Pre-Dredging)	Alternative C1 with Deep Burial (Pre-Dredging)	Alternative C1 with Trenchless	Alternative C3					
Summary of Route Characteristics												
Total Route Submarine Export Cable Route Length (Lease Area to Cable Landfall) a/	29.1 mi (46.8 km)	28.7 (46.2 km)	27.1 mi (43.6 km)	27.1 mi (43.6 km)	27.1 mi (43.6 km)	27.1 mi (43.6 km)	29.8 mi (48.0 km)	26.8 mi (43.2 km)	29.3 mi (47.2 km)	30.4 mi (48.9 km)	30.0 mi (48.3 km)	23.8 mi (38.4 km)
Submarine Export Cable Route Length (New York boundary to cable landfall)	8.8 mi (14.2 km)	8.4 mi (13.6 km)	6.8 mi (11.0 km)	6.8 mi (11.0 km)	6.8 mi (11.0 km)	6.8 mi (11.0 km)	9.6 mi (15.4 km)	6.5 mi (10.5 km)	9.1 mi (14.6 km)	10.1 mi (16.3 km)	9.7 mi (15.7 km)	3.9 mi (6.2 km)
Approximate Total Onshore Route Length to POI (Onshore Export + Interconnection Cable)	3.3 mi (5.3 km)	3.2 mi (5.1 km)	3.8 mi (6.1 km)	3.8 mi (6.1 km)	3.8 mi (6.1 km)	3.8 mi (6.1 km)	3.8 mi (6.1 km)	5.2 mi (8.4 km)	3.3 mi (5.3 km)	3.9 mi (6.3 km)	2.8 mi (4.5 km)	11 mi (17.7 km)
Environmental Factors												
Submarine Export Cable Length Rank	5	4	3	3	3	3	7	2	6	9 (longest)	8	1 (shortest)
Utility Crossing Potential Sediment Disturbance Volume b/	8,820 cubic yards (yd^3) (6,744 cubic meters [m^3])	4,410 yd^3 (3,372 m^3)	2,205 yd^3 (1,686 m^3)	2,205 yd^3 (1,686 m^3)	2,205 yd^3 (1,686 m^3)	2,205 yd^3 (1,686 m^3)	4,410 yd^3 (3,372 m^3)	2,205 yd^3 (1,686 m^3)	8,820 yd^3 (6,744 m^3)	8,820 yd^3 (6,744 m^3)	2,205 yd^3 (1,686 m^3)	2,205 yd^3 (1,686 m^3)
Estimated Total Cable Protection Volume c/	**177,691 yd^3**	**172,903 yd^3**	**161,924 yd^3**	**161,924 yd^3**	**161,924 yd^3**	**161,924 yd^3**	**179,414 yd^3**	**160,149 yd^3**	**180,059 yd^3**	**180,059 yd^3**	**179,091 yd^3**	**142,407 yd^3**
Number of dredged/maintained channels crossed d/	0	0	0	0	0	0	0	0	0	0	1	0
Length across Sand Resource Area e/	0	0	4,100 ft (1,250 m)	4,100 ft (1,250 m)	4,100 ft (1,250 m)	4,100 ft (1,250 m)	0	4,100 ft (1,250 m)	0	0	0	0
Centerline distance to Sand Resource Area e/	1,991 ft (607 m)	223 ft (68 m)	0 ft (0 m)	0 ft (0 m)	0 ft (0 m)	0 ft (0 m)	176 ft (54 m)	0 ft (0 m)	3,539 ft (1,079 m)	1,991 ft (607 m)	253 ft (77 m)	4,270 ft (1,300 m)
Wrecks and obstructions within the cable corridor f/	0	0	0	0	0	0	0	0	0	0	2	2
Significant Coastal Fish and Wildlife Habitat	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Technological and Logistical Factors												
Cable Landfall Area	2.38 ac	0.72 ac	4.9 ac	4.9 ac	4.9 ac	4.9 ac	4.9 ac	57.4 ac	1.56 ac	3.29 ac	11.6 ac	3.5 ac
Maximum Water Depth, ft (m) g/	55.4 ft (16.9 m)	52.2 ft (15.9 m)	53.1 ft (16.2 m)	53.1 ft (16.2 m)	53.1 ft (16.2 m)	53.1 ft (16.2 m)	44 ft (13.4 m)	51.2 ft (15.6 m)	33.8 ft (10.3 m)	51.8 ft (15.8 m)	50.5 ft (15.4 m)	61.7 ft (18.8 m)
Number of existing and planned utility crossings within New York state waters	5	3	2	2	2	2	3	2	5	5	2	2
Hydrodynamics/Sediment dynamics/Coastal Erosion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Assessment Criteria	Cable Landfall Alternative A (Proposed)	Cable Landfall Alternative B	Cable Landfall Alternative C					Cable Landfall Alternative D	Cable Landfall Alternative E	Cable Landfall A + Landfall E Alternative	Barnum Island Cable Landfall	Jones Beach Cable Landfall Alternative
			Alternative C1	Alternative C1 with Deep Burial (no Pre-Dredging)	Alternative C1 with Deep Burial (Pre-Dredging)	Alternative C1 with Trenchless	Alternative C3					
Potential Cable Landfall Installation Methods	HDD	HDD	HDD or Direct Pipe®	HDD or Direct Pipe®	HDD or Direct Pipe®	HDD or Direct Pipe®	HDD or Direct Pipe®	HDD or Direct Pipe®	HDD	HDD	HDD	HDD or Direct Pipe®
Construction Complexity	High	High	Low	High	High	High	Moderate	Low	High	High	High	High
Potential Residential Noise Impact of Cable Landfall	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Low	High	High	High	Low
Potential Traffic Impact of Cable Landfall h/	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	Low	Low
Availability of Existing Technology	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Commercial Factors												
Parkland alienation potentially required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No i/
Parkland conversion potentially required	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Unknown	No
Cable landfall easement/permit risk	Moderate	Moderate	High	High	High	High	High	High	Moderate	High	Unknown	Unknown
Practicable (Technology/Cost/Logistics)	**Yes**	No	No	No	No	No	Yes	No	Yes	Yes	No	No
Least Environmentally Damaging Practicable Alternative	**Yes**	No	No	No	No	No	No	No	No	No	No	No

Notes:
a/ as measured from the edge of the Lease Area.
b/ based on up to 735 yd^3 (562 m^3) at applicable utility crossings.
c/ based on up to remedial cable protection on up to 10% of each of the three submarine export cables, and additional cable protection at utility crossings.
d/ Based on USACE Maintained Channel Quarter Reach (USACE 2007).
e/ Based on BOEM sand and gravel lease areas (BOEM 2020).
f/ Based on NOAA Automated Wrecks and Obstruction Information System (NOAA 2009) mapped locations within a 900-ft (274-m) corridor of the submarine cable route alternative.
g/ Bathymetry is measured for the submarine cable corridor where it enters state waters, from NOAA NCEI's U.S. Coastal Relief Model (CRM).
h/ This assessment is excluding the consideration of the onshore cable routing from the cable landfall to the POI. See Section 3.5 for the alternatives analysis of the onshore export and interconnection cable routes.
i/ Although alienation of municipal parkland is not required, this alternative would need an agreement from New York Office of Parks, Recreation and Historic Preservation for crossing Jones Beach State Park.

3.3.3 Long Beach/Lido Beach Landfall Alternatives

Empire identified five export cable landfall options within the City of Long Beach and Town of Hempstead, New York. These include, from west to east: Laurelton Boulevard and West Broadway (Alternative E); Riverside Boulevard and East Broadway (Alternative A); Shore Road and Monroe Boulevard (Alternative B); the Lido Beach West Town Park (Alternative C); and the Lido Beach Town Park (Alternative D). Each is described in more detail below and shown in **Figure 3.3-1**. Submarine constraints associated with the submarine export cable route(s) to each cable landfall alternative are presented in **Figure 3.3-2**. Based on the evaluation of different installation methods (Section 3.3.1), this section primarily considers trenchless installation solutions (HDD or Direct Pipe®) for these export cable landfalls.

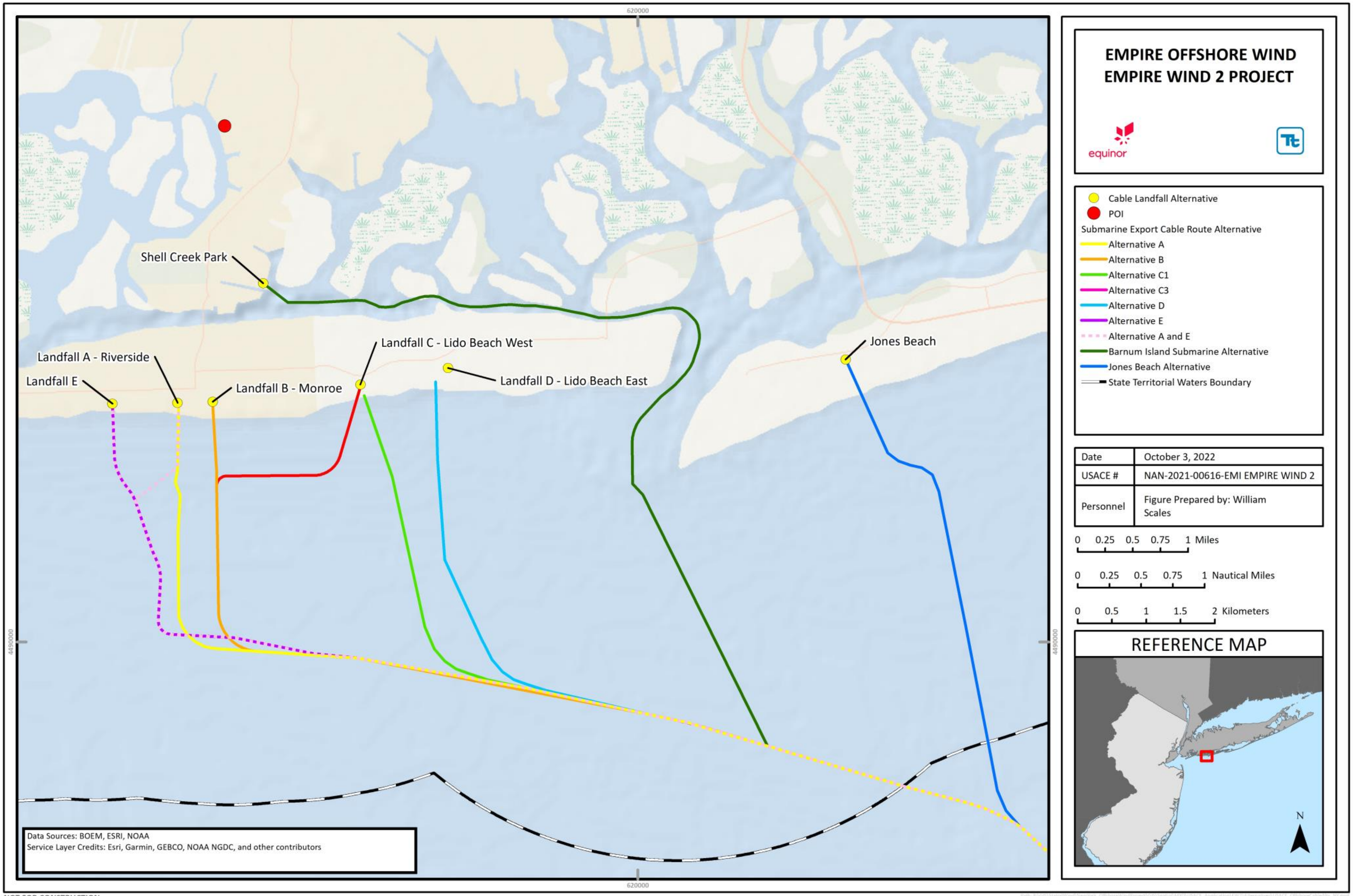
In the selection of export cable landfall alternatives, optimizing the combination of the submarine and onshore export cable routes was a key priority due to the potential complexity of cable routing in this area.

3.3.3.1 Alternative A (Proposed)

Cable landfall Alternative A is located in the City of Long Beach and encompasses approximately 2.4 acres (ac, 1.0 hectares [ha]). The cable landfall is located partially within Riverside Boulevard and partially on a mostly bare, privately owned, approximately 4.9-ac (2-ha) vacant parcel located to the west of Riverside Boulevard and to the south of East Broadway. This vacant parcel has been used for parking and equipment storage in the past, and potential future development plans for this parcel are uncertain. The adjacent parcel located to the east of Riverside Boulevard is under redevelopment as part of the Long Beach Superblock Project[5]. Immediately to the north of cable landfall Alternative A, across East Broadway, there are various high-rises. To the south of the cable landfall, the export cable route traverses the end or Riverside Boulevard, in close proximity to or underneath an existing small commercial building, and underneath the raised oceanfront boardwalk adjacent to Long Beach/Ocean Beach Park. The conceptual export cable landfall alignment is designed so that two cables are within Riverside Boulevard, and the third cable is along the easternmost portion of the privately owned parcel to minimize impact to developable space on the privately owned parcel. The onshore export cable route alternatives from cable landfall Alternative A are approximately 1.3 to 1.5 mi (2.0 to 2.4 km) long and offer some of the shortest routes to the proposed onshore substation (Onshore Substation C).

The Riverside Boulevard corridor is narrow and constrained by utility congestion, allowing limited space for siting of the transition joint bays and duct banks within the roadway. Cable landfall Alternative A has sufficient space for a cable landfall of all three export cables and the temporary workspace for cable landfall activities if the vacant parcel is commercially available and the necessary land rights can be obtained. Empire is currently evaluating whether an export cable landfall with three circuits in the right-of way is practicable in the event that the export cables and cable landfall workspace is limited to the public right-of-way. In the event that the cable landfall can be entirely limited to public right-of-way, it is anticipated that one of the export cable circuits would require drilling under the existing commercial building at the southern end of Riverside Boulevard.

[5] The Superblock Project is located along Shore Road between Riverside Boulevard and Long Beach Boulevard.



NOT FOR CONSTRUCTION

Figure 3.3-1 Cable Landfall and Submarine Export Cable Alternatives

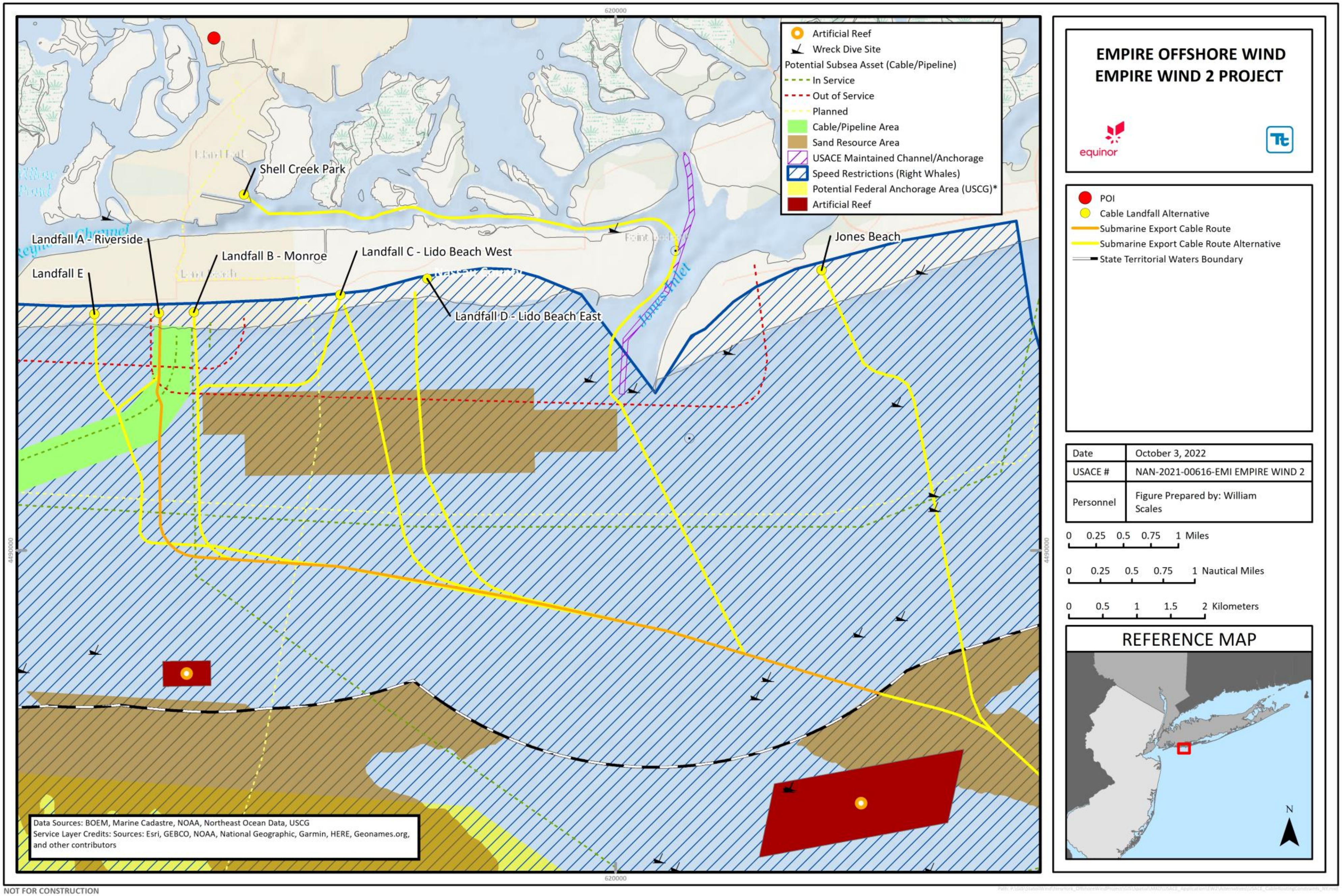


Figure 3.3-2 Cable Landfall Alternatives and Submarine Export Cable Offshore Constraints

Due to the limited space availability and the presence of shoreline obstructions, Empire determined that the Direct Pipe® installation method is not feasible for Alternative A. Engineering evaluation concluded that the Direct Pipe® installation method is not feasible at Empire's proposed cable landfall (Alternative A) location due to deep foundation and sheet piles supporting the boardwalk and existing structures (Section 3.3.3). Direct Pipe® installation is not suitable because it requires a fabricated steel pipe behind the launch pit that would extend 400 to 500 ft (122 to 152 m) for the extent of the operations, resulting in multiple road closures for several months.The Direct Pipe® installation also requires the onshore entry pit to be much further north than for the HDD installations, since the angle of installation for Direct Pipe® is less steep. Onshore impacts from Direct Pipe® installation at this location would be significant, requiring more street closures, heavy equipment (side booms) to support the steel pipe behind the entry pit, a larger footprint from additional equipment, and noise impacts for a greater duration. Therefore, the HDD installation method is proposed and Direct Pipe® was not considered further at this location.

