Empire Wind Farm and Offshore Export Cable

Essential Fish Habitat Assessment with NOAA Trust Resources

April 2023

For the National Marine Fisheries Service

U.S. Department of the Interior

Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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Abbreviations

AC	alternating current
APM	Applicant Proposed Mitigation
BACI	Before-After Control-Impact
BAG	Before-After Gradient
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
DAS/DVS	Distributed Acoustic/Vibration Sensing
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EMF	electromagnetic field
Empire Wind	Empire Offshore Wind, LLC
EW 1	Empire Wind 1
EW 2	Empire Wind 2
FDR	Facility Design Report
FIR	Fabrication and Installation Report
FMP	fishery management plan
HAPC	habitat areas of particular concern
HAT	high astronomical tide
HDD	Horizontal Directional Drilling
HRG	high-resolution geophysical
HVAC	high voltage alternating current
Lease Area	BOEM Renewable Energy Lease Area OCS-A 0512
LIRR	Long Island Rail Road
MAFMC	Mid-Atlantic Fishery Management Council
MBES	multibeam echo sounder
m/f	male/female
MLLW	mean lower low water
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEFMC	New England Fishery Management Council
NMFS	National Marine Fisheries Service
NWI	National Wetlands Inventory
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NY WEA	New York Wind Energy Area
OCS	outer continental shelf
OEC	Offshore Export Cable

OSS	offshore substation
O&M	Operations and Maintenance
PAM	Passive Acoustic Monitoring
POI	Point of Interconnection
SAV	submerged aquatic vegetation
SCADA	Supervisory Control and Data Acquisition
SBMT	South Brooklyn Marine Terminal
SEL	sound exposure level
sf	sub-female
SPI	sediment profile imagery
SPL	sound pressure level
SSS	side scan sonar
TSS	total suspended sediment
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
WTA	wind turbine area
WTG	wind turbine generator
YOY	young-of-year

Unit Abbreviations

℃	degrees Celsius
dB	decibels
dB RMS	root mean-square decibels
°F	degrees Fahrenheit
ft	feet
g	grams
Hz	hertz
kHz	kilohertz
kJ	kilojoules
km	kilometers
kV	kilovolts
$L_{E,\,24}$	cumulative sound exposure level, 24 hour equivalent
L_{pk}	peak sound exposure level
L_{rms}	root mean-square sound pressure level
m	meters
m^2	square meters
m^3	cubic meters
mG	milligauss
mg/L	milligrams per liter
mm	millimeters
mV/m	millivolts per meter
MW	megawatts
nm	nautical miles
ppt	parts per thousand
R_{max}	maximum range
µm	micrometers
$\mu m/s^2$	micrometers per second squared
µPa	micro Pascal
$\mu Pa^2 s$	micro Pascal squared second
µV/cm	microvolts per centimeter

1. Introduction

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)I to the Outer Continental Shelf Lands Act, which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 United States Code [USC] § 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM). On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) § 585.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires Federal agencies to consult with the Secretary of Commerce, through the National Marine Fisheries Service (NMFS), with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act," 16 U.S.C. § 1855(b)(2). This process is guided by the requirements of the Essential Fish Habitat (EFH) regulation at 50 CFR 600.905. BOEM will be the lead Federal agency for the consultation, and will coordinate with any other Federal agencies that may be issuing permits or authorizations for this project, as necessary, for one consultation that considers the effects of all relevant Federal actions, including in offshore and inshore coastal environments [e.g., issuance of permits by the U.S. Army Corps of Engineers (USACE)]. Pursuant to the MSA, each Fishery Management Plan (FMP) must identify and describe EFH for the managed fishery, and the statute defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity" 16 U.S.C. § 1853(a)(7) and § 1802(10). NMFS's regulations further define EFH adding, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The EFH final rule published in the Federal Register on January 17, 2002, defines an adverse effect as: "any impact which reduces the quality and/or quantity of EFH." The rule further states that an adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. The EFH final rule also states that the loss of prey may have an adverse effect on EFH and managed species. As a result, actions that reduce the availability of prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat may also be considered adverse effects on EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Empire Offshore Wind, LLC (Empire Wind) has submitted the draft Construction and Operations Plan (COP) for two wind farms that would be located in the New York Bight, known as Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2), and two Offshore Export Cables (OECs), collectively referred to hereafter as the Project, to BOEM for review and approval. Consistent with the requirements of 30 CFR 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Project and Empire Wind completes all studies and surveys defined in their site assessment plan. BOEM's renewable energy development process is described in the following section. Empire Wind is working with BOEM to address additional information needs to finalize the COP. This EFH assessment relies on the most current information available for the Project.

BOEM has responsibility as the lead federal agency to initiate an EFH consultation in compliance with the MSA prior to approval, approval with conditions, or disapproval of the COP for the Project. This report describes the Project and presents an assessment of the potential for the proposed construction, operation and maintenance, and conceptual decommissioning of the Project to adversely affect EFH and managed species.

BOEM is consulting on the proposed COP for the Project, as well as other permits and approvals from other agencies that are associated with the approval of the COP. Other co-action agencies for this project include the USACE. The USACE will adopt this EFH assessment for impacts resulting from the Proposed Action that are relevant to USACE permitting actions under Section 10 of the Rivers and Harbors Act of 1899 (33 USC § 403) and Section 404 of the Clean Water Act (33 USC § 1344).

This EFH assessment provides a comprehensive description of the Proposed Action, defines the Project Area, describes EFH and EFH species potentially impacted by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect EFH and EFH species. The activities being considered include approving the COP for the construction, operation, maintenance, and conceptual decommissioning of the proposed Project. A separate EFH consultation will be conducted for Project decommissioning.

2. Proposed Action

The Proposed Action includes up to 147 wind turbine generators (WTGs) with a nameplate capacity of up to 18 megawatts (MW) per turbine, two offshore substations (OSSs), a submarine transmission cable network connecting the WTGs (interarray cables) to the OSSs, five Offshore Export Cables (OECs) that will carry electricity from EW 1 and EW 2 to onshore substations, and an Operations and Maintenance (O&M) facility that will be located onshore at South Brooklyn Marine Terminal (SBMT) in New York. The WTGs, OSSs, and interarray cables will be located in BOEM Renewable Energy Lease Area OCS-A 0512 (Lease Area), part of the New York Wind Energy Area (NY WEA). The Lease Area is in federal waters of the OCS approximately 14 statute miles (22 kilometers [km]) south of Long Island, New York, and 19.5 statute miles (31.4 km) east of Long Branch, New Jersey. The WTGs will be supported by 31.5-foot (9.6-meter) to 36-foot (11 meter) diameter monopile foundations. The interarray cable networks for EW 1 and EW 2 will be 94 statute miles (152 km) and 113 statute miles (181 km) long, respectively. The EW 1 OEC route will be approximately 47 statute miles (75 km) long from the OSS to landfall, and the EW 2 OEC route will range from 30 to 33 statute miles (49 to 52 km) long from the OSS to landfall, depending on the landfall location.