In the event that the cable landfall is limited to the public right-of-way, one potential limitation at cable landfall Alternative A is that there may not be sufficient space for contingency in the case of an HDD failure along one or more of the export cable alignments. Typically, if an initial HDD attempt fails, another attempt may be made along a parallel alignment immediately adjacent; however, for cable landfall Alternative A, a separate contingency landfall may be required due to the highly constrained spacing of the three cables.

The submarine export cable route to Alternative A will extend a total length of 7.7 nm (8.8 mi, 14.2 km) from the cable landfall to the New York State boundary. This route requires crossing a total of three existing, two planned, and two out-of-service submarine utilities within New York state waters, including the existing Transco Lower New York Bay Lateral (LNYBL), a 26-inch diameter natural gas pipeline. The LNYBL is located approximately 3,280 ft (1 km) from shore along this route; the submarine export cable route also crosses the high-voltage direct current (HVDC) Neptune Power Transmission Cable and the FLAG Atlantic telecommunications cable. The planned utilities are the Wall, New Jersey to Long Island (Wall-LI) telecommunications cable and the Poseidon transmission cable. These utility crossings are expected to involve the use of hard substrate cable protection measures on the seafloor (e.g., rock berm, concrete mattresses, etc.).

The most challenging aspect of the nearshore routing at this location is the Transco LNYBL crossing in shallow water. Empire evaluated trenched asset crossing solutions for this crossing as well as trenchless HDD crossing solutions. HDD solutions included:

- Extending the export cable landfall HDDs at Alternative A to approximately 5,000 ft (1500 m) and including the Transco LNYBL crossing as part of the landfall; or
- Completing separate, shorter, water-to-water HDDs underneath the Transco LNYBL pipeline, with a shorter (1,650 ft to 3,280 ft [500 m to 1000 m]) trenchless cable landfall segment exiting to the north of the Transco LNYBL crossing.

HDD crossings of the Transco LNYBL pipeline have the additional benefit of reducing the length of jetting impact to the seafloor along the submarine export cable route; however, both of these trenchless options were eliminated from consideration due to the risks associated with drilling underneath an active natural gas pipeline, length of the drill, cable rating and pull-in considerations. The length of the installation to extend the cable landfall past the pipeline crossing would be too great for the technical limitations of an HDD at this location, given geotechnical and ground conditions, environmental risk, cable rating, and other factors. Given the potential for sandy and mobile sediment in the vicinity of the export cable landfall, which increases the risk of inadvertent returns of drilling fluid, undermining of the sediments surrounding the pipeline, and uncertainty of the drill path, the HDD crossing of the Transco LNYBL was deemed impracticable.

A trenched crossing design was also evaluated for the Transco LNYBL crossing location approaching cable landfall Alternative A. The area of the crossing is expected to have medium to high fishing activity and water depths of approximately 31 ft (9.5 m). To reduce potential conflict with fishing activities and ensure sufficient cover and protection over the submarine export cables, rock berm or concrete mattress protection over the cables will be required at the Transco LNYBL crossing location. Evaluation of crossing options indicated that up to approximately 7 ft (2 m) of shoaling will result from each pipeline crossing. Shoaling decreases the water depth above the seafloor, which may result in navigational impacts and reduce the accessibility of the area to deeper-draft vessels. Utilizing the Northeast Ocean Data Portal (2021 dataset) and Automatic Identification System (AIS) data, an initial characterization of vessel traffic within the area of the pipeline crossing, which occurs less than 1 nm offshore landfall Alternative A, identified the presence of pleasure craft, sailing vessels, passenger vessels, tug and tow vessels, and fishing vessels (listed in order of most frequent to lowest occurrence). Average vessel lengths are approximately 72 to 79 ft (22 to 24 m) with an average of approximately 12 ft (3.7m) draft. Traffic frequency crossing the area is one vessel approximately every one to two days. There were no identified cargo vessels or tanker vessels within the area of the crossing.

Pre-installation, localized dredging over the pipeline, either with mass flow excavation (MFE) or diver-assisted dredging operations, could reduce shoaling height to some extent, but the existing depth of the pipeline is uncertain due to seabed dynamics and both methods carry potential safety risks to the pipeline that would require further evaluation to determine feasibility. This method also may not be feasible due to the prohibitions or limitations on dredging by the asset owner. Therefore, available information cannot confirm that it would be technically feasible to install the Transco LNYBL crossing with less than 7 ft (2 m) of shoaling.

During evaluation of potential submarine export cable routes to the landfall alternatives, Empire also considered avoidance of a sand resource area that is located offshore of Lido Beach (**Figure 3.3-2**). The submarine export cable route (centerline) for Alternative A is located approximately 1,991 ft (607 m) west of the sand resource area. Existing infrastructure (the FLAG Atlantic telecoms cable) is located between Alternative A and the sand resource area; therefore, installation of the submarine export cables along this route is not expected to result in any impacts to or new limitations on the use of the sand resource area.

Considering the nearshore environment, the Alternative A cable landfall has a relatively short distance to deeper waters, suitable for setting up the offshore portion of the HDD installations. Water depths at the exit pits offshore are expected to be approximately 30 ft to 33 ft (9 m to 10 m) below mean lower low water (MLLW) for HDD installation lengths of 1,650 ft (500 m) to 3,280 ft (1000 m). HDDs on the shorter end of that range offer more favorable, flexible routing between the offshore exit points of the HDDs and the Transco LNYBL.

The cable landfall HDDs will need to traverse underneath the raised oceanfront boardwalk. The HDDs will need to be installed deep enough to allow adequate spacing between the export cable conduits and the bottom of the sheet pile associated with the boardwalk structure. As part of Empire's conceptual design, casing pipes may be installed on the onshore entry side of each HDD below the existing commercial building and the boardwalk.

The Ocean Beach Park area offers a variety of recreation to visitors in summer, including summer concerts. Since Ocean Beach Park is municipal parkland, parkland alienation by State legislation may be required for the underground crossing of the beach. According to correspondence received from the New York State Office of Parks, Recreation and Historic Preservation (NYOPRHP) dated December 9, 2021, the City of Long Beach received three Land and Water Conservation Fund (LWCF) grants in the 1980s for the development of the Long Beach boardwalk, dunes, and swimming facilities. NYOPRHP indicated that the use of Landfall A could impact LWCF areas, and additional coordination with NYOPRHP and/or National Park Service (NPS) will be required. Crossing underneath a LWCF area may result in additional regulatory challenges if a federal conversion process is required. A federal conversion process requires the provision of replacement property that is of equal or greater fair market value and of reasonably equivalent usefulness and location as the lands being removed from outdoor recreation use.

The onshore workspace at cable landfall Alternative A is in close proximity to sensitive noise and air quality receptors, including residences adjacent to Riverside Boulevard. The export cable landfall installation would require space at the intersection of East Broadway and Riverside Boulevard, which would likely require road closure, traffic impacts and disruption of access to residential buildings for a prolonged period of time (approximately 6 to 24 months). Due to the space constraints, limited mitigation options may exist for these potential noise and traffic impacts.

As one of the three westernmost export cable landfalls (which include Alternatives E, A, and B) the export cable landfall would cross through the proposed Bayside Development, a potential project listed in the City of Long Beach's comprehensive plan, "Creating Resilience: A Planning Initiative," which was updated in a draft in January 2018 (City of Long Beach 2018).

In summary, Alternative A is a practicable alternative for an export cable landfall of three circuits, in the event that land rights can be obtained for the vacant parcel to the west of Riverside Boulevard, as well as other necessary land rights (i.e., parkland alienation and conversion). Empire is evaluating the feasibility of installation of three circuits in the right-of-way in the event that the cable landfall is limited to the public right-of-way. Challenges for Alternative A include installation of the cable landfall underneath the Long Beach boardwalk, shoaling required for the submarine export cable crossings of the Transco LNYBL, parkland alienation and conversion, and potential noise, traffic and air quality impacts. However, cable landfall Alternative A results in submarine export cable routing that avoids close proximity to the sand resource area and minimizes the submarine export cable route length, cable protection footprint and potential area of pre-sweeping, relative to the other alternatives that are practicable (Alternative E, Alternative C3, and Alternative A+E) on the basis of existing technology, logistics and cost. As such, Alternative A was determined to be the least environmentally damaging practicable alternative and has been selected as the Empire's proposed alternative.

3.3.3.2 Alternative B

Alternative B is in the City of Long Beach and consists of only approximately 0.7 ac (0.3 ha) of workspace within Monroe Boulevard. The onshore workspace for the export cable landfall is bounded to the west by apartments and to the east by an apartment building and a parking area. To the north, the cable landfall traverses the intersection of Monroe Boulevard and East Broadway. To the south, the cable landfall is bounded by Shore Road, and the HDD path would traverse the end of Monroe Boulevard and a raised oceanfront boardwalk, adjacent to Ocean Beach Park. Compared to other sites considered, the onshore side of Alternative B is relatively far from the shoreline along the beach, which increases the length of the required trenchless installation segment. Potential onshore export cable routes from Alternative B are approximately 1.4 mi (2.2 km) long and offer some of the shortest routes to the proposed onshore substation (Onshore Substation C).

The submarine export cable route to cable landfall Alternative B extends a total length of 7.3 nm (8.4 mi, 13.6 km) to the New York state waters boundary. This route requires crossing a total of one existing, two planned, and two out-of-service utilities within New York state waters, including crossing the existing HVDC Neptune Power Transmission Cable, which is crossed approximately 9,630 ft (2,940 m) from shore. The planned utilities are the Wall, New Jersey to Long Island (Wall-LI) telecommunications cable and the Poseidon transmission cable. The submarine export cable route and the trenchless landfall installation would also be constrained by the FLAG Atlantic telecoms cable, which is located immediately to the west of this landfall alternative.

During evaluation of potential submarine export cable routes to the landfall alternatives, Empire also considered avoidance of the sand resource area that is located offshore of Lido Beach (**Figure 3.3-2**). The submarine export cable route approaching Alternative B avoids the sand resource area, with the route centerline located approximately 223 ft (68 m) west of the sand resource area. Empire expects that the submarine cable corridor for Alternative B would have a similar offset from the sand resource area as Alternative C3 (see Section 3.3.3.3).

Similar to Alternative E (see Section 3.3.3.5), installation activities would be directly adjacent to noise sensitive areas, including high-rise and residential buildings; however, this cable landfall alternative is surrounded by buildings and residences, and does not have the adjacent vacant parcels that are present at cable landfall Alternatives A and E. The cable landfall installation requires space at the intersection of East Broadway and Monroe Boulevard, which would likely require road closure and traffic impacts for a prolonged period of time. Due to the extremely constrained space availability, limited mitigation options exist for these potential noise and traffic impacts.

This cable landfall also has a relatively short distance to deeper waters suitable for setting up the offshore portion of the trenchless installation. Access from offshore is obstructed, however. The route would need to traverse the raised oceanfront boardwalk and also the narrow corridor at the end of Monroe Drive between two buildings.

Since Ocean Beach Park in the City of Long Beach is municipal parkland, parkland alienation by State legislation may be required for the underground cables to cross the beach. According to correspondence received from the NYOPRHP dated December 9, 2021, the City of Long Beach received three LWCF grants in the 1980s for the development of the Long Beach boardwalk, dunes, and swimming facilities. NYOPRHP indicated that the use of landfall Alternative B could impact these LWCF areas, and additional coordination with NYOPRHP and/or NPS will be required. A crossing of the LWCF area may result in additional regulatory challenges in the case a federal conversion process is required. A federal conversion process requires the provision of replacement property that is of equal or greater fair market value and of reasonably equivalent usefulness and location as the lands being removed from outdoor recreation use.

Alternative B is a not a practicable alternative due to the limited availability of workspace, and adjacency of buildings and residences, combined with the potential regulatory challenges of installing the submarine export cable route in proximity to the sand resource area. Installation of one or two cables to Alternative B in combination with another landfall may alleviate some of the challenges (similar to Alternative A+E, Section 3.3.3.6) but would result in greater environmental impact, due to the need for an additional submarine export cable corridor, which would spread impacts over a greater area rather than aligning the three submarine export cables along a single route. Using multiple landfalls would also increase onshore impacts and the extent of resident disruptions associated with potential noise and traffic impacts.

3.3.3.3 Alternative C

Cable landfall Alternative C is located at Lido Beach West Town Park in the Town of Hempstead and consists of an existing large, paved parking lot used for beach access. The overall parcel is approximately 34 ac and includes beach, dune, and adjacent beach shrubs; however, the portion of the parking lot proposed for landfall activities includes approximately 4.9 ac (2.0 ha) of the overall site. The site extends to the north as a parking area, not quite reaching Lido Boulevard. Access to the area is from the west, off of Regent Drive. The park extends further to the west with tennis courts and overflow parking areas. Immediately to the south is the beach access, a protective dune area, and a wide, sandy beach. The beach is open daily with lifeguards in the summertime. Potential onshore export cable routes from Alternative C to the proposed onshore substation are approximately 2.0 to 2.3 mi (3.3 to 3.6 km) long.

The submarine export cable route Alternative C3 would extend a total length of 8.3 nm (9.6 mi, 15.4 km) from the New York State boundary to cable landfall Alternative C. Any submarine export cable route to Alternative C would require crossing a total of one existing, two planned and one out-of-service submarine utilities within New York state waters, including crossing the existing HVDC Neptune Power Transmission Cable approximately 10,990 ft (3,350 m) from shore. The planned utilities are the Wall, New Jersey to Long Island (Wall-LI) telecommunications cable and the Poseidon transmission cable.

Due to the size of the parcel and the Lido Beach West Town Park, cable landfall Alternative C has abundant available space for the cable landfall for all three export cable circuits and the associated onshore workspace. This parcel has a somewhat longer distance to deeper waters for setting up the offshore portion of the trenchless landfall installation, compared to other alternatives evaluated. However, due to the ample potential onshore workspace for setup and transition to the onshore export cables, either HDD or Direct Pipe® methods may be used for cable landfall installation at this location. Cable landfall Alternative C also has sufficient space for a contingency to attempt to re-drill in an immediately adjacent, parallel alignment, in the case of an initial HDD failure along one or more of the export cable alignments.

According to correspondence received from the NYOPRHP dated December 9, 2021, Lido Beach West Town Park has not received LWCF grants and would not be encumbered by a federal land conversion process and coordination with the National Park Service. Since Lido Beach West Beach is municipal parkland, parkland alienation by State legislation may be required for an agreement to cross the beach and parking area, similar most of the other alternatives considered, with the exception of Jones Beach.

As an existing open space, the parking lot at cable landfall Alternative C is significantly farther from residences and other noise and air quality receptors than Alternatives A, B and E. The nearest residential areas to the cable landfall onshore entry points are approximately 450 ft (137 m) to the east along Allevard Street in Lido Beach. There are also residential areas on the north side of Lido Boulevard (approximately 670 ft [204 m] north) and Eva Drive (660 ft [201 m] northwest). Impacts to adjacent residences, therefore, are expected to be relatively low compared to other cable landfall alternatives.

A variety of protected migratory shorebirds (including federally listed Piping Plovers) are known to nest in the restored dune area along Lido Beach; however, the restored dune habitat is mostly to the west of the Alternative C export cable landfall. Impacts to habitat would be avoided by trenchless installation of the export cable landfall segment across the dunes, and indirect impacts to dune-nesting birds could be mitigated with seasonal timing, as appropriate.

Empire assessed submarine export cable routing options associated with cable landfall Alternative C to avoid or minimize impact to the sand resource area that is located directly offshore opposite Lido Beach (**Figure 3.3-2**). The following submarine export cable route alternatives were assessed:

- Submarine Export Cable Route Alternative C1

  The submarine export cable route Alternative C1 approaches landfall Alternative C along the most direct path and crosses the sand resource area approximately perpendicularly. This submarine export cable route from landfall to the New York state boundary has a total length of approximately 5.9 nm (6.8 mi, 11.0 km). With a standard target submarine export cable burial depth of 6 ft, the presence of the cable and its operational requirements would restrict dredging/use of the sand resource area within an approximately 360 ft (110 m) corridor along the submarine export cable route, bisecting the sand resource area. Based on several stakeholder meetings with the USACE, Empire understands that a submarine export cable route alternative that crosses the sand resource area will pose regulatory challenges. As such, Empire determined this alternative to be impracticable.

- Submarine Export Cable Route Alternative C1 with Deep Burial (no Pre-Dredging)

To avoid or minimize restrictions on dredging and future use of the sand resource area, Empire also investigated installation of the submarine export cables along the submarine export cable Alternative C1 route across the sand resource area, but with deeper burial. Based on feedback from the USACE on the depths that would be required to avoid interference with dredging operations, Empire assessed burial depth of 30 to 40 ft across the sand resource area. Empire determined that with no pre-dredging to remove cover along the submarine export cable route, installation below 30 ft is not technically feasible. Under ideal sediment conditions, the maximum depth of installation with a vertical injector, which provides the deepest installation of industry-standard tools available, would be 29 ft (9 m); however, even achieving this lesser depth consistently under realistic field conditions cannot be assumed. As such, Empire determined that deep burial without pre-dredging cannot achieve the required depths due to technical limitations of the available installation tools and therefore this alternative was deemed impracticable.

- Submarine Export Cable Route Alternative C1 with Deep Burial (with Pre-Dredging)

Given the technical limitations of installing the submarine export cables to a depth of 30 to 40 ft below the existing seabed along the submarine export cable route without pre-dredging, Empire also considered a deeper burial solution that would require dredging along the cable corridor to remove sand and lower the seafloor prior to the installation of the submarine export cables. Empire determined that pre-dredging prior to cable installation would be challenging; due to the seabed mobility of the area, keeping the dredged area from backfilling prior to installation would be difficult. This could be exacerbated if seasonal timing restrictions increase the time between dredging and cable installation, and would require significant over-dredging to counteract, producing large dredge volumes even if the deepest burial tool (vertical injector) is used. It is estimated that dredging a 131 ft (40 m) corridor, an area of 155,479 yd^2 (130,000 m^2) for the installation across the sand resource area would be extremely costly, generate 1,256,680 yd^3 (960,800 m^3) of dredged material, and add over a year of work activity to the Project. Moreover, the dredged material would need to be disposed of or temporarily stored unless an immediate use is identified, which would also not be practicable for large volumes of dredge material. Empire determined that the cost of dredging so large an area before cable installation is not viable for the Project. Finally, the depth of cover along the submarine export cable route post-installation would still not allow dredging to occur over the cables, so an approximately 360-ft no-dredge corridor would need to be applied for all three cables, which would be inconsistent with USACE's future use of the area. Empire therefore determined that this alternative is impracticable and would also result in greater aquatic and sediment transport impact within the marine environment, due to the significant additional dredging activity.