The OECs are alternating current (AC) electric cable that will connect EW 1 and EW 2 to the mainland electric grid on Long Island. The EW 1 OEC The connection point for EW 1 would be located in Brooklyn, New York, and the connection point for EW 2 would be located in Oceanside, New York. The OECs includes both offshore and onshore segments. The OECs includes an offshore component located in federal waters (OEC – OCS) and a component located in New York State territorial waters (OEC – NYS).

The final design of the Proposed Action is currently in development. Empire Wind is considering the following WTG alternatives for EW 1 and EW 2:

- Up to 147 18-MW turbines mounted on 31.5-foot (9.6-meter) monopile foundations

- Up to 147 18-MW turbines mounted on 36-foot (11-meter) monopile foundations

Empire Wind is considering the following cables route alternatives for the OECs (Figure 2-1):

- EW 1 Gravesend Anchorage Area route
- EW 1 Ambrose Navigation Channel route
- EW 2 Landfall A: Riverside Boulevard, Long Beach, New York
- EW 2 Landfall B: Monroe Boulevard, Long Beach, New York
- EW 2 Landfall C: Lido West Town Park, Hempstead, New York
- EW 2 Landfall E: Corner of Laurelton Boulevard and West Broadway, Long Beach, New York

Project construction and operational components are summarized in Table 2-1 and described in the following sections.

2.1. Project Area

The Project area comprises the project footprint for the EW 1 and EW 1, OEC, and O&M facility and all areas affected by the construction and operation of these facilities, which includes coastal nearshore habitats on Long Island and adjacent New York State waters, Upper New York Harbor, and ocean habitats in the NY WEA on the OCS offshore of New York. The WTGs, OSSs, and inter-array cables would be installed in an approximately 65,458-acre (264.9-square kilometer [km^2]) Wind Turbine Area (WTA) within the Lease Area (Figure 2-1). Empire Wind 1 occupies the western 27,095 acres (109.7 km^2) of the WTA, and Empire Wind 2 occupies the eastern 38,363 acres (155.3 km^2) of the WTA.

Two export cable routes are currently being considered (Figure 2-1). The EW 1 OEC route would depart the WTA along its northwestern boundary and travel northwest to the landfall site at SBMT. The length of the EW 1 OEC route from the OSS to the landfall site would be approximately 47 miles (75 kilometers). The EW 2 OEC route would depart the WTA near the center of its northern boundary and travel north to one of four potential landfall sites on the south shore of Long Island. The length of the EW 2 OEC route from the OSS to the landfall site would range from 30 to 33 miles (49 to 52 kilometers), depending on the landfall location.

Table 2-1. Summary of EW 1, EW 2, and OEC construction and O&M effect mechanisms by design Alternative

Project Component	Design Element	Effect Mechanism	Measurement Parameter	Component	Options	Effect Measurement
WTG construction	Turbine selection/spacing	Installation disturbance area	Pile diameter at base	WTG monopile	31.5-foot (9.6-meter) monopile	31.5 feet (9.6 meters)
					36-foot (11-meter) monopile	36 feet (11 meters)
			Number of turbines			Up to 147
			Hub height above HAT			525 feet (160 meters)
			Minimum spacing			0.75 linear miles (1.20 km, 0.65 nautical miles)
			Array area			64,506 acres (26,105 hectares)
	Foundation installation	Habitat alteration, physical disturbance	Number of piles	WTG monopile	All	Up to 147 (1 per WTG)
				OSS pile	All	Up to 24 (up to 12 per OSS)
			Footprint area total (with scour protection)	WTG monopile	31.5-foot (9.6-meter) monopile	0.88 acres (0.36 hectares) per foundation
					36-foot (11-meter) monopile	0.92 acres (0.37 hectares) per foundation
				OSS monopile	8.2-foot (2.5-meter) pile	2.15 acres (0.87 hectares) per foundation
			Installation method	WTG monopile	All	5,500 kJ impact hammer, 40 strikes per minute, 3 hours per foundation
				OSS monopile	All	4,000 kJ impact hammer, 40 strikes per minute, 4.2 hours per foundation
			Underwater noise (approximate)	WTG monopile	31.5-foot (9.6-meter) monopile	SEL up to 200 dB re 1 $\mu Pa^2 * s$ @ 10 meters
					36-foot (11-meter) monopile	SEL up to 195 dB re 1 $\mu Pa^2 * s$ @ 10 meters
	Interarray cable construction	Physical disturbance, turbidity, entrainment	Installation method	All		Cable trenching/burial 6-feet (1.8-meters) depth
			Short-term to long-term disturbance			1,167 acres (472 hectares)
			Permanent habitat conversion (exposed cable protection)			58 acres (23.5 hectares)

Project Component	Design Element	Effect Mechanism	Measurement Parameter	Component	Options	Effect Measurement
	Construction vessels	Physical disturbance, noise	Number of vessels	All		18 vessels during construction of EW 1 18 vessels during construction of EW 2
			Anchoring disturbance	All		18 acres (7.3 hectares)
			Vessel noise	All		SPL 150 to 180 dB re 1 µPa for dynamically positioned vessels (BOEM 2014), SPL 177 to 188 dB re 1 µPa for large shipping vessels (McKenna et al. 2012), duration of construction
WTG operation		Operational EMF (interarray cable)	Transmission voltage	Interarray cable		66 kV
			Magnetic field			Buried cable at seabed: 21 mG Exposed cable at seabed: 65.1 mG
Offshore export cable	Export cable construction	Installation disturbance area	Total length	EW 1 route	Alternative C1	46.8 linear miles (75.3 km)
					Alternative C2	46.5 linear miles (74.8 km)
				EW 2 route	Landfall A	32.4 linear miles (52.1 km)
					Landfall B	31.6 linear miles (50.9 km)
					Landfall C	30.4 linear miles (48.9 km)
					Landfall E	32.6 linear miles (52.4 km)
			Installation method	All		Cable trenching/burial 6-feet (1.8-meters) depth
			Short-term to long-term disturbance	EW 1 route		368 acres (149 hectares)
				EW 2 route		360 acres (146 hectares)
			Area exposed to sedimentation > 3 mm	All		82 feet (25 meters) from trench centerline
			Permanent habitat conversion	EW 1 route		33 acres (13.4 hectares)
				EW 2 route		32 acres (13.0 hectares)
		Vessel traffic	Number of vessels	EW 1		18 vessels during construction
				EW 2		18 vessels during construction

Project Component	Design Element	Effect Mechanism	Measurement Parameter	Component	Options	Effect Measurement
			Anchoring disturbance	EW 1		9 acres (3.6 hectares)
				EW 2		9 acres (3.6 hectares)
			Vessel noise	All		SPL 150 to 180 dB re 1 µPa for dynamically positioned vessels (BOEM 2014), SPL 177 to 188 dB re 1 µPa for large shipping vessels (McKenna et al. 2012) , duration of construction
	Operation and maintenance	Operational EMF (export cable)	Transmission voltage	All		230 kV
			Magnetic field			Buried cable at seabed: 30 mG Exposed cable at seabed: 76.6 mG

dB = decibels
EMF = electromagnetic field
kJ = kilojoules
km = kilometers
kV = kilovolts
mG = milligauss
HAT = high astronomical tide
OSS = offshore substation
SEL = sound exposure level
SPL = sound pressure level
WTG = wind turbine generator
µPa = micro Pascals

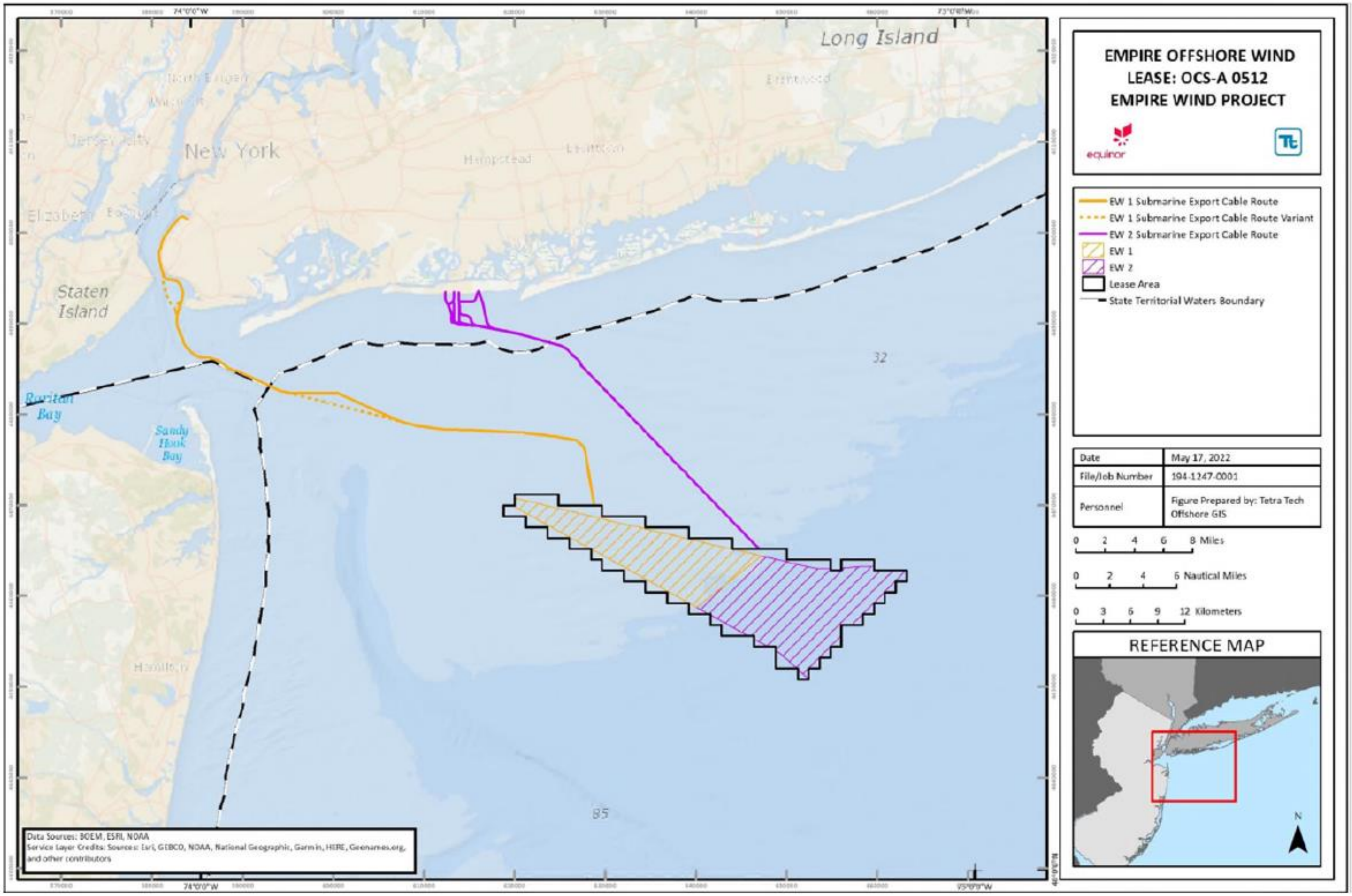

Figure 2-1. Project area overview (Lease Area and Offshore Export Cable Routes)

2.2. Construction and Installation

The construction of EW 1, EW 2, and the OECs would result in short-term and long-term impacts on aquatic habitats in the nearshore and offshore waters of the Mid-Atlantic OCS, and the nearshore estuarine waters of Upper New York Harbor where the proposed O&M facility is sited. Project construction methods and estimated quantities for each design alternative are described in the following section. The short-term and long-term impacts of project construction on the environment are quantified in Section 5.

The total number of construction days for each project component would depend on several factors, including environmental conditions, planning, construction and installation logistics. The general installation schedule is provided in Figure 2-2. This schedule is approximated based on several assumptions, including the estimated timeframe in which permits are received, anticipated regulatory seasonal restrictions, environmental conditions, planning, and logistics. The installation schedule includes both pile driving and non-pile driving activities.

2.2.1. Installation of WTG/OSS structures and foundations

The Proposed Action includes installation of up to 57 WTGs and 90 WTGs within the EW 1 and EW 2 proposed work areas, respectively, which would extend up to 951 feet (290 meters) above the water surface. Turbines would be oriented in a southwest-northeast direction within the 79,350-acre (321-km^2) Lease Area with minimum spacing of no less than 0.75 linear miles (1.2 km). Figure 2-3 depicts all of the potential WTG locations that may be selected under the Proposed Action. Figure 2-4 depicts the WTG locations that are most likely to be selected for the Proposed Action, which are the basis of the EFH impacts analysis presented in Section 5. The most likely WTG layout was developed in order to avoid glauconite soils identified from geotechnical and geophysical (G&G) survey data. The selected WTGs would be up to 18 MW and would be mounted on 31.6-foot (9.6-meter) to 36-foot (11-meter) tapered monopile foundations driven up to 180 feet (55 meters) into the seabed using an impact hammer deployed on a jack-up or heavy-lift barge. The final WTG layout and WTG foundation size will be determined by the FDR/FIR stage.