- Submarine Export Cable Route Alternative C1 with Trenchless Installation

Another alternative Empire evaluated for a deep crossing of the sand resource area was use of an HDD installation underneath. Two general concepts for an HDD crossing of the sand resource area are 1) to include the sand resource area within the export cable landfall and start the trenchless installation of the landfall on the south side of the sand resource area, or 2) to install a separate water-to-water HDD across the sand resource area, and then begin the installation of the export cable landfall on the north side of the sand resource area, as proposed. Empire determined that to install the submarine export cables deep enough across the sand resource area, the length of the installation would be too great for the technical limitations of an HDD at this location, given geotechnical and ground conditions, environmental risk, cable rating, and other factors. A length of 3,300 ft (1,000 m) is the approximate limit for standard HDD installation at this location, and this would be exceeded by either option, since the width of the sand resource area is approximately 4,600 ft (1,400 m), and the HDD would need to extend even further to the south to be able to reach the required depths (30 to 40 ft) across the sand resource area. Moreover, the longer an HDD installation, the deeper it needs to be at the bottom depth, which risks derating the submarine export cables due to thermal constraints. Derating reduces the current the cable is able to carry, to prevent degradation of the cable insulation due to heat. Therefore, due to technical limitations on the available technology, Empire determined that installing the submarine export cables across the sand resource area via HDD is not a practicable alternative for the Project.

- Submarine Export Cable Route Alternative C3

  This alternative would route around the western side of the sand resource area and has a total length of approximately 8.3 nm (9.6 mi, 15.4 km) from landfall to the New York State boundary. This route would require crossing a total of one existing, two planned, and one out-of-service submarine utilities, including crossing the existing HVDC Neptune Power Transmission Cable. The submarine export cable route and the trenchless landfall installation would also be constrained by the FLAG Atlantic telecoms cable, located immediately to the west of this landfall alternative, but would be appropriately offset. Due to the constraints of routing between the sand resource area and the FLAG Atlantic telecoms cable, the centerline of this route would be located approximately 176 ft (54 m) from the edge of the sand resource area. Considering space requirements for installing all three cables and the FLAG Atlantic telecoms cable, the edge of the submarine export cable corridor required for installation approaches 49 ft (15 m) at its closest point, which could be further optimized to 90 ft (27.4 m). Empire determined this route is a practicable alternative that avoids the shoaling and potential navigational impacts associated with shallow waters at the Transco LNYBL crossing, avoids direct impact to the sand resource area, and minimizes potential onshore impacts to residents associated with the cable landfall, such as noise and traffic. However, submarine export cable route Alternative C3 has additional challenges associated with its proximity to the sand resource area and potential regulatory hurdles, as well as an overall longer submarine export cable route compared to the proposed alternative (Alternative A).

- Jones Inlet Alternative (not shown)

  Empire also considered an alternative that would avoid the sand resource area by routing around to the east, curving around past Jones Inlet and continuing west along the north side of the sand resource area to cable landfall Alternative C. Technical challenges for this routing include shallow waters, charted wrecks, and vessel traffic near the mouth of Jones Inlet (described for the Barnum Island Alternative in Section 3.3.5), as well as dredging and maintenance activity that occurs in the vicinity of Jones Inlet itself. For these reasons, a submarine export cable route around the east of the sand resource area is not practicable and would not reduce environmental impacts relative to the proposed route. Moreover, because of the proximity of the eastern end of the sand resource area to the western tip of Jones Beach and the narrow entrance to Jones Inlet, siting in this area is as constrained as submarine export cable route Alternative C3 and is expected to result in similar proximity to the sand resource area. As such, a Jones Inlet Alternative was determined to be impracticable.

Based on this assessment of space and technical requirements for a trenchless landfall installation of three cables, Empire considers cable landfall Alternative C, with submarine export cable route C3, to be a practicable alternative, but it was not selected as the proposed alternative due to the longer overall submarine export cable route, proximity to the sand resource area and potential regulatory challenges. All other submarine cable route alternatives to cable landfall Alternative C were determined to be impracticable on the basis of available existing technology, cost and/or logistical considerations.

3.3.3.4 Alternative D

Alternative D is located at Lido Beach Town Park in the Town of Hempstead, in an area consisting of a paved parking lot, which is used for beach access and a ball field. The site extends to the north as a parking area, not quite reaching Lido Boulevard. The overall parcel is approximately 57 ac (23 ha) and includes beach, dune, and adjacent beach shrubs. Access to the area is from the north, off Lido Boulevard. Immediately to the south of the parking lot is the beach access, a protective dune area, and a wide, sandy beach. The beach is open daily, with lifeguards in the summertime. Potential onshore cable routes from this export cable landfall to the proposed onshore substation are approximately 3.4 mi (5.5 km) long. Alternative D extends the length of the onshore export cable route by approximately one mile [mi] compared to Alternative C.

The submarine export cable route to landfall Alternative D extends a total length of 5.7 nm (6.5 mi, 10.5 km) from the cable landfall to the New York State boundary. This route requires crossing a total of one existing, one planned submarine and one out-of-service submarine utility, including crossing the existing HVDC Neptune Power Transmission Cable approximately 11,614 ft (3,540 m) from shore. The other utility is identified as the planned Poseidon cable.

The submarine export cable route approaching Alternative D crosses the sand resource area approximately perpendicularly. Installation and operational requirements would restrict future dredging/use of the sand resource area within the submarine export cable corridor. Based on feedback from USACE, Empire understands that a submarine export cable route alternative that crosses the sand resource area will pose regulatory challenges. Routing and installation options to avoid or minimize impact to the sand resource area are similar to those described in Section 3.3.3.3.

Since Lido Beach is municipal parkland, parkland alienation by State legislation may be required for the underground cables to cross the beach and parking area. According to correspondence received from the NYOPRHP dated December 9, 2021, Lido Beach Town Park received two LWCF grants in the 1970s; NYOPRHP indicated that any action that would remove any part of this LWCF-protected park from public outdoor recreation use for longer than 12 months or would entail the permanent conveyance of surface land rights may trigger a conversion process with the National Park Service. This process requires the provision of replacement property that is of equal or greater fair market value and of reasonably equivalent usefulness and location as the lands being removed from outdoor recreation use.

For construction of an HDD, this export cable landfall offers ample potential workspace for trenchless installation, transition joint bays, and separation distance for three export cable circuit. Either HDD or Direct Pipe® methods may be used for cable landfall installation at this location and cable landfall Alternative D also has sufficient space for a contingency to attempt to re-drill in an immediately adjacent, parallel alignment, in the case of an initial HDD failure along one or more of the export cable alignments. This alternative also provides an opportunity for cable landfall installation that is spatially separated from adjacent residential neighborhoods and potential noise and air quality receptors.

Access to cable landfall Alternative D from offshore is mostly unobstructed. Due to the presence of shallower water nearshore, the distance to deeper offshore contours for the trenchless landfall installation is the farthest of the alternatives evaluated, so this site is expected to require the longest trenchless landfall segment. A variety of protected migratory shorebirds, including federally listed Piping Plovers, are known to nest in the restored dune area along Lido Beach. Considerations for work in proximity to the dune area are similar to those described for cable landfall Alternative C (Section 3.3.3.3).

Cable landfall Alternative D has similar space and constructability advantages as Alternative C and is feasible but requires longer onshore export cable routing, increasing the onshore logistical complexity, installation duration and costs. Alternative D is considered not practicable due to the likelihood of additional regulatory challenges associated with a federal conversion process with the National Park Service in combination with the regulatory challenges of submarine export cable routing that crosses the sand resource area (see similar discussion for Alternative C in Section 3.3.3.3). Alternative D is also in closer proximity to the restored dunes, although impacts to nesting shorebirds could likely be mitigated by implementation of appropriate time-of-year windows, since direct disturbance to the dune habitat will be avoided by the trenchless installation of the landfall segment.

3.3.3.5 Alternative E

Cable landfall Alternative E is located in the City of Long Beach and is the farthest west of the sites evaluated along Long Beach. The onshore workspace for the cable landfall is approximately 1.6 ac (0.6 ha), within Laurelton Boulevard and adjacent privately owned parcels to the west of Laurelton Boulevard on both sides (north and south) of West Broadway. According to the Nassau County Land Records online viewer, there are three parcels to the south of West Broadway totaling approximately 1.7 acres and categorized as ocean waterfront land. The parcel to the north of West Broadway is a 0.2-ac (0.1 ha) privately owned parcel that is categorized as vacant commercial land. The onshore export cable route alternatives from cable landfall Alternative E are approximately 1.8 mi (3.0 km) long and offer some of the shortest routes to the proposed onshore substation.

Alternative E is bounded to the south by the raised oceanfront boardwalk adjacent to the City of Long Beach Ocean Beach Park. There is a high-rise residential complex called Lafayette Terrace along Lafayette Boulevard to the west of the cable landfall. Immediately across Laurelton Boulevard to the east, there is a high-rise assisted living facility at 274 West Broadway. To the north, the cable landfall area is bounded by high-rises and residences along W Broadway and Laurelton Boulevard. The private parcels to the south of West Broadway at the Alternative E cable landfall site have housed construction trailers and been used for parking in the past, but potential future development plans for these parcels are uncertain.

The landfall cable alignment is designed so that two cables are within Laurelton Boulevard, and the third cable is along the easternmost portion of the private parcel to the southwest of West Broadway, to minimize the limitation on potentially developable space. To the south of the cable landfall, along the export cable landfall alignment, the route traverses the end of Laurelton Boulevard and the export cables need to be installed underneath the Long Beach boardwalk. A temporary police trailer sits at the end of Laurelton Boulevard, which will likely need to be relocated for use of Alternative E as an export cable landfall.

The Laurelton Boulevard corridor is narrow and constrained by utility congestion, allowing limited space for siting of the transition joint bays and duct banks within the roadway. Cable landfall Alternative E has sufficient space for a cable landfall of all three export cables and the temporary workspace for cable landfall activities if the vacant parcel is commercially available and the necessary land rights can be obtained. Empire is currently evaluating whether an export cable landfall with three circuits is technically feasible in the event that the export cables and cable landfall workspace is limited to the public right-of-way.

Due to the limited space availability, Empire determined that the Direct Pipe® installation method is not feasible for Alternative E; therefore, the HDD installation method is required. Direct Pipe® installation is not suitable because it requires a fabricated steel pipe behind the launch pit that would extend 400 to 500 ft (122 to 152 m) for the extent of the operations. The Direct Pipe® installation also requires the onshore entry pit to be much further north than for the HDD installations, since the angle of installation for Direct Pipe® is less steep. Onshore impacts from Direct Pipe® installation at this location would be significant, requiring more street closures, heavy equipment (side booms) to support the steel pipe behind the entry pit, a larger footprint from additional equipment, and noise impacts for a greater duration. Therefore, Direct Pipe® was not considered further at this location. In the event that the cable landfall is limited to public right-of-way, one potential limitation at cable landfall Alternative E is that it may not have sufficient space for contingency in the case of an HDD failure along one or more of the export cable alignments. Typically, if an initial HDD attempt fails, another attempt may be made along a parallel alignment immediately adjacent; however, for cable landfall Alternative E, a separate contingency location may be required due to the highly constrained spacing of the three cables.

The submarine export cable route to landfall Alternative E extends a total length of 7.9 nm (9.1 mi, 14.6 km) from the New York State boundary to shore. Similar to the submarine export cable route to Alternative A, this route would require crossing a total of three existing, two planned and one out-of-service submarine utilities, including crossing the existing Transco LNYBL approximately 4,593 ft (1.4 km) from shore, as well as crossing the HVDC Neptune Power Transmission Cable and the FLAG Atlantic telecoms cable. These utility crossings are expected to involve the use of hard substrate cable protection measures on the seafloor (e.g., rock berm, concrete mattresses, etc.

As previously described for landfall Alternative A, challenges exist for crossing the Transco LNYBL along the submarine export cable route approaching Alternative E. However, for Alternative E, the Transco LNYBL crossing is located slightly further offshore due to the alignment of the existing pipeline. As with Alternative A, an HDD crossing of the Transco LNYBL is impracticable (see Section 3.3.3.1). A trenched crossing design could result in up to approximately 7 ft (2 m) of shoaling. Utilizing the Northeast Ocean Data Portal (2021 dataset), an initial characterization of vessel traffic within the area of the pipeline crossing, which occurs less than 1 nm offshore landfall Alternative E, identified the presence of pleasure craft, sailing vessels, passenger vessels, tug and tow vessels, and fishing vessels (listed in order of most frequent to lowest occurrence). There were no identified cargo vessels or tanker vessels within the area of the crossing.

Empire also considered avoidance of a sand resource area that is located offshore of Lido Beach (**Figure 3.3-2**). As the westernmost route, the centerline of the submarine export cable route approaching Alternative E would be approximately 4,270 ft (1,300 m) at its closest to the sand resource area. Existing infrastructure (the FLAG Atlantic telecoms cable) is located between Alternative E and the sand resource area; therefore, installation of the submarine export cables along this route is not expected to result in any impacts to or new limitations on the use of the sand resource area.

Considering the nearshore environment, the Alternative E cable landfall has the shortest distance to deeper water suitable for setting up the offshore portion of the trenchless landfall installation. Water depths at the exit pit offshore are expected to be approximately 30 ft to 33 ft (9 m to 10 m) below MLLW for trenchless installation lengths of 1,650 ft (500 m) to 3,280 ft (1000 m).

The cable landfall HDDs will need to traverse underneath the raised oceanfront boardwalk. The HDDs will need to be installed deep enough to allow adequate spacing between the export cable conduits and the bottom of the sheet pile associated with the boardwalk structure.

Since Ocean Beach Park is municipal parkland, parkland alienation by State legislation may be required for an underground crossing of the beach. According to correspondence received from the NYOPRHP dated December 9, 2021, the City of Long Beach received three LWCF grants in the 1980s for the development of the Long Beach boardwalk, dunes, and swimming facilities. Additional coordination with NYOPRHP and/or NPS will be required. Crossing a LWCF area may result in additional regulatory challenges in the case a federal conversion process is required. A federal conversion process requires the provision of replacement property that is of equal or greater fair market value and of reasonably equivalent usefulness and location as the lands being removed from outdoor recreation use.

The onshore workspace at cable landfall Alternative E is in close proximity to sensitive noise and air quality receptors, including residences adjacent to Laurelton Boulevard and along W Broadway and an assisted living facility directly adjacent to the site. The cable landfall installation would occupy space at the intersection of these two roadways, which would likely require road closure, traffic impacts and disruption of access to residential buildings for a prolonged period (up 6 to 24 months). Due to the space constraints, limited mitigation options exist for these potential noise and traffic impacts.

As one of the three westernmost export cable landfalls (which include Alternatives E, A and B) the cable landfall would cross through the proposed Bayside Development, a potential project listed in the City of Long Beach's comprehensive plan, "Creating Resilience: A Planning Initiative," which was updated in a draft in January 2018 (City of Long Beach 2018).

In summary, Alternative E is a practicable alternative for an export cable landfall of three circuits, in the event that land rights can be obtained for the vacant parcel to the west of Riverside Boulevard, as well as other necessary land rights (i.e., parkland alienation and conversion). Empire is evaluating the feasibility of installation of three circuits in the right-of-way event that the cable landfall is limited to the public right-of-way. Challenges for Alternative E include installation of the cable landfall underneath the Long Beach boardwalk, shoaling required for the submarine export cable crossings of the Transco LNYBL, potential parkland alienation and conversion, and potential noise, traffic and air quality impacts. Due to the proximity of cable landfall Alternative E to sensitive noise and air quality receptors, as well as potential onshore traffic impacts, this cable landfall alternative is anticipated to have greater potential onshore environmental and stakeholder impacts compared to the proposed alternative (Alternative A), as well as having a longer submarine export cable route. As such, Alternative E was not selected as the proposed alternative.

3.3.3.6 Alternative A+E

Cable landfall Alternative A+E is a combination that uses the cable landfall areas both at Alternative A (as described in Section 3.3.3.1) and Alternative E (as described in Section 3.3.3.5). Under this cable landfall alternative, two submarine export cables make landfall at the Alternative A location, and one submarine export cable makes landfall at the Alternative E location. Cable landfall Alternative A and Alternative E are located approximately 0.6 mi (1 km) apart. Up to the full available workspace acreage at each location (1.7 ac [0.7 ha] at Alternative A and 1.6 ac [0.6 ha] at Alternative E) are used under this alternative.

The cable landfall Alternative A+E alleviates some of the space constraints associated with a three-circuit cable landfall at either Alternative A or Alternative E. In particular, it would provide space for a contingency in the case of an HDD failure. If an initial HDD attempt fails, another attempt could be made along a parallel alignment immediately adjacent at either cable landfall Alternative A or Alternative E.

For Alternative A+E, the submarine export cable routes are adjusted so that all three submarine export cables cross the Transco NYLBL at one location in parallel, before splitting into separate routes to each of the respective cable landfalls. North of where the route splits to the north of the NYLBL crossing, the submarine export cable corridor to cable landfall Alternative A would be approximately 500 ft (152 m) wide, and the submarine export cable corridor to cable landfall Alternative E would be approximately 300 ft (91 m) wide.

The use of two separate submarine export cable routes/corridors spreads the impacted area within the marine environment over a greater area instead of aligning the three submarine export cables in parallel along a single corridor. Co-locating cables along a single corridor and alignment is generally considered to minimize the extent of environmental impacts, and Alternative A+E will have a slightly longer submarine export cable route than the proposed alternative A+E.

As described above, the City of Long Beach received LWCF grants in the 1980s for the development of the Long Beach boardwalk, dunes, and swimming facilities, and crossing the boardwalk and LCWF area will require additional coordination with NYOPRHP and/or NPS will be required. In the event that a federal conversion process is required, this process could pose additional regulatory challenges for Alternative A+E, since the federal conversion process would be required in disjunct locations. As described above, a federal conversion process requires the provision of replacement property that is of equal or greater fair market value and of reasonably equivalent usefulness and location as the lands being removed from outdoor recreation use. Since both locations may also require parkland alienation by State legislation, Alternative A+E additionally has the potential challenge of obtaining State legislation at both locations.

Additionally, Alternative A+E will require additional onshore export cable routes north of the export cable landfalls at the two locations. The use of two separate cable landfalls for installation will somewhat reduce the duration of potential environmental, traffic, and stakeholder impacts at each location (Alternative A and Alternative E) relative to a three-circuit installation at the same location. However, use of two cable landfalls will also disperse the potential impacts over a broader area. Because the two cable landfall locations are less than 1 mi (1.6 km) apart and both located along the E/W Broadway corridor, construction activities at multiple locations associated with Alternative A+E likely would increase the potential traffic impacts and logistical challenges of road closures.