The Proposed Action includes installation of up to 10 OSSs between the EW 1 and EW 2 proposed work areas. Each OSS would be supported by a piled jacket foundation, a vertical steel lattice structure consisting of four or six legs connected through cross bracing, which is secured to the seabed through the installation of piles. Each foundation would consist of twelve 8.2-foot (2.5-meter) piles driven up to 197 feet (60 meters) into the seabed using the same construction methods. The OSSs connect the interarray cable network to the OEC transmission lines. Each WTG would contain up to 2,378 gallons of transformer oil, 317 gallons of hydraulic oil, and 1,057 gallons of gearbox oil. Use of other chemicals would include diesel fuel, coolants/refrigerants (872 gallons), grease (275 gallons), and sulfur hexafluoride (287 pounds). OSSs would hold up to 158,503 gallons of transformer oil, 7,925 gallons of diesel fuel, and 11,023 pounds of sulfur hexafluoride.

As summarized in Figure 2-2, above, installation of the EW 1 WTG foundations would occur from April through August 2025, installation of the EW 1 WTGs would occur from December 2025 through August 2026, and installation of the EW 1 OSS would occur in June 2025. Installation of the EW 2 WTG foundations would occur from September through November 2025 and again from April through December 2026, installation of the EW 2 WTGs would occur from December 2026 through November 2027, and installation of the EW 2 OSS would occur in July 2025 and again in May 2026. During this period, activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species.

2.2.1.1. Vessel activity

The construction and installation phase of the proposed Project would require both construction and support vessels to complete tasks in the Lease Area. Many vessels would remain in the Lease Area for days to weeks at a time, potentially only making infrequent trips to port for bunkering and provisioning as needed. During construction, Empire Wind will receive equipment and materials to be staged and loaded onto installation vessels at one or more existing third-party port facilities. Construction and installation activities may be based out of more than one port, and Empire has not yet finalized selection of construction ports, staging areas, and other factors. SBMT has been selected as a potential staging area for WTG components (e.g., blades, turbines, nacelles), foundation transition pieces, and other facility parts during construction of the WTGs. Construction activities would result in increased vessel traffic in SBMT and any other ports that are used. Global industry practices, such as temporary laydown areas and construction safety zones, would be followed during construction within the Lease Area.

Probable vessel classes used to install WTGs and OSSs, with their associated foundations, include heavy lift and derrick barges, jack-up barges, material transport barges, a jack-up crane work vessel, fall pipe vessels, transport and anchor handling tugs, and safety vessels. Monopile supply vessels would be used to transport monopile foundations, wind turbine supply vessels would be used to transport WTG components, and heavy transport vessels would be used to transport OSS topsides. Heavy lift vessels would be used for installation of the WTG and OSS foundations, wind turbine installation vessels would be used for installation of WTGs and fall pipe vessels would be used for installation of scour protection. Additional barges, and accompanying tugboats, may be used for transporting other construction materials. Crew transport vessels would be used to rotate construction crews to and from area ports, and small support vessels would be used for construction monitoring. Empire Wind estimates that approximately 18 vessels would be used for the construction of EW 1 and approximately 18 vessels would be used for the construction of EW 2.

Temporary seafloor disturbance may arise from wind turbine installation in the form of jack-up vessel footings or anchors from construction vessels. The seafloor disturbance associated with anchored or jack-up vessels would be up to 0.5 acres (0.2 hectares) per foundation. Installation of the OSS jacket foundations would require the use of transport vessels and heavy lift or jack-up vessels. Once the installation vessel is in place, the jacket foundation would be lifted from the vessel and lowered onto the seabed. The support piles would then be placed in the jacket structure and driven into the seabed. Jack-up vessels would result in a seabed disturbance of up to 0.5 acres (0.2 hectares) per jacket foundation.

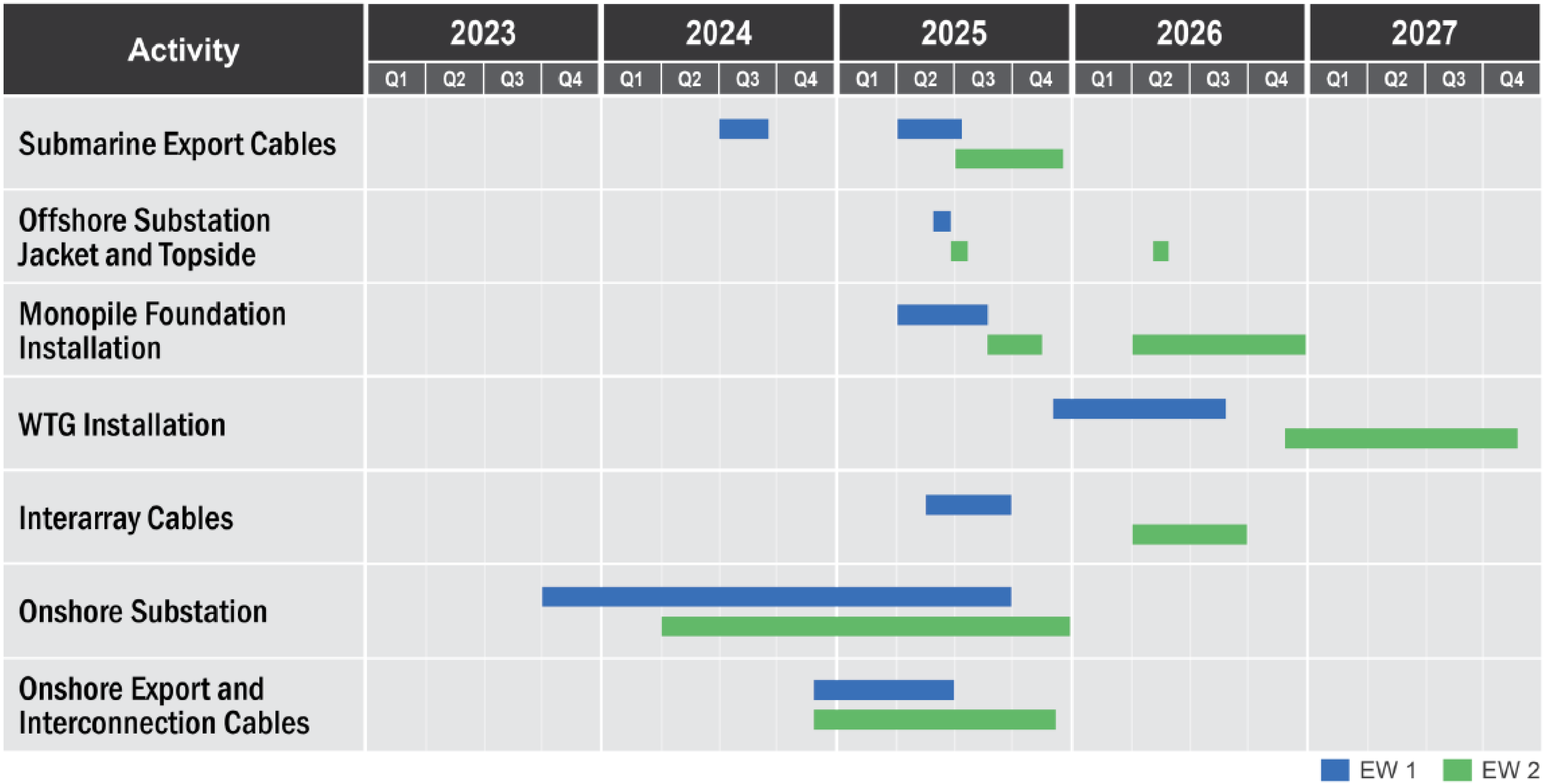

Figure 2-2. Anticipated construction schedule for EW 1, EW 2, and OECs

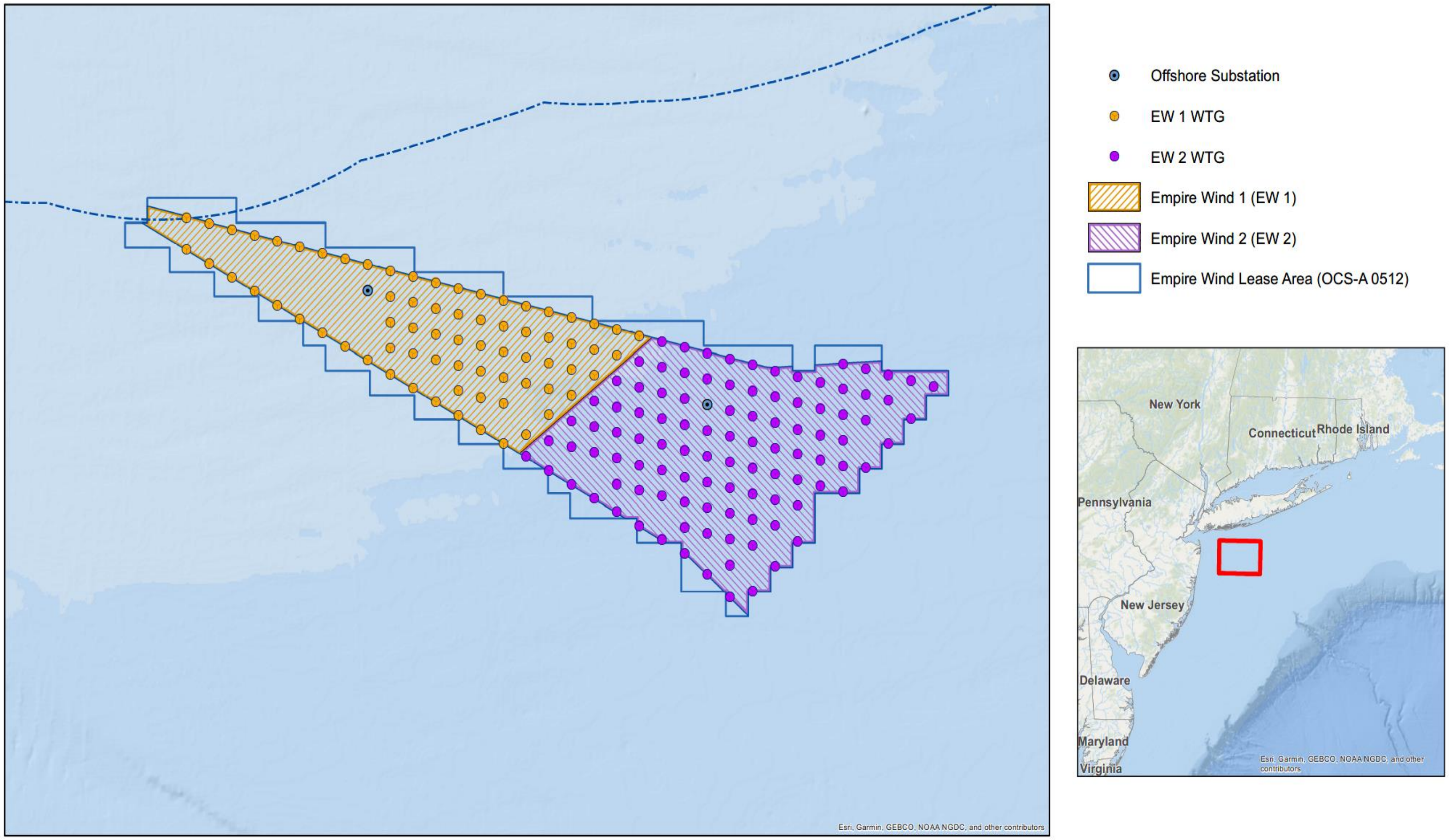

Figure 2-3. Proposed Action potential WTG and OSS positions

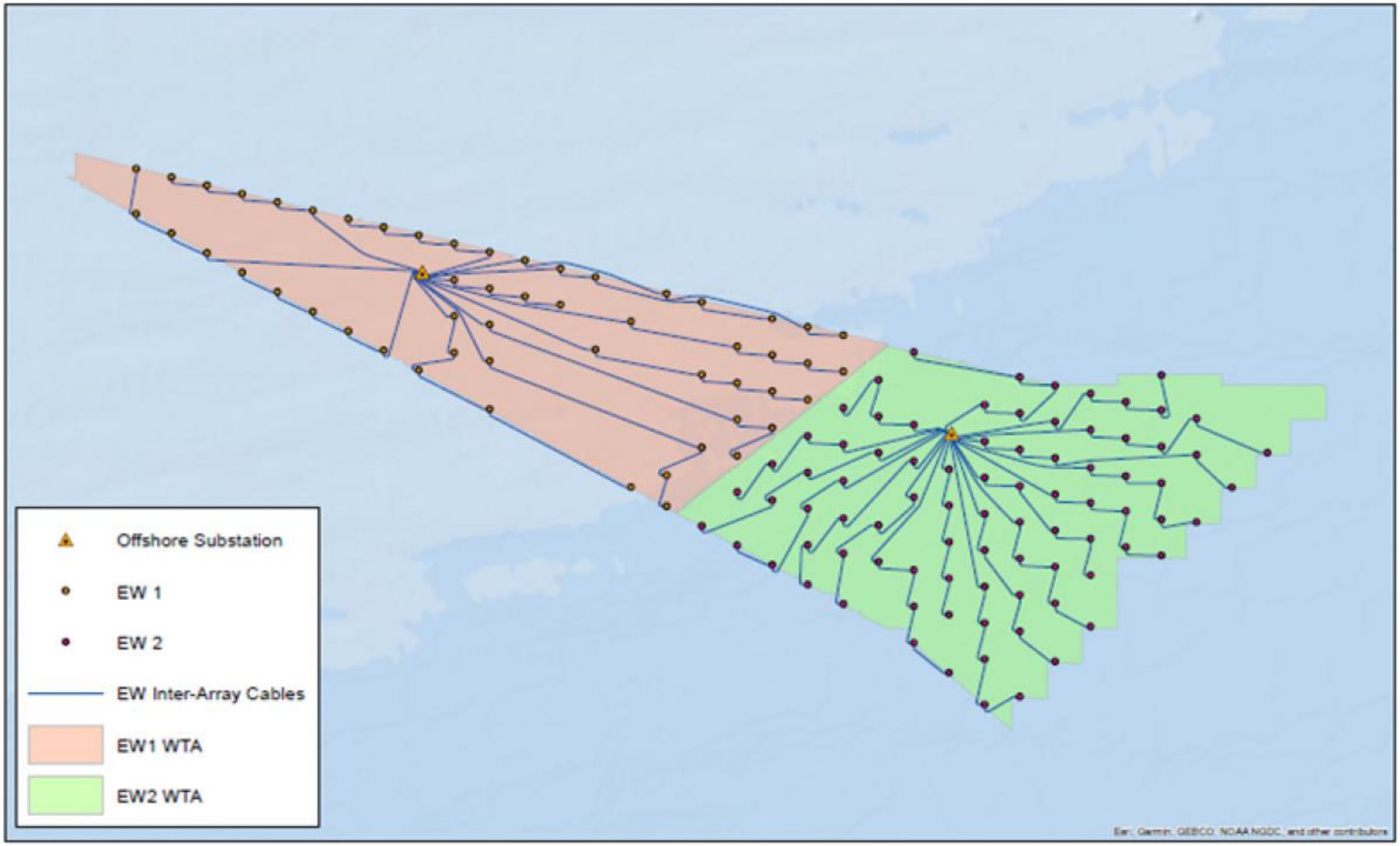

Figure 2-4. Most likely wind turbine generator layout

2.2.1.2. Pile driving

Each WTG would require one 31.5-foot (9.6-meter) to 36-foot (11-meter) tapered monopile foundation, which would be installed using a hydraulic impact hammer with a maximum rated capacity of up to 5,500 kilojoules. Installation of monopiles is expected to take up to 3 hours per pile, such that installation of up to 147 monopile foundations would require approximately 522 hours of pile driving. Only one foundation is proposed to be installed via pile driving at a given time. Pile driving operations would occur during the daytime but could extend to nighttime hours if pile driving was started during daylight. After the seabed has been prepared for foundations, Empire Wind would begin pile driving until the target embedment depth is met. If pile driving for the entire piling installation is not possible because of the presence of rock or hard sediment, the foundation would be drilled out below the pile tip until either the hard rock has been passed and piling can resume, or the target embedment depth is met.

Empire Wind would construct two OSSs to collect the electricity generated by the offshore turbines. The OSSs would consist of a topside structure with one or more decks on a piled jacket foundation. The OSSs would be installed in two phases: first, the foundation substructure would be installed in a similar method to that described for the WTG foundations, then the topside structure would be installed on the foundation structure. Each OSS foundation would require 12 8.2-foot (2.5-meter) piles, which would be installed using a hydraulic impact hammer with a maximum rated capacity of 4,000 kilojoules. It is expected that piles would take 4.2 hours each to install, such that installation of all 24 piles for the 2 OSSs would require approximately 100 hours of pile driving.

Installation of the EW 1 WTG and OSS foundations would occur from April through August 2025, and installation of the EW 2 WTG and OSS foundations would occur from September through November 2025 (Figure 2-2). Pile driving of the WTG and OSS foundations would occur intermittently from May 1 through November 30, depending on protected species time-of-year restrictions, weather, and other potential delays and logistical constraints, and is anticipated to be completed within a two-year period. Pile driving may also occur from December 1 through December 31 if unanticipated delays from weather or technical issues arise that necessitate extending pile driving into December, in which case Empire would notify NMFS and BOEM in writing by September 1 that circumstances are expected to necessitate pile driving in December. During the foundation installation period, construction activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species.