Alternative A+E is a practicable alternative for an export cable landfall in the event that land rights to use the adjacent private parcels cannot be obtained and construction at cable landfall Alternative A and/or Alternative E is restricted to the public right-of-way and provides a contingency in the case of an HDD failure. However, due to the additional regulatory challenges of potential parkland alienation and conversion processes in two separate locations, as well as the potential for noise, traffic, air quality impacts and marine cable installation impacts over a broader area, Empire selected Alternative A, with all three submarine export cables making landfall in the same location, as the proposed alternative.

3.3.4 Jones Beach Landfall Alternative

As an alternative to landfall on the Long Beach barrier island, Empire also considered routing the submarine export cables further to the east and installing the export cable landfall to Jones Beach (Jones Beach Landfall Alternative) (**Figure 3.3-1**). This landfall alternative is located along the open coast at Jones Beach State Park off of Bay Parkway, near Meadowbrook State Parkway. The Jones Beach Landfall Alternative is sited within an approximately 3.5-ac [1.4-ha] paved parking area located near the west end of Jones Beach. The site is bounded to the south by approximately 1,800 ft of dunes and wide sandy beach, with beach dune habitat to the east and west. Bay Parkway lies immediately to the north of the site.

The submarine export cable route to Jones Beach extends a total length of approximately 3.4 nm (3.9 mi, 6.2 km) from the New York State boundary to shore. A submarine export cable route to the Jones Beach Landfall crosses the existing HVDC Neptune Power Transmission Cable further offshore, similar to Alternatives C and D. As the easternmost route, the Jones Beach Landfall Alternative would avoid the sand resource area that is located offshore of Lido Beach (**Figure 3.3-2**). Since the cable landfall at Jones Beach is far from the shoreline and because of the gradual sloping of the shoreline, it is a longer distance to deep water for HDD installation than at other assessed locations. The minimum HDD length assessed was 2,625 ft (800 m) where water depth is only approximately 20 ft (6 m) below MLLW. Water depths of approximately 33 ft (10 m) depth that are typically required for the submarine export cable installation vessel. To reach 33 ft depth (10 m) a length of approximately 6,890 (2,100 m) would be needed, which is beyond the practicable length for HDD installation.

Jones Beach is a popular State Park for summer recreation and swimming, but open year-round, with programs including concerts and fireworks displays. The Jones Beach Landfall Alternative would require obtaining an agreement with NYOPRHP to cross state park lands.

The most challenging aspect of a Jones Beach landfall is, however, the onshore routing. Two routing options were considered from Jones Beach:

1. After landfall at Jones Beach, completing a second HDD from the Jones Beach parking lot to the Long Beach barrier island in the vicinity of Point Lookout, and routing onshore through Jones Beach and Barnum Island from there; and
2. Routing onshore along Meadowbrook State Parkway towards Freeport and Sunrise Highway, traversing densely developed areas from Freeport west to Oceanside.

An HDD from a Jones Beach landfall to the Long Beach Barrier Island was determined to be infeasible, due to a combination of HDD length, angle, and space availability in the vicinity of Point Lookout. HDD lengths required to reach a suitable staging area at Point Lookout, and avoid houses and other existing structures, would be 6,000 to 8,000 ft, which is beyond the technical limitations for installation. Other options (such as entering the water) would result in greater environmental impacts than the proposed alternatives (also see Section 2.3.4).

Onshore routing from Jones Beach through Freeport would be approximately 11 miles (17.7 km), which is more than double the length of the onshore route from the Long Beach barrier island and is expected to be significantly greater in technical and logistical complexity due to development and infrastructure density. Meadowbrook State Parkway is one of the only two roads that connects the Jones Beach barrier island to mainland Long Island. The road shoulder, which is elevated above adjacent wetlands is flat, but construction along the shoulder would require obtaining approval for accommodation of utilities within state highway right-of-way from the New York State Department of Transportation (NYSDOT). There are three bridges on the Meadowbrook State Parkway between the barrier island and mainland Long Island (traversing from Jones Beach to Jones Island, Petit Marsh and finally the Long Island mainland). These crossings would require HDD or open cut construction across the tidal channels. Estuarine and marine wetlands are adjacent to the length of Meadowbrook State Parkway from the Jones Beach barrier island to Sunrise Highway. For most of the length, there appears to be sufficient space for installation of onshore export cables between the parkway and the wetlands; however, HDD crossings of the tidal channels may require impacts to tidal wetlands for staging and pullback. Empire also understands there are weight restrictions along the Meadowbrook Parkway bridges, which may pose an additional challenge for construction access.

Additionally, Jones Beach State Park Causeway and Park System is a historic district listed on the National Register of Historic Places (NRHP), which includes the Wantagh, Ocean, Meadowbrook, and Loop State Parkways. Installation along the Meadowbrook State Parkway has the potential to result in direct impacts to an NRHP-listed property.

The Jones Beach landfall is not practicable due to the length and complexity of the onshore routing, potential cultural resource impacts, and expected impacts to tidal wetlands along the route. Construction challenges and logistical constraints for the onshore route also include vehicular traffic, construction vehicle access restrictions, pedestrian foot traffic, residential and commercial development density, noise impacts, business impacts, constructability, and workspace constraints due to existing infrastructure.

3.3.5 Shell Creek Park (Barnum Island) Landfall Alternative

A cable landfall alternative on Barnum Island avoids an export cable landfall on the Long Beach barrier island, and instead the submarine export cables continue in-water through Jones Inlet and traverse west along Reynolds Channel on the north side of the barrier island. The evaluated cable landfall is located at Shell Creek Park, an approximately 8-ac municipal park in the unincorporated portion of Barnum Island in the Town of Hempstead. Shell Creek Park consists predominantly of playing fields and ball fields, with a walkway built along the seawall at the shoreline. The park is bounded by water to the south and east, and residential neighborhoods to the west and north.

The submarine export cable route to Barnum Island extends a total length of approximately 8.5 nm (9.7 mi, 15.7 km) from the New York State boundary to shore. Like the other evaluated submarine export cable route alternatives, this route crosses into New York State south of Jones Beach, heading northwest. The Barnum Island submarine export cable route alternative requires crossing a total of one existing, one planned, and one out-of-service submarine utility, including the HVDC Neptune Power Transmission Cable. Empire also considered avoidance of a sand resource area that is located offshore of Lido Beach (**Figure 3.3-2**). Due to the proximity of the eastern end of the sand resource area to the western tip of Jones Beach and the narrow entrance to Jones Inlet, siting in this area is constrained, and the centerline of the submarine export cable route is approximately 300 ft (90 m) to the east of the sand resource area.

Technical challenges for the submarine export cable route include shallow waters, several charted wrecks, and vessel traffic near the mouth of Jones Inlet. Jones Inlet and the north side of the Long Beach barrier island also may have limited barge access due to bridges and narrow clearance. Shallow waters between Jones Inlet and the export cable landfall would require special shallow draft construction vessels for the cable installation, increasing the cost and complexity of installation activities.

Moreover, Jones Inlet and Reynolds Channel are maintained by dredging and maintenance activity for navigation. As such, cable burial would need to take into consideration de-risking future dredging operations, requiring deeper burial and more extensive disturbance along this route. The mouth of Jones Inlet itself is subject to high seabed mobility and erosion, which present logistical challenges for cable burial and protection. Marine traffic data shows that vessel traffic is relatively high through Jones Inlet and along the north side of the Long Beach barrier island, so interference with marine traffic during construction is also of concern.

The Barnum Island Landfall Alternative is associated with greater impacts within the marine environment than other alternative routes evaluated. At Jones Inlet, the submarine export cable route enters mapped Significant Coastal Fish and Wildlife Habitat in Middle Hempstead Bay, considered one of the largest undeveloped coastal wetland systems in New York State, with a significant nesting habitat for coastal shorebirds and colonial wading birds, as well as being a productive area for marine finfish, shellfish, and other wildlife (NYSDOS 2008a).

The onshore export cable route to the onshore substation from Shell Creek Park is only 1.0 mi (1.6 km) long; however, it requires routing along the relatively constrained Vanderbilt Avenue, through a residential neighborhood. Since Shell Creek Park is a municipal parkland, parkland alienation by the New York State legislature may be required for an underground crossing of the parkland.

Empire's evaluation concluded that a landfall at Barnum Island results in greater impacts to the marine environment, including Significant Coastal Fish and Wildlife Habitat than the proposed alternative and has significantly more logistical challenges associated with construction through Jones Inlet and in an area of high marine traffic. The submarine export cable route to the Shell Creek Park Alternative is also located in proximity to the east side of the sand resource area. Since the submarine export cable route is not practicable, the cable landfall at Shell Creek Park is also not practicable.

3.4 Onshore Substation Alternatives

Empire evaluated three onshore substation site alternatives, which are shown in **Figure 3.4-1**.

3.4.1 Onshore Substation A

The Onshore Substation A is an approximately 6.4-acre (2.6 ha) site located on a property at the corner of Daly Boulevard and Hampton Road, in Oceanside, New York. The site is bounded by Hampton Road to the west, Daly Boulevard to the south, and the Long Island Rail Road (LIRR) and a residential development to the east. North of the site is predominately used as an industrial area. The site does not contain any existing structures that would need to be removed for the construction of the onshore substation; however, it is expected that existing soil contamination at the site would require remediation before construction.

Onshore Substation A is adjacent to NWI and NYSDEC-mapped tidal waters to the west, but no direct impact to or loss of WOTUS would result in use of the site for the onshore substation.

The onshore export cable route from the proposed cable landfall to Onshore Substation A crosses Barnums Channel along the same route as the interconnection cable route from Onshore Substation C (see further discussion in Section 3.4.3). The combined length of the onshore export and interconnection cables (approximately 3.4 mi [5.5 km]) for the Onshore Substation A alternative is approximately the same as for the proposed Project.

Based on the Empire's ongoing communications with Long Island Power Authority (LIPA), Empire understands that interconnection at the Barrett 138-kV Substation will require an expansion of the existing substation due to available space limitations on LIPA's existing facility. In light of the anticipated LIPA substation expansion onto the Onshore Substation A parcel, there is not also sufficient space available for Empire's onshore substation facility (primarily due to the space required for the installation of the Subsea Distribution Units [SDUs]) on the same site. Logistical complexities of having both Empire and LIPA operating on the same property, such as separate entrances and material handling routes, also increase the space requirements. Based on these space limitations, future plans and remediation requirements, Onshore Substation A is not a practicable alternative for the Project.

3.4.2 Onshore Substation B

The Onshore Substation B is an approximately 7.4-acre (3.0-ha) site located at 4005 Daly Boulevard, in Oceanside, New York. The site is bordered by Daly Boulevard and a residential development to the north, Long Beach Road to the east, and an existing power station to the west and south. The parcel is owned by National Grid and currently contains an existing power station. The portion of the parcel evaluated for the proposed onshore substation is undeveloped and contains vegetation. It is immediately adjacent to mapped NWI wetland and is located within NYSDEC-mapped tidal wetland adjacent areas. Empire has not conducted a formal wetland delineation of the site and it is expected that tidal wetland may also extend within the site boundary. Onshore Substation B does not contain any existing structures that need to be removed for the construction of the onshore substation.

The onshore export cable route from the proposed cable landfall to Onshore Substation B is approximately 4.0 mi (6.4 km). The interconnection cable route from Onshore Substation B to the POI is approximately 0.1 mi (0.2 km), for a total onshore cable route length of 4.1 mi (6.6 km). The onshore export cable route to Onshore Substation B crosses Barnums Channel to the east of the proposed route and is expected to require an open cut crossing solution (Section 3.5.3), resulting in a greater net impact to wetland areas than the proposed onshore substation (Onshore Substation C) and its associated interconnection cable route.

Onshore Substation B is not practicable because Empire has determined that it is not commercially available for the Project. Moreover, construction and operation of Onshore Substation B, as well as the onshore export cable route to Onshore Substation B, is expected to result in greater direct and indirect impacts to tidal wetlands than the proposed alternative.

3.4.3 Onshore Substation C (Proposed)

Onshore Substation C is a 5.2-ac (2.1-ha) site located at 15 Railroad Place, in Island Park, New York. The site is bordered by the LIRR to the west, Reynolds Channel to the south, and Long Beach Road to the east. The parcels are privately owned and contain existing commercial uses. Onshore Substation C requires the demolition and removal of existing structures for the construction of the onshore substation. Construction of the onshore substation and associated access will require site grading and elevation, including refurbishment of existing bulkheads and shoreline stabilization (including filling within three existing boat slips).

A small acreage less than 0.1 ac [0.04 ha] of mapped NWI and NYSDEC-mapped tidal wetland is present within the onshore substation site boundary. However, based on Empire's Wetland and Terrestrial Vegetation Report (**Attachment F**), wetlands onsite are associated with open water areas of Reynolds Channel; these mapped wetland areas do not represent vegetated tidal wetlands or mudflats. Impacts will be minimal and predominantly within an area of existing bulkheaded shoreline and existing boat slips. Empire may remove the floating and pile structures associated with the existing marina. Removal of floating and pile structures associated with the existing marina, if conducted, would remove shading impacts and artificial structures within the marine environment.

The onshore export cable route from the proposed cable landfall to Onshore Substation C is approximately 1.5 mi (2.4 km). The interconnection cable route from Onshore Substation C to the POI is approximately 1.8 mi (2.9 km), for a total onshore cable route length of 3.3 mi (5.3 km).

Due to the minimization of impacts to vegetated tidal wetlands along the proposed export and interconnection cable routes (see Section 3.5), minimal impacts to WOTUS associated only with shoreline stabilization (where already bulkheaded), commercial availability and ability to achieve the Project purpose, Onshore Substation C is proposed as the practicable alternative with the least impact to environmental resources.

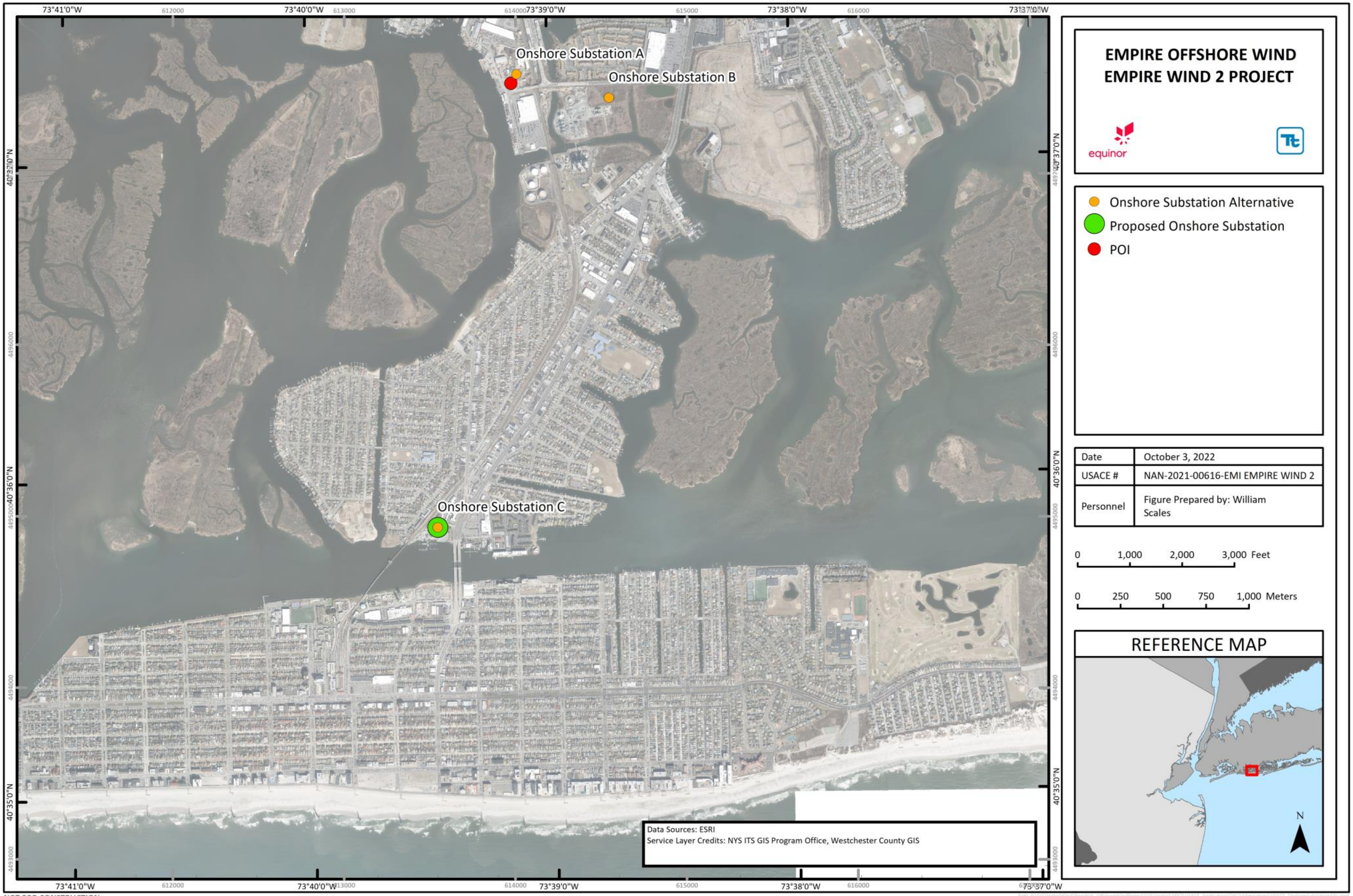


Figure 3.4-1 Onshore Substation Alternatives

3.5 Onshore Export and Interconnection Cable Alternatives

This section provides the evaluation for the route and installation alternatives considered for the onshore export and interconnection cables.

The goal of the onshore export cable and interconnection cable routing alternatives analysis was to develop a constructible route that is largely sited within public rights-of-way and minimizes impacts to the environment and the public. Conceptual routes developed for further analysis incorporate the following objectives, to the extent practicable: maximize use of public rights-of-way; minimize in-street work; avoid existing utilities; allow sufficient space for construction by routing in wider corridors; and maintain construction flexibility.

Public rights-of-way, which include roadways, medians and adjacent areas, railroads, etc., limit the number of stakeholders directly impacted and the number of new landowner easements that must be acquired for the onshore export and interconnection cable routes. Minimizing in-street work within the public right-of-way reduces impacts on traffic, enhances safety during construction, and typically shortens the duration of installation. It is also preferable to avoid siting directly within roadways (where possible) because they typically contain gas, sewer, water, telecommunications, and electric utilities, which add routing and workspace constraints, construction logistics challenges, and project complexity.