2.2.1.3. Seabed preparation

Seabed preparation may need to be completed prior to installation of some foundations. The need for seabed preparation will be further assessed during the detailed design stage and will be documented in the Facility Design Report (FDR) and Fabrication and Installation Report (FIR). Seabed preparation can include one or all of the following options: removal of soft, mobile or uneven sediments; level of the seabed without removal of sediment; and/or installation of a stone or aggregate foundation bed, such as a skirt, as an alternative leveling/stabilizing strategy. Seabed preparation, if required, will be completed prior to transport of the foundation to the Lease Area, as early as one season prior to initiation of foundation installation activities.

2.2.1.4. Installation of scour protection

Scour protection is used to protect the offshore foundations from erosion of the seabed. Where required, scour protection would be placed around WTG and OSS foundations to stabilize the seabed near the foundations, as well as the foundations themselves. The scour protection radius would extend 207 feet (63 meters) outward from the center of each pile at a depth of 16.4 feet (5 meters) and would have a volume of 13,080 cubic yards (10,000 cubic meters) per monopile.

The locations requiring scour protection, the type of protection selected, and the amount placed around each foundation will be based on a variety of factors, including foundation type and water flow and substrate type (hydrodynamic scour modeling). Descriptions of the scour protection types proposed are:

- Rock: the installation of crushed rock or boulders around a structure
- Rock bags: pre-filled bags containing crushed rock to be placed around a structure
- Concrete blocks: the installation of pre-cast blocks of concrete around a structure

Methods of installation may include side stone dumping, fall pipe, or crane placement. Rock placement scour protection may comprise a rock armor layer resting on a filter layer. The filter layer can either be installed before the foundation is installed (pre-installed) or afterwards (post-installed). Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and pre- or post-install a single layer of scour protection. The need for and amount of scour protection required would vary for the different foundation types being considered and based on the local site conditions. The amount of scour protection required and the types of scour protection to be used will be determined by the FDR/FIR stage.