The evaluation of onshore export and interconnection cable route alternatives was conducted as an iterative process that involved multiple steps of evaluation of the offshore and onshore cables routes, constraints on potential landfall locations, and the feasibility of landfall installation methodologies at potentially suitable landfall sites. Each of the Project components, although described as separate evaluations, were considered in concert for the selection of the overall proposed solution for the Project.

Onshore export cable route alternatives are limited to routes starting at practicable cable landfall alternatives (Section 3.3) and ending at the proposed onshore substation (Onshore Substation C, Section 3.4). An overview of onshore export and interconnection cable route alternatives considered is provided in **Figure 3.5-1**. To identify the proposed cable route, Empire conducted a comparative analysis to assess the benefits and risks of several route options. The analysis considered the following criteria:

- Route length;
- Land use;
- Constructability;
- Presence of utilities;
- Prioritizing existing rights-of-way;
- Easement acquisition; and
- Environmental aspects such as wetlands and waterbodies, historic and cultural resources, sensitive species habitat, potential for contamination, community impacts, and potential community opposition, among others.

3.5.1 Onshore Export Cable Route Alternatives

Onshore export cable routing from practicable cable landfall alternatives (Alternatives A, C, E and A+E) to the proposed onshore substation are depicted in **Figure 3.5-1** and **Figure 3.5-2** and described in this section. Cable landfall alternative A+E uses the same onshore export cable routes as described individually for cable landfall Alternative A and E.

Minor variations of these routes were also considered (see Volume 1, Section 3 of the COP in Appendix D-1 of **Attachment D**). All of the evaluated onshore export cable routes south of Reynolds Channel (Section 3.5.2) are located along existing roadway corridors and avoid impacts to wetlands and other WOTUS. No other significant environmental impacts have been identified along the onshore export cable segment of the cable routing for any of the alternatives. As such, although Empire has selected the route from cable landfall Alternative A traversing E Broadway and Lincoln Boulevard as the proposed alternative, based on constructability characteristics, all of the routes described are considered practicable alternatives that minimize environmental impacts.

3.5.1.1 Onshore Export Cable Route Alternatives from Cable Landfall A

The following three alternatives were evaluated from cable landfall Alternative A to the proposed onshore substation:

- Proposed alternative: from the export cable landfall at Alternative A (Riverside Boulevard/E Broadway) in the City of Long Beach, the proposed onshore export cable route will turn east on E Broadway to Lincoln Boulevard and turn north. This route will continue north across E Park Ave to E Harrison Street and turn west, traversing across Long Beach Boulevard to Long Beach Road. The onshore export cable route then turns north along Long Beach Road to Park Place and a City of Long Beach property, where it continues north across Reynolds Channel to the onshore substation site.

- From the export cable landfall at Alternative A (Riverside Boulevard/E Broadway), the onshore export cables traverse north up Riverside Boulevard and turn east on E Walnut Street. The onshore export cables then turn north on Lincoln Boulevard, continuing north across E Park Ave to E Harrison Street where the route turns west, traversing across Long Beach Boulevard to Long Beach Road. The onshore export cable route then turns north along Long Beach Road to Park Place and a City of Long Beach property, where it continues north across Reynolds Channel to the onshore substation site.

- From the export cable landfall at Alternative A (Riverside Boulevard/E Broadway), the onshore export cables traverse north up Riverside Boulevard to E Walnut Street. The onshore export cables then turn west to Edwards Boulevard, where the cables turn north, cross E Park Ave, and continue onto Reverend JJ Evans Boulevard. Reverend JJ Evans Boulevard turns into Park Place. The onshore export cables turn north onto a City of Long Beach property just before the eastern end of Park Place, and then the route crosses Reynolds Channel.

3.5.1.2 Onshore Export Cable Route Alternatives from Cable Landfall C

The following three alternatives were evaluated from cable landfall Alternative C to the onshore substation:

- From the export cable landfall at Alternative C (Lido Beach West Park) in the Town of Hempstead, the onshore export cables traverse west through the park to Richmond Road. The onshore export cables continue west on Richmond Rd until turning south on Maple Boulevard and then immediately west on E Broadway. The onshore export cables then turn north onto Lincoln Boulevard. From Lincoln Boulevard, the onshore export cables will continue north until turning west onto E Harrison Street. The onshore export cables then cross perpendicular to Long Beach Boulevard and turn north onto Long Beach Road, to the crossing at Reynolds Channel.

- From the export cable landfall at Alternative C (Lido Beach West Park), the onshore export cables traverse west through the park to Richmond Road. The onshore export cables continue west on Richmond Rd until turning south on Maple Boulevard and then immediately west on E Broadway.

The onshore export cables then turn north onto Franklin Boulevard. From Franklin Boulevard, the onshore export cables will continue north until turning west onto E Harrison Street. The onshore export cables then cross perpendicular to Long Beach Boulevard and turn north onto Long Beach Road, to the crossing at Reynolds Channel.

- From the export cable landfall at Alternative C (Lido Beach West Park), the onshore export cables connect north into Lido Boulevard and traverse west, as Lido Boulevard turns into E Park Ave. The onshore export cables turn north Lincoln Boulevard, until turning west onto E Harrison Street. The onshore export cables then cross perpendicular to Long Beach Boulevard and turn north onto Long Beach Road, to the crossing at Reynolds Channel.

3.5.1.3 Onshore Export Cable Route Alternatives from Cable Landfall E

The following two alternatives were evaluated from cable landfall Alternative E to the onshore substation:

- From the export cable landfall at Alternative E (Laurelton Boulevard) in the City of Long Beach, the proposed onshore export cable route will turn east on W Broadway, continuing on to E Broadway. From E Broadway, the onshore export cable route will continue to Lincoln Boulevard and turn north. This route will continue north across E Park Ave to E Harrison Street and turn west, traversing across Long Beach Boulevard to Long Beach Road. The onshore export cable route then turns north along Long Beach Road to Park Place and a City of Long Beach property, where it continues north across Reynolds Channel to the onshore substation site.

- From the export cable landfall at Alternative E (Laurelton Boulevard) the onshore export cables continue north along Laurelton Boulevard to West Park Avenue and turn east. The onshore export cables continue until Reverend JJ Evans Boulevard, where the cables turn north. The onshore export cables then continue along Reverend JJ Evans Boulevard, which turns into Park Place, until the crossing at Reynolds Channel.

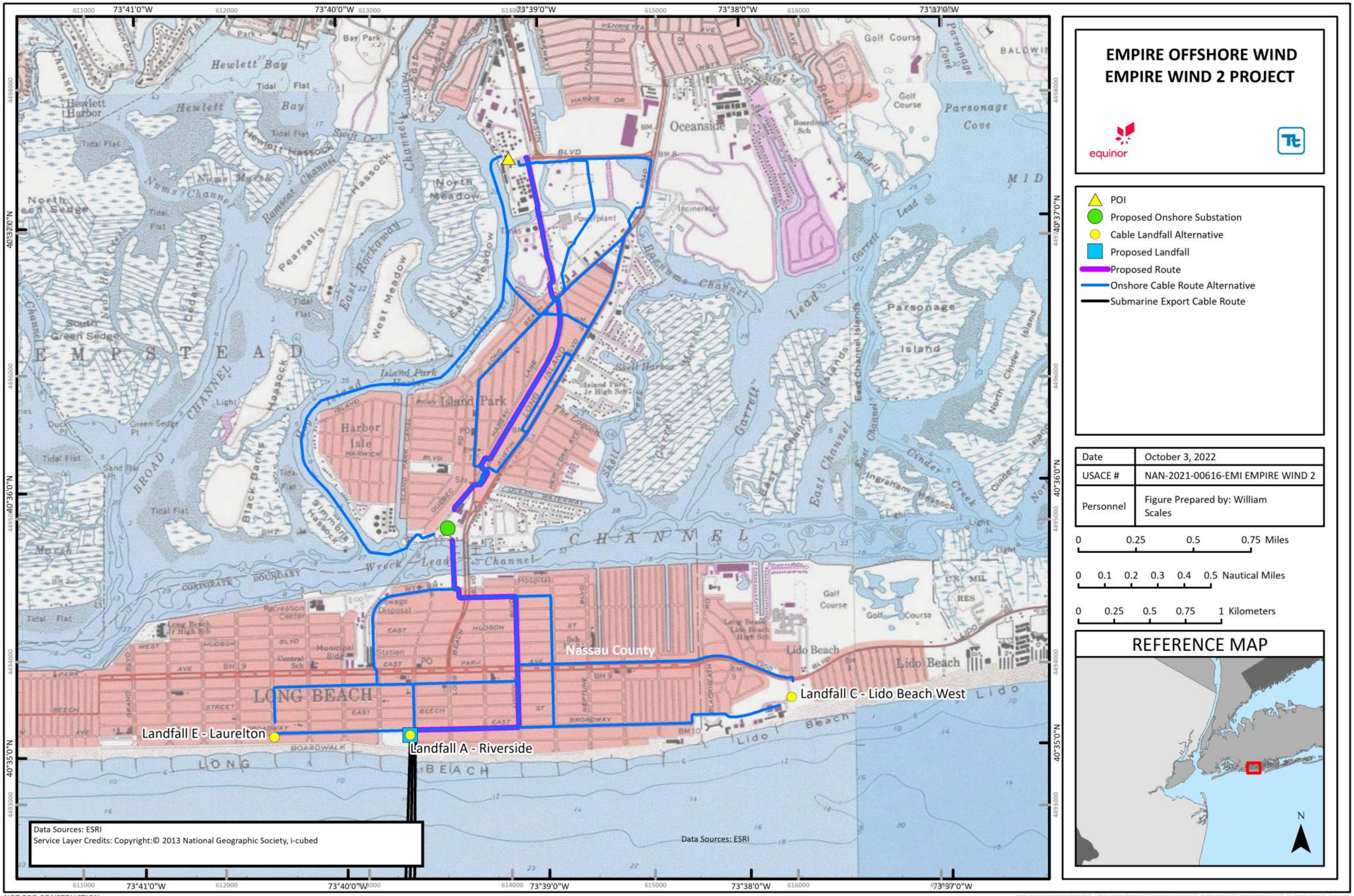


Figure 3.5-1 Onshore Export and Interconnection Cable Route Alternatives

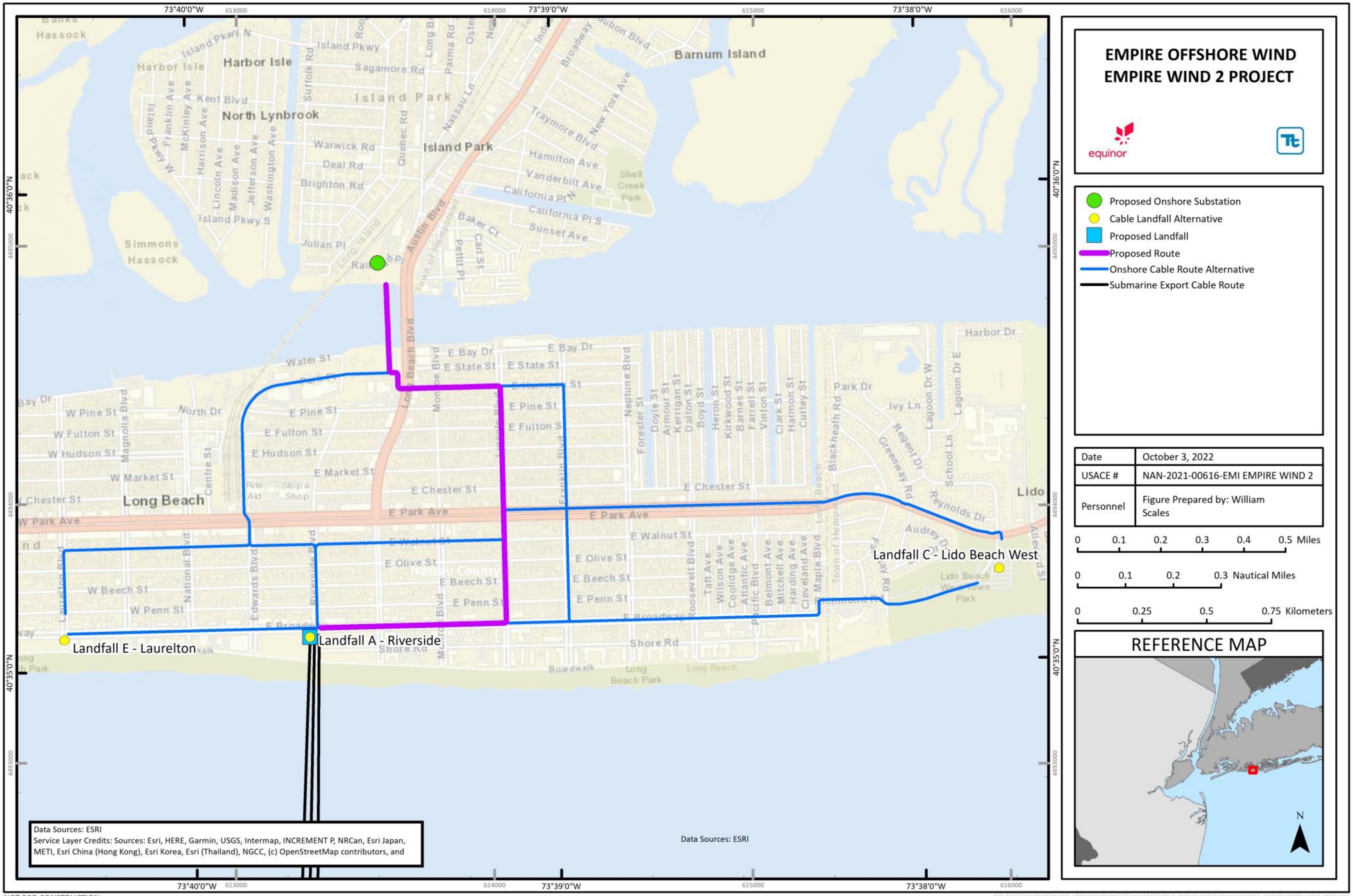


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Figure 3.5-2 Onshore Export Cable Route Alternatives

3.5.2 Reynolds Channel Crossing Alternatives

Empire evaluated crossing methods and alignments for the onshore export cable installation across Reynolds Channel between the Long Beach barrier island and Barnum Island. Alternative methods considered include:

- HDD Alternative; and
- Open Cut Alternative.

The HDD alternative involves the installation of the three land-to-land HDDs, one for each of the onshore export cables, for approximately 1,014 ft (309 m) across Reynolds Channel. HDDs are frequently used to install cables in ducts under sensitive coastal and nearshore habitats, such as dunes, beaches, waterways, and submerged aquatic vegetation The method for HDD installation on land is similar to that described for the export cable landfall in Section 3.3.1, except that both workspaces are onshore, with the environmental resource crossing in between. Onshore crossings via HDD utilize a rig that drills a borehole underneath the waterway or other environmental resource. Once the rig exits onshore, the ducts in which the cable will be installed are then pulled back within the drilled borehole. Onshore crossings require two onshore work areas (approximately 246 ft by 246 ft [75 m by 75 m] on each side) to support the activities. For the Reynolds Channel crossing, both workspaces are located on previously developed commercial/industrial lands adjacent to the waterbody.

An open cut crossing of Reynolds Channel requires an approximately 72-ft (22-m) wide trench per cable, within an approximately 300 ft (91 m) wide installation corridor and requires excavation of the shoreline on both sides of the crossing. Water depths reach 30 ft (9.1 m) or more in the deepest portions of the Reynolds Channel crossing. In addition to requiring extensive dredging/in-water impact to the tidal channel to install all three cables, Reynolds Channel is used by boats and the installation of the open cut crossing would occur alongside the Long Beach Bridge twin drawbridge that connects the Long Beach barrier island to Barnum Island and the Village of Island Park. Construction of an open cut installation across Reynolds Channel in this location, adjacent to the drawbridge, could result in impacts to marine traffic in this area during construction activities. Immediately upstream and downstream of the crossing area, Reynolds Channel also contains Significant Coastal Fish and Wildlife Habitat designated by the New York Department of State, including potential habitat for winter flounder, a managed species.

Based on Empire's evaluation, an open cut installation is a practicable alternative for constructing the Reynolds Channel crossing, but it would result in greater environmental impacts than the proposed HDD crossings. Although all HDD installations carry some risk of an inadvertent drilling fluid return (see Section 3.3.1), Empire will minimize and mitigate risks by implementing an Inadvertent Return Plan. HDD installation of the three export cables is a practicable solution that minimizes the potential environmental impacts of the Reynolds Channel crossing.

Empire evaluated alternative alignments for the HDDs; however, other HDD crossing alignments in this vicinity require longer distances and/or curved HDD installation, which add time, cost and complexity to the installation. In addition to the proposed HDD alignment, Empire considered an alternative HDD alignment from the intersection of Park Place and Riverside Boulevard on the south side of Reynolds Channel, to the north end of the onshore substation along the LIRR, to be a practicable alternative. However, this alignment can likely support up to two export cable circuits and requires an extra approximately 600 ft (183 m) of installation along Park Place, which is narrow and has existing utility congestion. Therefore, the preferred solution is to install all three export cable circuits along the proposed alignment, to the west of and roughly parallel to the Long Beach Bridge along Long Beach Boulevard.

Availability of alternative parcels for HDD workspace is constrained along Reynolds Channel. Since in-water impacts are avoided with the proposed HDD alignment and other alternatives would result in an equal or greater environmental impact, alternative HDD installation alignments are not discussed further.

3.5.3 Interconnection Cable Route Alternatives

Empire also considered interconnection cable route alternatives through Barnum Island and/or the Village of Island Park from the proposed onshore substation to the POI at an expansion of LIPA's substation (**Figure 3.5-1** and **Figure 3.5-3**). Onshore interconnection cable route alternatives from the onshore substation follow one of three general north/south corridors: 1) the LIRR corridor, 2) the Long Beach Road corridor or 3) the Austin Boulevard/Industrial Place corridor. These routes follow existing developed road or railroad rights-of-way corridors in upland areas until the northern portion of the route, in the vicinity of Barnums Channel. From there, each of the route corridors can connect to one of three Barnums Channel crossing locations, either along the LIRR, across the E.F. Barrett Generating Station property, or along Long Beach Road.

Crossing Barnums Channel adjacent to the LIRR bridge was determined to provide the best alternative for minimizing impacts to tidal wetlands and within the tidal channel itself. Empire is proposing a cable bridge crossing (see Section 3.5.4), which will require installation of supports/footings within the channel; however, this will occur along a corridor already containing both the railroad bridge, and another utility bridge on the east side of the railroad crossing. Since the north and south sides of the crossing comprise an existing parking lot and a tank farm, respectively, impacts to wetlands and natural habitats on either side of the crossing are avoided. Even in the case of an open cut crossing, the LIRR route alternative would be expected to result in a smaller footprint of disturbance to tidal wetlands than the open cut for other routes evaluated. Thus, Empire's proposed alternative route at Barnum's Channel represents the practicable solution with the least environmental impact.