2.2.2. Interarray and offshore/onshore cable installation

Empire Would install an interarray cable, a series of transmission cables linking each of the WTGs to the OSSs. The interarray cables would consist of three-core high voltage alternating current (HVAC) cables with a maximum transmission capacity of 66 kilovolts (kV). The EW1 and EW 2 interarray cables would have lengths of 94 miles (152 km) and 113 miles (181 km), respectively. Empire Wind would install five offshore export cables along two cable corridors that would link the EW 1 and EW 2 OSSs to a sea-to-shore transition. Each offshore export cable would consist of three-core HVAC cables with a maximum transmission capacity of 230 kV that would deliver power from the OSSs to the onshore facilities. The EW 1 offshore export cable corridor would have a length of approximately 47 miles (75 kilometers) from the OSS to landfall and would support two export cables, such that the total length of offshore export cables for EW 1 would be 94 miles (150 kilometers). The EW 2 offshore export cable corridor would have a length of 30 to 33 miles (49 to 52 kilometers) from the OSS to landfall, depending on the landfall location, and would support three export cables, such that the total length of offshore export cables for EW 2 would be 90 to 99 miles (147 to 156 kilometers). The total installed length of in-water transmission cables for the Project would range from 391 to 400 miles (630 to 639 kilometers), depending on the landfall location of the EW 2 offshore export cables..

The export cable routes currently being considered include several routing options (Figure 2-1). The final export cable routes will be determined by the FDR/FIR stage. The EW 1 export cable would depart the Lease Area along its northern boundary, continue north-northwest across the outbound lane of the Ambrose to Nantucket Traffic Separation Scheme, and then enter the Separation Zone between the traffic lanes before turning to the west. The route would continue through the Traffic Separation Zone toward New York Harbor. Approaching Gravesend Bay, Empire has proposed route variants for the EW 1 submarine export cable that would either route the submarine cable within the maintained Ambrose Channel or through the charted Anchorage #25 area. North of the Anchorage #25 area, the EW 1 route would turn to the northeast and follow the Bay Ridge Channel to the EW 1 landfall. At the EW 1 export cable landfall, which would be located at SBMT, the submarine export cable would most likely connect directly into the onshore substation, as the onshore substation is proposed to be located at the export cable landfall location.

The EW 2 submarine export cable would exit the Lease Area from the central north edge and travel in a relatively straight, northwestern direction, then turn west seaward of the New York state water boundary before making landfall. The EW2 submarine export cables would be joined to onshore export cables at the export cable landfall, which would be located in either Long Beach or Lido Beach, New York (see Section 2.2.2.3, below).

As summarized in Figure 2-2, above, installation of the EW 1 interarray cables would occur from May through September 2025, installation of the EW 2 interarray cables would occur from April through September 2026, installation of the EW 1 OEC would occur from July through September 2024 and again from April through June 2025, and installation of the EW 2 OEC would occur from July through December 2025. During this period, activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species.

2.2.2.1. Vessel activity

Probable vessel classes used to install the interarray cables and offshore export cables include cable lay vessels, grapnel run vessels, fall pipe vessels, transport and anchor handling tugs, and safety vessels. It is estimated that the Project will require approximately 18 vessels for construction of EW 1 and approximately 18 vessels for construction of EW 2. During construction, Empire Wind will receive equipment and materials to be staged and loaded onto installation vessels at one or more existing third-party port facilities. Cable lay vessels will be used to install submarine cables, pre-lay grapnel run vessels will be used for seabed clearance along cable routes, and fall pipe vessels will be used for installation of scour protection. Transport vessels would be used to rotate construction crews to and from area ports. Small support vessels would be used for construction monitoring.

The vessels used for the installation of the interarray cables and offshore export cables will contribute to part of the estimated 189 acres of seabed that will be disturbed by anchoring during construction of EW 1 and EW 2. However, most construction vessels will maintain position using dynamic positioning systems or jack-up features, limiting the use of anchors. Any anchors would be placed within the previously cleared and disturbed area around the foundations. Project-related vessel anchoring is expected to occur in up to 1,400 locations. Within each location, anchoring is expected to occur in an area of up to 269 ft^2 (25 m^2) with a maximum penetration depth of 49 ft (15 m). Based on the number of anchoring locations and the anchoring area within each location, the maximum area of seafloor disturbance from anchoring during export cable installation is estimated to be 8.6 acres (3.5 hectares).

2.2.2.2. Seabed preparation

Seabed preparation activities may be conducted in some areas prior to the installation of cables to ensure that the submarine export cable and burial equipment will not be impacted by any debris or hazards, both natural and man-made, during the burial process, which may cause equipment damage and/or delays, and to ensure sufficient burial depth. Seabed preparation activities may include grapnel runs, munitions and explosives of concern (MEC) and unexploded ordnance (UXO) clearance, pre-sweeping, pre-trenching, and localized dredging.

In some areas, existing, out of service cables and pipelines may be cut-away and removed to install the submarine export cables. This removal will only be completed upon pre-determined cables and pipelines in which written agreement is received from the owners and/or appropriate agencies. Should this be required, details of the cutting or removal will be agreed upon by all associated parties and will be consistent with sound engineering practices and relevant requirements. (Additional details on crossing existing submarine assets are provided within the Cable and Pipeline Crossings subsection).

During Project construction, the likelihood of MEC/UXO encounter is very low. Empire Wind has implemented a Risk Assessment with Risk Mitigation Strategy (RARMS) plan designed to evaluate and reduce risk in accordance with the As Low As Reasonably Practicable (ALARP) risk mitigation principle. The RARMS consists of a phased process beginning with a desktop study and risk assessment that identifies potential sources of MEC/UXO hazard based on charted MEC/UXO locations and historical activities, assesses the baseline (pre-mitigation) risk that MEC/UXO pose to the Project, and recommends a strategy to mitigate that risk to ALARP. A geophysical survey will be conducted in Spring 2023 to identify potential MEC/UXO (pMEC/pUXO) in the Project area. A ROV reconnaissance survey planned for Spring 2024 will confirm the pMEC/pUXO identified in the Spring 2023 geophysical survey. Avoidance is proposed as the preferred approach for mitigation of any confirmed MEC/UXO. There is a possibility that confirmed MEC/UXO may be removed through physical relocation to another suitable location on the seabed within the Project area or previous designated disposal areas for wet storage using a "Lift and Shift" operation. Selection of these two mitigation strategies will depend on the location, size, and condition of the confirmed MEC/UXO, and will be made in consultation with a MEC/UXO specialist and in coordination with the appropriate agencies.