Empire also considered submarine export cable routes from the onshore substation to the POI, as discussed in Section 3.5.3.4. **Figure 3.5-3** provides a visual comparison of the interconnection cable route alternatives and **Table 3.5-1** summarizes the assessment criteria for interconnection cable route alternatives.

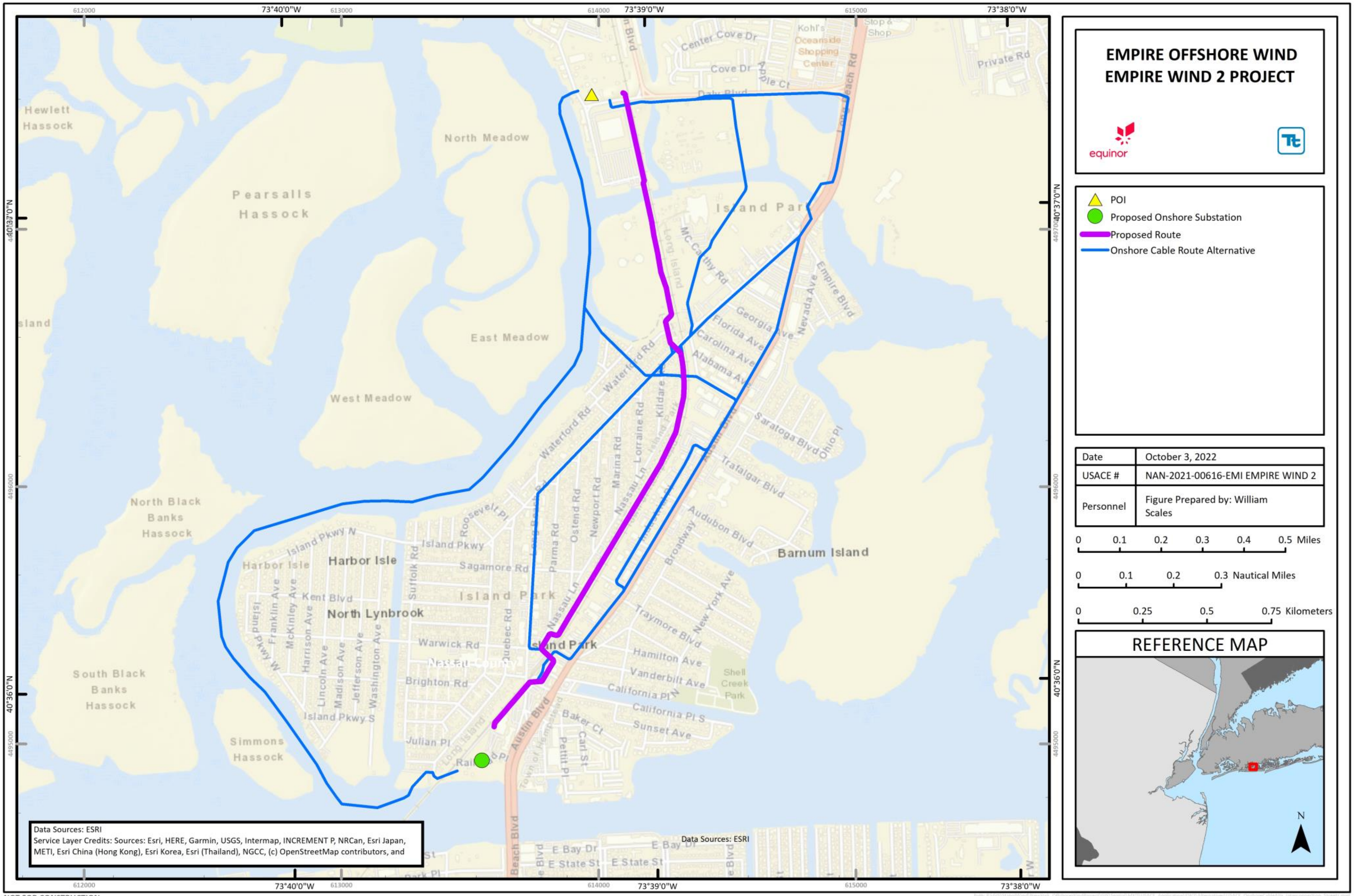

Figure 3.5-3 Interconnection Cable Route Alternatives

Table 3.5-1 Comparison of Interconnection Cable Route Alternatives

Assessment Criteria	LIRR Corridor Route Alternatives		Long Beach Road Corridor Route Alternatives		Austin Boulevard/Industrial Place Corridor Route Alternatives				Submarine Cable Route Alternatives	
	Full LIRR (Proposed)	LIRR to Parente Lane	Long Beach Road/LIRR	Long Beach Road to Daly Boulevard	Industrial Place to LIRR	Austin Boulevard	Industrial Place to Daly Boulevard	Industrial Place to E.F. Barrett	Submarine Interconnection Cable Route	LIRR to In-Water
Summary of Route Characteristics										
Total Interconnection Cable Route Length	1.7 mi (2.8 km)	1.8 mi (2.9 km)	1.8 mi (2.8 km)	2.5 mi (4.1 km)	2.0 mi (3.2 km)	1.9 mi (3.1 km)	2.5 mi (4.0 mi)	2.2 mi (3.6 km)	2.7 mi (4.4 km)	1.9 mi (3.1 km)
Approximate submarine interconnection cable route length	0	0	0	0	0	0	0	0	2.6 mi (4.1 km)	0.6 mi (1.0 km)
Environmental Factors										
Waterbody Crossing Length (linear)	0.02 mi (0.04 km)	0.02 mi (0.04 km)	0.02 mi (0.04 km)	0.02 mi (0.03 km)	0.02 mi (0.04 km)	0.02 mi (0.04 km)	0.02 mi (0.03 km)	0.02 mi (0.04 km)	2.6 mi (4.1 km)	0.6 mi (1.0 km)
Open Water Crossing Acreage	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	31.1 ac (12.6 ha)	7.3 ac (2.9 ha)
Mapped NYSDEC Tidal Wetlands a/	1.7 (0.7 ha)	1.7 (0.7 ha)	1.7 (0.7 ha)	13.3 ac (5.4 ha)	1.7 (0.7 ha)	1.7 (0.7 ha)	13.3 ac (5.4 ha)	6.4 ac (2.6 ha)	7.0 ac (2.8 ha)	7.0 ac (2.8 ha)
Loss of wetland function	No	No	No	No	No	No	No	No	No	No
Areas of potential cultural sensitivity crossed	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
Land Use Characteristics b/										
Land Use, Percent Developed Land	98%	98%	98%	93%	98%	98%	94%	88%	8%	69%
Land Use, Percent Emergent Herbaceous Wetlands	0%	0%	0%	3%	0%	0%	2%	4%	1%	1%
Land Use, Percent Open Water	1%	1%	1%	1%	1%	1%	1%	1%	91%	30%
Land Use, Barren Land (Rock/Sand/Clay)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%
Land Use, Percent Developed Open Space	1%	1%	1%	0%	1%	1%	0%	1%	0%	0%
Land Use, Grassland/Herbaceous	0%	0%	0%	2%	0%	0%	2%	3%	0%	0%
Land Use, Woody Wetlands	0%	0%	0%	1%	0%	0%	1%	1%	0%	0%
Technological and Logistical Factors										
Expected onshore infrastructure congestion	Moderate	Moderate	High	High	High	High	High	High	Low	Low
Number of railroad crossings	1	1	1	3	1	1	1	3	1 c/	1
Cable route easement/permit risk	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	High

Assessment Criteria	LIRR Corridor Route Alternatives		Long Beach Road Corridor Route Alternatives		Austin Boulevard/Industrial Place Corridor Route Alternatives				Submarine Cable Route Alternatives	
	Full LIRR (Proposed)	LIRR to Parente Lane	Long Beach Road/LIRR	Long Beach Road to Daly Boulevard	Industrial Place to LIRR	Austin Boulevard	Industrial Place to Daly Boulevard	Industrial Place to E.F. Barrett	Submarine Interconnection Cable Route	LIRR to In-Water
Number of abutters	Moderate	Moderate	High	High	High	High	High	High	Low	Low
Expected stakeholder considerations	Moderate	Moderate	High	High	High	High	High	High	Low	Low
Noise impacts	Moderate	Moderate	High	High	High	High	High	High	Low	Low
Traffic impacts	Moderate	Moderate	High	High	High	High	High	High	Low	Low
Commercial Factors										
Easement acquisition risk	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Low	Moderate
Practicable (Technology/Cost/Logistics)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Least Environmentally Damaging Practicable Alternative	Yes	Yes d/	No	No	No	No	No	No	No	No

Notes
a/ based on a 100 ft corridor for each route alternative. However, the crossing along the proposed route is a cable bridge, which will minimize in-water impacts. NYSDEC acreage does not include mapped Littoral Zone (LZ) or adjacent area (AA).
b/ 2016 National Land Cover Dataset (NLCD): Land Cover Conterminous United States (Dewitz 2019).
c/ this includes the crossing under the LIRR bridge within Reynolds Channel.
d/ this route is practicable and environmental impacts are equivalent to the proposed alternative, but it is not preferred for logistical reasons.

3.5.3.1 LIRR Corridor Interconnection Cable Route Alternatives

The LIRR corridor interconnection cable route alternatives (**Figure 3.5-3**) are routed parallel to, alongside or within the LIRR right-of-way for the majority of the length of the interconnection cable route from the onshore substation to the POI, with certain variations. Both of these route alternatives cross Barnums Channel via a proposed cable bridge (Section 3.5.4) immediately to the west of the existing LIRR bridge across the channel.

Full LIRR Alternative (Proposed)

The full LIRR Alternative for the interconnection cable route is approximately 1.7 mi (2.8 km). This route travels north, crossing the LIRR with horizontal auger bores near Warwick Road and continues along the LIRR corridor. The route stays parallel to the LIRR corridor as it enters the public right-of-way around the cul-de-sac of Parente Lane North, continuing north to traverse D'Amato Drive. The route crosses Long Beach Road before entering North Nassau Lane and paralleling the LIRR corridor. Along the LIRR corridor, the proposed interconnection cable route crosses Barnums Channel for approximately 300 ft (91 m) on the west side of the LIRR bridge, and then continues north across Daly Boulevard until it enters the POI.

The considerations for the full LIRR alternative are similar to the LIRR to Parente Lane Alternative below. This route is sited predominantly within or alongside the LIRR right-of-way, which has the advantage of reducing in-street construction and associated disruption to the community from traffic impacts and street closures. The LIRR right-of-way has sufficient space for joint bay siting and reduces cable bends. It also reduces the conflicts with utility congesting along roadway rights-of-way, and potential need for utility relocations, which reduces the duration of construction activities. The LIRR right-of-way is also one of the most direct and shortest routes from the onshore substation to the POI.

Crossing Barnums Channel adjacent to the LIRR bridge provides the best alternative for minimizing impacts to tidal wetlands and within the tidal channel itself (see Section 3.5.4). Since the north and south sides of the crossing comprise an existing parking lot and a tank farm, respectively, impacts to wetlands and natural habitats on either side of the crossing are avoided. Even in the case of an open cut crossing, crossing adjacent to the existing LIRR crossing is expected to result in a smaller footprint of disturbance to tidal wetlands than the open cut for other routes evaluated.

Based on the Empire's assessment, which indicates that this route reduces construction complexity and space constraints and largely avoids the traffic impacts of construction activities and road closures along heavily-trafficked portions of public roadways, the Full LIRR Alternative is practicable and the proposed alternative for the interconnection cable route. Construction along the LIRR corridor will require close coordination with the railroad on requirements within the right-of-way.

LIRR to Parente Lane Alternative

The LIRR to Parente Lane Alternative for the interconnection cable route is approximately 1.8 mi (2.9 km). From the onshore substation site, the route travels north, crossing the LIRR with horizontal auger bores in the parking lots of LIRR Island Park Station. The route continues in the west side of the LIRR right-of-way until entering Parente Lane North, bearing west before a slight turn north on Kildare Road. The route connects to Long Beach Road, heads north onto North Nassau Lane, then parallels the west side of the railroad, adjacent to an existing tank farm. Along the LIRR corridor, the interconnection cable route crosses Barnums Channel for approximately 300 ft (91 m) on the west side of the LIRR bridge. From the north side of Barnums Channel this alternative continues within the LIRR right-of-way north across Daly Boulevard until it enters the POI.

This route is sited predominantly within the LIRR right-of-way, which has the advantage of reducing in-street construction and associated disruption to the community from traffic impacts and street closures. The LIRR right-of-way has sufficient space for joint bay siting and reduces cable bends. It also reduces the conflicts with utility congesting along roadway rights-of-way, and potential need for utility relocations, which reduces the duration of construction activities. The LIRR right-of-way is also one of the most direct and shortest routes from the onshore substation to the POI. This route avoids a narrow area of the LIRR right-of-way between Parente Lane and the E.F. Barrett Station property, by routing into public rights-of-way along Parente Lane, Kildare Road, and Long Beach Road, as well as private property.

Crossing Barnums Channel adjacent to the LIRR bridge provides the best alternative for minimizing impacts to tidal wetlands and within the tidal channel itself (see Section 3.5.4). Since the north and south sides of the crossing comprise an existing parking lot and a tank farm, respectively, impacts to wetlands and natural habitats on either side of the crossing are avoided. Even in the case of an open cut crossing, crossing adjacent to the existing LIRR crossing is expected to result in a smaller footprint of disturbance to tidal wetlands than the open cut for other routes evaluated.

Based on the Empire's assessment, which indicates that this route reduces construction complexity and space constraints and largely avoids the traffic impacts of construction activities and road closures along heavily-trafficked public roadways, the LIRR to Parente Lane Alternative is a practicable alternative for the interconnection cable route. Due to logistical considerations of routing along Parente Lane, traffic along Long Beach Road, and additional tight cable bends, this route is not proposed.

3.5.3.2 Long Beach Road Interconnection Cable Route Alternatives

The two Long Beach Road corridor interconnection cable route alternatives share a section of the cable route, which crosses most of the Village of Island Park along Long Beach Road. These cable route alternatives diverge for the northernmost portion of the route, with different crossing locations for Barnums Channel.

Long Beach Road/LIRR Alternative

The Long Beach Road/LIRR Alternative for the interconnection cable route is approximately 1.8 mi (2.9 km). The route leaves the onshore substation site heading northeast within the parking lot adjacent to the LIRR tracks then crossing the LIRR with horizontal auger bores in the parking lot of LIRR Island Park Station. The route continues up Long Beach Road to North Nassau Lane, then parallels the west side of the railroad, adjacent to an existing tank farm. Along the LIRR corridor, the interconnection cable route crosses Barnums Channel for approximately 300 ft (91 m) on the west side of the LIRR bridge (similar to the proposed alternative, Section 3.5.3.1), and then continues north across Daly Boulevard until it enters the POI.

The Long Beach Road/LIRR Alternative is relatively narrow (approximately 35 ft [11 m]), which poses logistical challenges for installation of the interconnection cables and joint bay siting, and potentially increases conflicts with existing utility congestion. Installation of the interconnection cables within Long Beach Road is challenging because Long Beach Road represents the only access to Barnum Island from the Long Island mainland and is one of only three routes to the Long Beach barrier island in general. It is the main route serving the central portion of the barrier island, including densely developed areas of the City of Long Beach. In this area, the average annual daily traffic is 45,688. As such, road closures and/or traffic impacts along this corridor for construction of the Project are likely to result in significant impacts. Additionally, existing transmission lines are already present along Long Beach Road, which limits potential space for the installation of the interconnection cables.

The Long Beach Road/LIRR Alternative is a practicable alternative for the interconnection cable route but has additional construction complexity and traffic impacts associated with construction along Long Beach Road in comparison to the proposed alternative.

Long Beach Road to Daly Boulevard Alternative

The Island Park to Daly Boulevard Alternative for the interconnection cable route is approximately 2.5 mi (4.1 km). This interconnection cable route alternative leaves the onshore substation site heading northeast within the parking lot adjacent to the LIRR tracks then crosses the LIRR with horizontal auger bores in the parking lot of the LIRR Island Park Station. The route connects to Long Beach Road and continues on Long Beach Road all the way to the Austin Boulevard intersection. It then continues across Barnums Channel in the vicinity of the bridge along Long Beach Road and turns west onto Daly Boulevard. The route then crosses the LIRR with horizontal auger bores and into the POI.

This route alternative involves several challenging crossings of the LIRR right-of-way: north of Island Park Station, along Long Beach Road between D'Amato Drive and Sherman Road, and along Daly Boulevard approaching the POI. Installation of the interconnection cables within Long Beach Road is challenging because the Long Beach Road bridge represents the only access to Barnum Island from the Long Island mainland and is one of only three routes to the Long Beach barrier island in general. It is the main route serving the central portion of the barrier island, including densely developed areas of the City of Long Beach. In this area, the average annual daily traffic is 45,688. The workspace needed for the LIRR crossing between D'Amato Drive and Sherman Road has the potential to result in temporary impacts to the egress/ingress to Barnums Island and the Village of Island Park for a more extended time. As such, road closures and/or significant traffic impacts along this corridor for construction of the Project are likely to result in unacceptable impacts.

This route alternative also crosses Barnums Channel along Long Beach Road. In this area, Barnums Channel is narrowed by the Long Beach Road bridge abutments to only approximately 100 ft (30 m). The Long Beach Road corridor approaching either side of the bridge is elevated, with tidal wetlands on either side. Cable installation within the existing road bridge may not be technically feasible and results in closure of the main ingress/egress to Barnum Island, which is considered impracticable. Empire therefore assumes that the Barnums Channel crossing along this corridor will need to occur alongside the Long Beach Road bridge. Since NYSDEC-mapped tidal wetlands are present to both the east and west of Long Beach Road in the vicinity of the bridge, any crossing solution (whether open cut, HDD or cable bridge) results in greater impacts to tidal wetlands than the proposed alternative. However, due to existing infrastructure, such as the bridge and bridge abutments, sufficient space for HDD is likely not available. A cable bridge solution in this location is expected to have greater impact to wetlands and visual impact than along the proposed route, since the surroundings along Long Beach Road lack the existing industrial infrastructure that is present along the proposed route. An open cut crossing could avoid impacts of new aboveground infrastructure along this corridor, and is assumed for this route, but will result in greater impacts to tidal wetlands than the proposed alternative.

Long Beach Road is relatively narrow (approximately 35 ft [11 m]), which poses logistical challenges for installation of the interconnection cables and joint bay siting, and potentially increases conflicts with existing utility congestion. There are also several tight bends for the interconnection cables along this route, which add construction cost and complexity. Additionally, Austin Boulevard is currently being redeveloped by Nassau County. In general, impacting recently restored roadways is discouraged by municipal and county agencies.

The Long Beach Road to Daly Boulevard Alternative is a practicable alternative for the interconnection cable route but is not proposed due to logistical complexity and environmental and traffic impacts associated with construction along Long Beach Road and the crossing of Barnums Channel.

3.5.3.3 Austin Boulevard/Industrial Place Interconnection Cable Route Alternatives

The Austin Boulevard/Industrial Place interconnection cable route alternatives follow the Austin Boulevard and/or Industrial Place corridors north of the onshore substation through unincorporated Barnum Island, east of the LIRR north-south corridor. From there, these cable route alternatives diverge for the northernmost portion of the route, with different crossing locations for Barnums Channel.

Industrial Place to LIRR Alternative

The Industrial Place to LIRR Alternative for the interconnection cable route is approximately 2.0 mi (3.2 km). The route leaves the onshore substation site heading northeast within the parking lot adjacent to the LIRR tracks. The route crosses Long Beach Road, travelling through the LIRR Island Park Station parking lot. The route enters Austin Boulevard, turns west onto Sagamore Road, then north onto Industrial Place. Industrial Place is taken until the end of the road, and then the route reconnects to Austin Boulevard. The route continues west onto Saratoga Boulevard and horizontal auger bores are required to cross underneath the LIRR tracks to Parente Lane. The route continues up Kildare Road to Long Beach Road to North Nassau Lane. From there, the route heads north crossing Barnums Channel for approximately 300 ft (91 m) on the west side of the LIRR bridge, and then continues north across Daly Boulevard until it enters the POI.

The Industrial Place to LIRR Alternative is routed partially along Austin Boulevard, which has significantly higher traffic volumes (38,078 average annual daily traffic) than Long Beach Road (11,684 average annual daily traffic). Industrial Place is relatively narrow (approximately 35 ft [11 m]), which poses logistical challenges for installation of the interconnection cables and joint bay siting, and potentially increases conflicts with existing utility congestion. There are also several tight bends for the interconnection cables along this route. Additionally, Austin Boulevard is currently being redeveloped by Nassau County. In general, impacting recently restored roadways is discouraged by municipal and county agencies.

Based on Empire's assessment, the Industrial Place to LIRR Alternative is a practicable alternative for the interconnection cable route but results in greater impact to heavily trafficked public roadways and additional construction complexity due to utility congestion and cable bends compared to the proposed route.

Austin Boulevard Alternative

The Austin Boulevard Alternative for the interconnection cable route is approximately 2.0 mi (3.1 km). This route is similar to the Industrial Place to LIRR Alternative, except that it does not deviate along Industrial Place but instead stays along Austin Boulevard until it reaches Saratoga Boulevard. From there, horizontal auger bores are required to cross underneath the LIRR tracks to Parente Lane. The route continues up Kildare Road to Long Beach Road to North Nassau Lane. From there, the route heads north crossing Barnums Channel for approximately 300 ft (91 m) on the west side of the LIRR bridge, and then continues north across Daly Boulevard until it enters the POI.

Routing along Austin Boulevard is challenging due to the high traffic volumes and logistical challenges for installation of the interconnection cables, joint bay siting, and conflicts with existing utility congestion. There are also several tight bends for the interconnection cables along this route. Austin Boulevard is currently being redeveloped by Nassau County, and general, impacting recently restored roadways is discouraged by municipal and county agencies.

The Austin Boulevard Alternative is a practicable alternative for the interconnection cable route but results in greater impact to heavily trafficked public roadways and additional construction complexity due to utility congestion and cable bends compared to the proposed route.

Industrial Place to Daly Boulevard Alternative

The Industrial Place to Daly Boulevard Alternative for the interconnection cable route is approximately 2.5 mi (4.0 km). The Industrial Place to Daly Boulevard Alternative exits the onshore substation routing northeast, crossing Long Beach Road and travelling through the LIRR parking lot. The route exits onto Austin Boulevard, turns west onto Sagamore Road, then onto Industrial Place. Industrial Place is taken until the end of the road, and then the route reconnects to Austin Boulevard. The route continues north to Long Beach Road and crosses Barnums Channel, turns west onto Daly Boulevard, crosses the LIRR with horizontal auger bores and into the POI.

As described in Section 3.5.3.2 for the Long Beach Road to Daly Boulevard Alternative, this route also crosses Barnums Channel along Long Beach Road. In this area, Barnums Channel is narrowed by the Long Beach Road bridge abutments to only approximately 100 ft (30 m). The Long Beach Road corridor approaching either side of the bridge is elevated, with tidal wetlands on either side. Cable installation within the existing road bridge may not be technically feasible, and results in closure of the main ingress/egress to Barnum Island, which is considered impracticable. Empire therefore assumes that the Barnums Channel crossing along this corridor will need to occur alongside the Long Beach Road bridge. Since NYSDEC-mapped tidal wetlands are present to both the east and west of Long Beach Road in the vicinity of the bridge, any crossing solution (whether open cut, HDD or cable bridge) results in greater impacts to tidal wetlands than the proposed alternative. However, due to existing infrastructure, such as the bridge and bridge abutments, sufficient space for HDD is likely not available. A cable bridge solution in this location is expected to have greater impact to wetlands and visual impact than along the proposed route, since the surroundings along Long Beach Road lack the existing industrial infrastructure that is present along the proposed route. An open cut crossing could avoid impacts of new aboveground infrastructure along this corridor, and is assumed for this route, but will result in greater impacts to tidal wetlands than the proposed alternative.

Long Beach Road and Industrial Place are each relatively narrow (approximately 35 ft [11 m]), which poses logistical challenges for installation of the interconnection cables and joint bay siting, and potentially increases conflicts with existing utility congestion. There are also several tight bends for the interconnection cables along this route, which add construction cost and complexity. This route is also partially located along Austin Boulevard, which has significantly higher traffic volumes than Long Beach Road. Additionally, Austin Boulevard is currently being redeveloped by Nassau County. In general, impacting recently restored roadways is discouraged by municipal and county agencies.

The Industrial Place to Daly Boulevard Alternative is a practicable alternative for the interconnection cable route but is not proposed due to logistical complexity and environmental and traffic impacts associated with construction along Long Beach Road and the crossing of Barnums Channel.

Industrial Place to E.F. Barrett Alternative

The Industrial Place to E.F. Barrett Alternative for the interconnection cable route is approximately 2.2 mi (3.6 km) long. The route leaves the onshore substation site heading northeast within the parking lot adjacent to the LIRR tracks. The route crosses Long Beach Road, travelling through the LIRR Island Park Station parking lot. The route enters Austin Boulevard, turns west onto Sagamore Road, then north onto Industrial Place. Industrial Place is taken until the end of the road, and then the route reconnects to Austin Boulevard. The route continues west onto Saratoga Boulevard and horizontal auger bores are required to cross underneath the LIRR tracks to Parente Lane. From there, the Industrial Place to EF Barrett goes north along D'Amato Drive to Long Beach Road, and crosses back to the east across the LIRR tracks. The route then immediately turns northwest onto Ladomus Ave, continuing across private property to the east of the E.F. Barrett Power Station. From there, the interconnection cable route crosses Barnums Channel for approximately 300 ft (91 m). Although unmapped, tidal wetlands are expected to be present on both the south and north side of Barnums Channel, approaching Daly Boulevard, before it turns west along Daly Boulevard to the POI. NYSDEC-mapped tidal wetlands are present immediately to the east of the crossing location, south of Daly Boulevard.

This route alternative involves several challenging crossings of the LIRR right-of-way: between Saratoga Boulevard and Parente Lane, along Long Beach Road between D'Amato Drive and Sherman Road, and along Daly Boulevard approaching the POI. Installation of the interconnection cables within Long Beach Road is challenging because the Long Beach Road bridge represents the only access to Barnum Island from the Long Island mainland and is one of only three routes to the Long Beach barrier island in general. It is the main route serving the central portion of the barrier island, including densely developed areas of the City of Long Beach. In this area, the average annual daily traffic is 45,688. The workspace needed for the LIRR crossing between D'Amato Drive and Sherman Road has the potential to result in temporary impacts to the egress/ingress to Barnums Island and the Village of Island Park for a more extended time. As such, road closures and/or significant traffic impacts along this corridor for construction of the Project are likely to result in unacceptable impacts.

Crossing Barnums Channel within the private property to the east of the E.F. Barrett Power Station is expected to result in the greatest impact to tidal wetlands. Tidal wetland may be located adjacent to either side of the crossing in this area. Moreover, construction of an HDD crossing of Barnums Channel is constrained by the presence of the existing power station infrastructure and may not be feasible; if determined possible, such a crossing is expected to require HDD workspace and pull back area within the mapped tidal wetlands south of Daly Boulevard. An open cut crossing is practicable and assumed for this crossing location. Empire also anticipates commercial challenges for obtaining an easement across the property in this area and the potential for routing conflicts with existing infrastructure on the E.F. Barrett property.

Based on the logistical challenges and increased cost and complexity due to the LIRR crossings, the potential challenge of obtaining easements, and impacts along highly-trafficked roadways, Empire determined the Industrial Place to E.F Barrett Alternative is not a practicable alternative for the Project. This route is also expected to result in greater impacts to tidal wetlands than the proposed alternative and associated regulatory challenges.

3.5.3.4 Submarine Interconnection Cable Route Alternatives

Empire also considered submarine export cable routes from the onshore substation to the POI, including:

- A 2.4 nm (2.7 mi, 4.4 km) route that exits the onshore substation to the west in Reynolds Channel, continuing north around Harbor Island and north through Hog Island Channel to the POI; and
- A shorter in-water route that would follow one of the north-south corridors onshore (LIRR, Austin Boulevard or Long Beach Road) to Saratoga Boulevard/Parente Lane/Redfield Road, and then enter the water at the end of Redfield Road, continuing north through Hog Island Channel to the POI.

Either submarine route from the onshore substation to the POI would result in increased impacts within the marine environment compared to other alternatives evaluated. Both of the submarine export cable routes would be at least partially located within the Significant Coastal Fish and Wildlife Habitat designated by the New York Department of State in West Hempstead Bay, considered one of the largest undeveloped coastal wetland systems in New York State, with a significant nesting habitat for coastal shorebirds and colonial wading birds, as well as being a productive area for marine finfish, shellfish, and other wildlife (NYSDOS 2008b). Moreover, similar to routes evaluated in Reynolds Channel (see Section 3.5.2), construction of a submarine export cable route through Hog Island Channel has disadvantages for constructability, associated with shallow waters, special construction techniques required, and existing marine traffic.

3.5.4 Barnums Channel Crossing Alternatives

Empire evaluated three different crossing methods for Barnums Channel, including:

- An HDD installation of the cables belowground;
- And open cut installation of the cables belowground; and
- An aboveground cable bridge.

These alternatives are discussed in this section.

3.5.4.1 HDD

An HDD solution at Barnums Channel would involve three land-to-land HDDs similar to those described for the proposed Reynolds Channel crossing (see Section 3.5.2) but over a shorter crossing distance. Empire determined that use of the HDD installation method is not practicable along the LIRR corridor, due to the lack of sufficient space on the south side of the crossing (at the tank farm) to stage HDDs for all three cables, and the lack of an alignment that would allow a sufficient separation distance between each of the three HDDs. Foundations of unknown depth associated with the tank farm, retaining walls on either side of Barnums Channel, and the bridge footings also pose space and alignment constraints, adding risk to the feasibility and safety of completing the HDDs in this area. Moreover, both sides of the crossing are areas that historically housed fuel oil storage facilities; therefore, there is the potential that HDDs would involve drilling through contaminated soils and/or groundwater on either side of the crossing, as well as a previously remediated area on the north side of the crossing.

3.5.4.2 Open Cut

As described in Section 3.3.1 for the export cable landfall, an open cut requires Empire to excavate, remove, and/or relocate sediment to install the interconnection cables in a trench across the tidal channel at the target burial depth. For a waterway crossing, an open cut is typically constructed using excavators working from both banks and/or within the channel, as necessary. Excavated material is collected in an appropriate manner for either re-use or disposal (depending on the nature of the material) and in accordance with applicable regulations.

An open cut crossing allows the cable to be buried below the waterway, with no aboveground structures or permanent fill within Barnum's Channel. However, installation via an open cut will require more extensive disturbance to the channel for dredging, excavation, and stockpiling, within an approximately 120 ft (37 m) construction corridor across the channel. Sediments within Barnums Channel may have existing contamination, due to the location near industrial properties and known discharges in the vicinity.

An open cut installation would result in greater disturbance to Barnums Channel; therefore, Empire is proposing the aboveground cable bridge solution at this location. In the case that further feasibility evaluation reveals that a cable bridge is not feasible for this crossing, Empire would evaluate installation of the interconnection cables via an open cut with a dry crossing method. A dry crossing method involves isolating the work area from the flow of water (with sandbags, bladderdam, cofferdam, or other measures) prior to trenching, and using a dam-and-pump, flume, or similar design to transport water from one side of the work area to the other. Dry crossings minimize the transport of sediment during an open cut by preventing water from flowing across the disturbance area until the bed and backs have been restored. In the case that a dry crossing is also not feasible, a wet crossing would be used, and Empire would consider the potential efficacy of alternative best management practices to minimize sediment transport (e.g., silt curtains).

3.5.4.3 Cable Bridge

A cable bridge crossing will use up to four support columns (pile caps) located within the waterway to support the truss system which will hold the cables above the water. These supports may be installed by hammer or other installation methods, up to 100 ft (30 m) below the seabed, with final design subject to geotechnical investigation. These supports will include up to three 1.5-ft (0.5-m)-diameter steel pipe piles per pile cap, for a total of twelve steel pipe piles within the waterway. The cable bridge will be constructed from a prefabricated steel truss system assembled offsite and set in place and the structure will measure up to 25 ft (7.6 m) wide and 8 ft (2.4 m) tall and span a length of approximately 300 ft (91 m). The crossing will be located adjacent to the existing LIRR railway bridge. The structure is anticipated to have a total height of up to 15 ft (4.6 m) above MSL, with a maximum total height of 30 ft (9.1 m). Empire is also further evaluating whether it is practicable to design the cable bridge without footings.

Since the north and south sides of the crossing comprise an existing parking lot and a tank farm, respectively, impacts to wetlands and natural habitats on either side of the crossing are avoided. The above ground cable bridge presents the best solution to span the waterway and avoid trenching or drilling through the existing bulkheads and potentially contaminated soils/groundwater that may exist to the north and south of the crossing. As such, Empire selected the aboveground cable bridge solution as the practicable alternative that minimizes environmental impacts.

3.6 Technology Alternatives

3.6.1 Foundation Alternatives

Empire evaluated several potential types of foundations for wind turbines and offshore substation: monopile, piled jacket, gravity base structure (GBS), suction bucket jacket, suction bucket monopile, and floating. Over the past several years, Empire has been evaluating the use of a GBS as a potential foundation for wind turbines to be deployed in the Lease Area, recognizing the potential of a GBS to avoid certain impacts to marine life (specifically, acoustic impacts from pile driving) from other foundation alternatives, such as monopiles or piled jacket foundations. Empire's evaluation of the GBS foundation alternative included consultation with experts across a spectrum of specialties, including design and construction engineering, acoustic engineering, marine mammal science, manufacturing process engineering, transportation logistics, procurement, permitting, and commercial contracting. Based on the evaluation, Empire has concluded that the GBS is not a practicable alternative for any wind turbine generator (WTG) foundations for EW 2, as stated in Section 3.6.1.1. Empire is instead proposing monopile foundations for the WTGs, and a piled jacket foundation for the offshore substation.

3.6.1.1 GBS

GBS foundations are strengthened concrete structures with a circular base fixed to a conical exterior and vertical concrete column. The vertical concrete column connects to a steel transition piece that holds secondary features (i.e. access platforms and boat landings) associated with deeper water sites. To support up to a 15-MW WTG, a GBS foundation would be approximately 118 ft (36 m) wide at the base, 210 ft (64 m) tall, and weigh up to 8,500 tons (7,711 metric tons). It would require approximately 10,000 tons (9,071 metric tons) of high-density aggregate to ballast down a GBS and would likely necessitate a considerable amount of scour protection when compared to a monopile foundation.

Structural integrity of the GBS foundation is dependent on stable and supportive seabed conditions. Weak horizontal seabed layers, which are commonly found in locations of sediment deposition (i.e., historic rivers and deltas), are not suitable for GBS foundations. Empire's geophysical and geotechnical survey campaigns of the Lease Area indicate much of the area contains thin layers of soft sediment and loose marine sand. The evaluation also indicates the Lease Area contains Glauconite, which is a highly friable sediment type that may degrade structural integrity under the cyclic loading (repeated application of a load) of a WTG and, therefore, cannot provide the necessary stability for GBS foundations.

Unsuitable seabed conditions necessitate seabed preparation prior to GBS installation. This process is necessary to ensure the wind turbine is adequately supported and involves a combination of dredging and backfilling with rock, adding an armor and filter layer above the mudline, and placing a gravel pad and scour protection on top of that. The dredging preparation would likely involve removing soft, uneven, or mobile sediments as well as a foundation bed of rock (or aggregate). By contrast, monopile foundations require no further seabed preparation after being piled into the ground and scour protection laid along the perimeter above the mudline. As such, GBS foundation installation involves seabed preparation and scour protection, which will disturb a larger area and result in greater impact to the marine environment and benthic resources when compared to impact from installation of the monopile foundation.

The primary advantage of the GBS foundations alternative is to avoid the pile driving into the sea floor that is required to install monopile foundation, and which generates acoustic energy potentially impactful to aquatic life. GBS foundations are transported and placed at the site without pile driving. However, the potential advantages of GBS foundations are offset by other negative environmental impacts. Empire's evaluation indicated there are higher overall carbon dioxide (CO_2) emissions associated with use of the GBS foundations

(Empire's evaluation estimated approximately 4,500 [4,082 metric tons] tons per foundation for GBS, compared to approximately 2,300 tons [2,086 metric tons] per foundation for monopile foundations). This is mostly due to much higher emissions from installation of the GBS foundation. GBS foundation transportation would also result in more marine traffic impacts (GBS foundations must be transported individually, unlike other foundation types).

Logistical challenges are also a consideration for GBS foundations. Since there are currently no GBS manufacturers in the United States, a fabrication site for the foundations is required. Empire would also need to develop its own supply chain to fabricate, transport, and install the GBS foundations. Empire would be entirely responsible for establishing the supply chain, skilled workforce, and adequate quality control. Empire identified Port of Coeymans (near Albany, New York) as a potential fabrication site, but determined it is impracticable due to associated upgrade costs, transportation and staging requirements, and logistics due to bridge height restrictions along the Hudson River. No other commercially viable options for the fabrication and supply chain for GBS foundations were identified.

After evaluation, Empire determined that the costs, logistical challenges, and commercial risks of GBS foundations render the alternative impracticable and would restrict Empire's ability to meet contractual commitments with New York and achieve the Project purpose (see Section 3.1). Moreover, the GBS foundations would cause greater potential environmental impacts to the seafloor due to a larger footprint, to air emissions from increased CO_2 emissions, and to navigation/marine traffic, which outweigh the benefits of GBS foundations in reducing the potential temporary acoustic impacts to marine wildlife during construction.

3.6.1.2 Monopile

Monopile foundations consist of a single vertical, broadly cylindrical steel pile driven into the seabed. A steel transition piece, which contains secondary structural components, cable hang-offs and material handling equipment for the WTG (i.e., boat landings, internal access platforms with cable hang-offs, external work platform equipped with gates and crane for equipment transfer from crew transfer vessels (CTVs)), will be connected to the monopile by bolting (see **Attachment B** Permit Drawings). The transition piece will also contain the Navaid equipment such as marine lanterns, foghorn, and AIS.

While a piled solution (monopile or piled jacket) for a wind turbine or offshore substation may not require the same level of ground preparation for installation as GBS, drivability relevant to geotechnical conditions need to be considered. Empire has completed an initial drivability assessment to confirm feasibility and has included contingent locations within the conceptual layout.

Empire's evaluation indicated that CO_2 emissions and seabed impacts are lower with installation of monopile foundations than GBS foundations, as discussed in Section 3.6.1.1 Based on the monopile foundation's previous use in the United States, known technology and existing supply chain, and Empire's ability to meet contractual commitments with New York to achieve the Project purpose (see Section 3.1), monopile foundations were selected for the EW 2 wind turbine foundations.

3.6.1.3 Piled Jacket

A piled jacket is a vertical steel lattice structure consisting of three or four legs to support a wind turbine, or up to eight legs to support an offshore substation, from which piles are inserted and connected through cross-bracing (see **Attachment B** Permit Drawings).

The piled jacket foundation was selected for the offshore substation, since monopile foundations are not designed for and are not practicable to support the larger size/weight of the offshore substation (approximately 5,500 tons [5,000 metric tons]).

3.6.1.4 Suction Bucket Jacket

A suction bucket jacket is a vertical steel lattice structure consisting of three or four legs, which contain inverted bucket-like structures at the base, connected through cross-bracing. Suction bucket jackets were removed from additional consideration because the conditions in the Lease Area are not suitable. Suction bucket jackets are more typically appropriate for areas with characteristics that allow the buckets to achieve appropriate penetration and the proper soil-structure interaction for the jacket. Empire's geophysical and geotechnical survey data has demonstrated that the seabed sediment in most locations (0 to 33 ft [0 to 10 m] below surface) consists of loose marine sand, limiting the holding capacity of the buckets. As such, based on the technical constraints of suction bucket jacket foundations, they are not a practicable alternative to meet the Project purpose.

3.6.1.5 Suction Bucket Monopile

A suction bucket monopile is a single vertical, broadly cylindrical steel monopile, which contains a single inverted bucket-like structure at the base. Suction bucket monopiles were also deemed not to be technically or commercially feasible for the development timescales associated with this Project and are therefore not a practicable alternative to meet the Project purpose.

3.6.1.6 Floating

This alternative uses a floating structure, typically a spar or semi-submersible, which is tethered to the seafloor through a set of anchoring devices. Floating foundations are used for installations at much deeper water depths than are present in the Lease Area. Floating foundations are not considered practicable for the Project because the water is not deep enough to justify the additional costs and engineering considerations.

3.6.2 Submarine Export Cable Technology Alternative

Empire evaluated different transmission technologies for the submarine export cables against the following criteria:

- Transmission distances;
- Economic considerations; and
- Land required to support onshore electrical facilities.

The submarine export cables are designed to use HVAC rather than HVDC due to the considerably lower costs to interconnect HVAC into the alternating current terrestrial grid at the Barrett 138-kV Substation. HVDC requires a considerably larger investment with greater complexity, significantly larger offshore and onshore space requirements, and higher maintenance needs than HVAC due to the need for converter stations onshore and offshore. HVDC becomes more cost-effective for wind farms with a larger nameplate capacity than is planned for the EW 2 Project, in part because HVDC may allow a reduction in the number of export cables for larger projects. This may also be preferable for long transmission lines carrying very large power capacities where HVDC reduces transmission losses relative to HVAC. The transmission distance and power rating of the EW 2 Project submarine export cables makes it suitable and more cost-effective to employ an HVAC system.

3.6.3 Submarine Export Cable Installation Alternatives

Empire also evaluated several alternative methods for cable installation offshore, including cable burial and direct placement on the seafloor. Empire is proposing to bury the submarine export cables using jetting, mechanical plow and trenching/cutting. Dredging or mass flow excavation are not proposed for cable burial in general, but may be required in certain locations, such as for pre-sweeping and seabed preparation activities prior to cable lay, and at certain asset crossings.

Placement of the submarine export cables directly on the seafloor as the primary installation method was determined to be not practicable due to the heightened risk of third-party damage to the cables and increased maintenance requirements from anchor or fishing gear snagging. Although direct seafloor disturbance from jetting or trenching during construction would be avoided with this method, the additional cable protection measures required to minimize third-party damage would result in a much larger footprint alteration of the seabed surface and long-term impact to the benthos. Additional cable protection requirements would also likely offset the installation time savings from placing cables on the seafloor instead of burying them. As such, Empire has retained placement of the cables directly on the seafloor, with cable protection (such as rock berm or matting) only for limited areas where sufficient burial depths cannot be achieved due to seabed conditions.

For cable burial, Empire assessed a variety of methods including jet plow, mechanical plow, trenching/cutting, and dredging. Both jetting and mechanical plowing may create a temporary trench and lay the cable in a single pass. 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. The water sufficiently liquifies the sediments such that the cable can then settle down through the suspended sediments to the desired burial depth. Mechanical plowing uses a 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. Due to gravity, the displaced sediment returns to the furrow, covering the cable.

Jetting methods (including capjet, jet sled, jet plow, and vertical injector equipment) are considered Empire's primary proposed methods for cable installation. Jetting is the most efficient method of submarine cable installation that minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route. The majority of temporarily suspended sediments from jetting settle back in the trench naturally, reducing sedimentation impacts.

Empire also considered trenching, or cutting, which may be used on seabed containing hard materials not suitable for mechanical plowing or jetting, as the trenching machine is able to mechanically cut through the material using a chain or wheel cutter fitted with picks or teeth. Once the cutter creates a trench, the submarine export cable is laid into it, and typically backfill is mechanically returned to the trench using a backfill plow. This method is less preferred due to lower efficiency, longer installation duration, and greater potential impacts from the additional step of backfilling the trench. However, both mechanical plowing and trenching (cutting) are proposed as potential installation methods to be used in the event that Empire encounters seabed or depth conditions where jet plowing is not practicable or efficient. Pre-sweeping or pre-trenching may be associated with any of the considered cable burial methodologies.

Mechanical dredging was also assessed as a potential method for submarine cable installation. Dredging is used to excavate, remove, and/or relocate sediment from the seabed in order to increase water depth and alter existing conditions; this can be completed through clamshell dredging, suction dredging, and/or hydraulic dredging. Because of the greater duration and extent of sediment disturbance associated with dredging, this method is not practicable for the majority of the cable installation. Dredging, however, may be proposed for certain locations such as the potential use of a suction dredge or mass flow excavation in limited locations for pre-sweeping, seabed preparation activities and utility asset crossings.

3.6.4 Cable and Pipeline Crossing Alternatives

The submarine export cable route will cross existing in-service and out-of-service assets including potentially existing transmission cables and natural gas pipelines. Empire is proposing to install the submarine export cables across third-party assets using concrete or rock-filled mattresses or rock berm protection (see Section 2 of **Attachment D**). As described in Section 3.3.1.1, a water-to-water HDD was determined to be impracticable for crossing the Transco LNYBL. Other asset crossing methods considered are evaluated in this section.

A traditional asset crossing with crushed rock installation or a rock berm will consist of installation of rock at the base, cable lay, followed by another layer of rock protection over the top. Rock installation provides protection for the cable against anchor drags or other external impacts. This method results in approximately 6.5 ft (2 m) of shoaling on the seafloor. For certain crossings, Empire is also evaluating the use of traditional asset crossing measures protected with mattresses filled with either rock or concrete. Potential methods include either laying the cable directly on the seafloor with a protective mattress on top or laying the cable on top of a layer of protective mattress on the seafloor, and then adding a second protective mattress over the top of the cable. These solutions do not cause significant shoaling, resulting in a less than 3 ft (0.9 m) reduction in water depth. Removal of sediment at crossings of identified assets to facilitate installation may be conducted before the crossing installation to allow for sufficient burial of the submarine export cables and reduce the need for supplemental cable protection material or shoaling on the seabed. This method may not be feasible due to site-specific limitations on dredging in the vicinity of existing assets.

These asset crossing methods have been retained as practicable for use on a case-by-case basis at cable and pipeline crossings along the submarine export cable route. Where the submarine export cable route requires the crossing of assets, specific crossing designs will be developed and engineered. Cable crossing methodologies will be based on a variety of factors, including the type of asset to be crossed (i.e., material), the depth of the existing buried cable or pipeline, and whether the assets are in-service or out-of-service.

Empire also evaluated artificial reef and pipe-supported bridge crossing methods. An artificial reef concept would use an artificial reef structure as cable protection in lieu of the mattress or rock protection that would be employed for a traditional trenched asset crossing. However, Empire did not find examples of artificial reefs having been previously used for cable protection at asset crossings; therefore, the effectiveness of these structures is unknown. Because of the soft soils present at the locations of the existing cable and pipeline crossings, it was determined that a mattress foundation would likely need to be employed in combination with the artificial reef structures for sufficient support. The reef units also carry the risk of creating anchor snag points. Therefore, Empire determined that the use of an artificial reef in conjunction with asset crossings was not a practicable option for the Project.

A pile-supported bridging crossing would require driving piles to either side of the asset crossing, and significant trench dredging. Seabed impacts, as well as potential underwater noise impacts, would be greater than with the preferred solutions. This method is also more labor-intensive and costly than traditional crossing methods. It was therefore determined that a pile-supported bridge crossing is not a practicable solution for the Project.

Rock filled mattresses, concrete articulated mats and rock berm protection were determined to be practicable options for asset crossings, considering concerns such as hydraulics, scour, and anchor drag/impact. These methods therefore have been retained for case-by-case use at the cable and pipeline crossings along the submarine export cable route.

3.6.5 Pre-Sweeping and Dredging Alternatives

In certain limited areas of the submarine export cable siting corridor, where underwater megaripples and sandwaves are present on the seafloor, pre-sweeping may be necessary prior to cable lay activities. Pre-sweeping involves smoothing the seafloor by removing ridges and edges, where present. Empire evaluated a variety of pre-sweeping and dredging equipment for these activities. Methods evaluated include trailing suction hopper dredging (TSHD), hydraulic dredging/cutter suction dredging (CSD), mechanical dredging, and mass flow excavation. Based on its evaluation, Empire is proposing mass flow excavation as the primary method for pre-sweeping, subject to regulatory approvals.

3.6.5.1 Pre-Sweeping and Dredging Equipment Alternatives

The primary pre-sweeping method will involve using a mass flow excavator from a construction vessel to smooth excess sediment on the seafloor along the footprint of the cable lay. A mass flow excavator uses jets to disturb and displace the material below the excavator. This equipment is deployed from a self-propelled vessel, making excavation continuous and adaptable. This technology may also incorporate dynamic positioning, allowing the operator to set way points and plan sediment disturbance with a high degree of accuracy. This equipment often works in close proximity to existing subsea objects in support of cable burial operations.

A TSHD is a self-propelled vessel that digs, stores, and pumps dredged material. TSHDs are beneficial in long, spread out excavation areas since they can freely move with no wires or spuds. This equipment can cover miles of excavation each day and return to a dig area for a "clean up" or small touch ups to a profile relatively easyilyeasy. There is little to no support equipment needed for the dredge to dig, transport, and pump off/bottom dump material. However, active dig time may be reduced to accommodate other activities, such as sailing or disposal of materials.. A typical mid-sized hopper dredge in the United States would be expected to remove between 1 and 3 ft (0.3 and 0.9 m) of material vertically, across a width of 6-12 ft (1.8 to 3.7 m). After filling the hopper, which typically will hold between 2,300 to 6,000 cubic yards (1,760 to 4,590 cubic meters), the TSHD will transit to a disposal site and prepare for disposal.

A TSHD can be used for ocean placement of material; for bottom placement, the dredge opens several gates/doors or splits its hull on a central hinge to release all the material over 4 to 12 minutes, usually while moving slowly through the disposal area to clean out the hopper. If pumping a slurry (combined water and sediment) of the dredged material to an upland disposal or beach location, the vessel discharge pipe will be connected to a land-based pipe and the operator will pump the slurry until the hopper is reasonably cleaned out. On a beach, the water runs into the ocean as the sediment settles on the beach. During upland disposal, typically the sediment settles in planned cells and the excess water discharges through weir boxes. If dry aggregate is required, the dredge will overflow any excess water using skimmers in the hopper, then will usually also require additional time to dry out the material. After it is adequately dried, cranes and/or conveyors can be used to offload the hopper. However, this dry aggregate method results in exceptionally long cycle times, and is often not selected due to cost implications and significant duration. Once the material disposal is completed, the dredge will travel back to the excavation area and continue with the next load.

A hydraulic dredge/cutter suction dredge (CSD) is a vessel with a large rotating cutter head that disturbs material then sucks it up and uses an onboard pump to pump it either through a pipeline directly to a disposal location or to a barge. A CSD can dig sand, clay, and rock in some cases, and can pump this material further than a hopper dredge due to the pump size. However, it is not self-propelled, so anchors and wires or spuds are used for small moves, and tugs are used for large moves or anchor resets. Because of this traveling limitation, CSDs are typically not used for narrow (<100 feet) and/or low-face (<5 feet) dig areas. They are exceptionally good at removing large amounts and can be expected to disturb and pump 8 ft (2.4 m) or more of vertical material in one swing. If the dredge is close enough to the pump out location, a long pipeline can be run directly from dredge to disposal. The length of this pipeline can be upwards of 6 mi (9.6 km) if additional boosters are brought in; boosters are barges (or land-based stations) with large pumps that are strategically put in line to increase the velocity through the pipe. If the disposal area is too far for a continuous pipeline, the CSD can pump to a spider barge which will fill scows for transport to disposal. A spider barge is an anchored barge connected to the pipeline from which the material is pumped; it has several "arms" which open, close, raise, and lower to load material in scows based on the scow's location. This method of CSD to spider barge allows the continuous pumping of material to scows, which are then sailed to an offshore disposal, location pumped to some type of upland disposal, or brought to a facility to be unloaded with a bucket or conveyors if dry aggregate is needed.

A mechanical or bucket dredge consists of a barge with a bucket to move material. The dredge moves itself a few hundred feet using spuds or wires, but ultimately requires several tugs for large moves or anchor resets. Therefore, this equipment is beneficial for protected waters with a wider dig area, to limit the amount of forward movement required. Mechanical dredges also require scows to move the material to a disposal site since there is no pump or material storage onboard. Each bucket of material, typically 12 to 30 cubic yards (9.2 to 22.9 cubic meters), is put in a scow alongside the dredge. When the scow is full, a tug brings that loaded scow to a disposal area and a different tug replaces an empty scow alongside the dredge, pausing digging for 20 to 60 minutes for each scow change. If material is to be pumped to an upland disposal or beach, each scow will have to be brought alongside an "unloader." An unloader is a stationary vessel with a large pump that sucks material from the scowto a pipeline can run to a disposal cell or location on land. The unloader pumps slurry from the scow until it is relatively clean, then the scow makes its trip back to the dredging area. A less common, but available mechanical dredging method uses a high-powered backhoe to break up and load rock.

3.6.5.2 Pre-Sweeping and Dredging Equipment Alternatives Analysis

Use of a mass flow excavator for pre-sweeping activities (to smooth sandwaves and at utility crossings) is expected to be much shorter in duration than dredging using TSHD, CSD, or mechanical dredging equipment. The shorter duration will result in less physical presence of work vessels in the cable corridor, less interference with other marine activities and navigation, and reduced overall duration of disturbance to the seabed and the marine enviornment. The reduction in duration will also increase the likelihood of being able to complete submarine export cable installaiton activities within one construction season, which greatly reduces the duration of construction-related disturbances to the marine environment, including disturbances to marine wildlife and fisheries.

Due to the efficiency of the operation, the mass flow excavator can be used immediately prior to the cable installation, minimizing the potential for sediment build up between the time of the pre-sweeping operation and the cable installation due to seabed sediment mobility. A dredging operation would likely need to be conducted significantly in advance of the cable lay and burial operation, which would necessitate overdredging additional volumes to account for the seabed mobility in the interim, in order to ensure the correct depths and seabed conditions are present at the time of cable installation and burial.

Once the pre-sweeping acivitity is completed and the mass flow excavator moveed to a different location, the disturbed sediment is expected to settle out quickly. Dredging equipment may result in longer duration of suspended sediment impacts, both due to the increased duration of operations at a given location along the submarine export cable route, and because of impacts associated with managing dredged material, such as barge overflow, hopper barge decanting, and/or onshore dewatering activities that may be necessary prior to disposal, as described in Section 3.6.5.1. MFE has the potential to generate greater sediment resuspension lasting for a shorter duration.

Use of mass flow excavation eliminates the dredged material disposal associated with this pre-sweeping methodology. With dredging, Empire would need to excavate, manage and dispose of material dredged from construction, including management of decanting and dewatering activities. Disposal of the volumes of dredged material anticipated for pre-sweeping will involve a significant cost to the Project, and introduce added logistical complexity associated with the management, sampling and transportation of the dredged material. Moreover, for pre-sweeping at utility crossings, dredging equipment is expected to be impracticable and/or prohibited in certain locations due to the potential risk of impact to existing assets. Mass flow excavation can remove material surrounding an existing asset with reduced risk of damage from contact with dredging equipment.

In the case that mass flow excavation cannot be used due to regulatory requirements, Empire would likely use a TSHD to pre-sweep sandwaves. Although not preferred, the TSHD allows more efficient production for pre-sweeping sandwaves than other dredging methods due to the independent mobility of the equipment, and disposal options.

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