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. The primary pre-sweeping method will involve using a suction hopper dredge vessel and/or mass flow excavator from a construction vessel to remove the excess sediment on the seafloor along the footprint of the cable lay; however, other types of dredging equipment may be used depending on environmental conditions and equipment availability. Pre-sweeping is anticipated to be required primarily along the nearshore portions of the export cable route and within New York State waters. Preliminary areas where Empire anticipates pre-sweeping will be required are identified on Figures Figure 2-5 and Figure 2-6. Where required, pre-sweeping activities will occur in an approximately 164-ft (50-m) width along the length of the megaripples and sandwaves; the length of clearance will vary along the submarine export cable route, ranging from approximately 197 ft (60 m) to 5,577 ft (1,700 m). Megaripple and sandwave height vary depending on localized seabed and current characteristics. Approximately 119,262.2 yd^3 (91,182.5 m^3) of sediment is anticipated to be dredged during these pre-sweeping activities along the EW 1 submarine export cable route. Empire anticipates that dredged material generated from the Project may be removed for beneficial reuse (e.g., beach nourishment) or proper disposal. The actual method of dredged material management will be based on sampling and consultation with regulatory agencies.

Pre-trenching activities will be required in select locations along the EW 1 submarine export cable route in areas where deeper burial depths may be required and/or seabed conditions are not suitable for traditional cable burial methods; pre-trenching activities may also be required in select locations along the EW 2 submarine export cable route. Pre-trenching involves running the cable burial equipment over portions of the route to soften the seabed prior to cable burial and/or the use of a suction hopper dredge to excavate additional sediment. This activity helps facilitate an easier burial process in areas of greater depth.

At locations where the EW 1 submarine export cable crosses other assets, local dredging may be needed to reduce the shoaling of the crossing design. This crossing design would consist of the removal of approximately 4 ft (1.2 m) of sediment within a 33 ft by 52.5 ft (10 m by 16 m) area at each crossing; utilizing a 3:1 side slope, the upper bounds of this area will be approximately 59 ft by 79 ft (18 m by 24 m). Approximately 679 yd^3 (519 m^3) of material is anticipated to be removed by suction hopper dredge and/or mass flow excavation at each crossing. The final depth of the dredged area will be governed by the vertical distance between the natural seabed and the assets to be crossed and will need to be approved by the asset owners through a crossing agreement.

Dredging will be required to prior to the installation of the export cables near the EW 1 and EW 2 landfalls. Dredging is used to excavate, remove, and/or relocate sediment from the seabed to increase water depth and alter existing conditions, thereby enabling deep draft vessels to safely navigate over shallow areas, as well as allowing for adequate burial of the submarine export cables in areas where deeper burial is required. Dredging methods may include clamshell dredging, suction dredging, and/or hydraulic dredging.

For the EW 1 export cable, an area of approximately 2.79 acres (1.13 hectares) near the cable landfall, between the existing 35th Street and 29th Street Piers at SBMT, will require dredging up to approximately -34.5 ft (-10.5 m) below MLLW to facilitate access by the cable installation vessel. Additionally, a dredge pit of approximately 82 ft wide by 12 ft long (25 m by 3.66 m) at the base of the two cable conduits at the cable landfall will be dredged to approximately -19.1 ft (-5.8 m) MLLW and backfilled with clean stone/scour protection to create a foundation to support the lower, seaward end of the conduits. Another area (at the bottom of the injector initiation pit) of approximately 0.079 acres (0.032 ha) beyond the end of the 35th Street Pier will also require dredging to slope down to a bottom elevation -55 ft (-16.7 m) MLLW to allow for the transition to the installation tool required for deeper burial within the Bay Ridge Channel. Additional dredging/excavation is required for installing the cable conduits below the existing platform and proposed outfall modification. To reach the required depths, a total of approximately 98,350 cubic yards (75,194 cubic meters), of sediment will need to be dredged in these areas, including assumed sideslopes and two feet of overdredge, to ensure that depth requirements are met. Empire is proposing to conduct localized dredging activities between the 35th Street and 29th Street Piers using a clamshell dredge with an environmental bucket. The dredge will be barge mounted and dredging will be controlled to minimize sediment resuspension. Dredged sediments will be placed directly into scows and settled for a minimum of 24 hours. For the localized dredging activities between the 35th Street and 29th Street Piers at SBMT, it is anticipated that scows will be dewatered on site within the submarine export cable corridor. Following the settling period, the scows will be decanted in accordance with applicable permits and regulatory requirements.

Additionally, dredging may be required within an approximately 17.6-acre (7.1-hectare) area in the Bay Ridge Channel, as the EW 1 submarine export cable route makes its approach into SBMT. This area overlaps with the area proposed for maintenance dredging by the USACE in a Public Notice issued on March 11, 2021. Empire is currently consulting with the USACE on the anticipated channel maintenance activities and does not anticipate conducting additional dredging within these USACE-managed channel reaches prior to construction and installation activities. However, dredging in this area could be required if sedimentation or shoaling decreases the water depth prior to or during construction. Sedimentation over the cables during operations may also result in an exceedance of the depth limitations of the cables over time. In that case, maintenance dredging may be required during Project operations.

For the EW 2 export cable, an area of up to 32.1 acres (13.0 hectares) may require dredging of up to 30 ft (10 m) below seabed level to facilitate sufficient burial depths near export cable landfall if the eastern approach to EW 2 Landfall C is selected for installation. Additionally, installation of the EW 2 export cable will require localized dredging for excavation of the HDD pits and/or cofferdams at the offshore HDD exit locations for the cable landfall.

Empire anticipates that dredged material generated from the Project will be removed for either beneficial reuse or proper disposal at a licensed facility. The actual method of dredged material management will be based on sediment characteristics and consultation with regulatory agencies.

2.2.2.3. Trenching/cable installation

Interarray and Offshore Export Cables

Following the pre-installation grapnel run and route clearance, the interarray cables and OECs will be brought to the appropriate section of the cable siting corridor on a deep-sea cable laying vessel. From there, the cables will be laid onto the seabed and either installed directly or a second vessel will follow the cable laying process and bury the cable using one of the following methods:

- Plowing: As the cable plow is dragged along the seabed, a small trench is created. The submarine export cable is then placed in the trench and displaced sediment is either mechanically returned to the trench and or backfills naturally under hydrodynamic forcing. Plowing is generally less efficient than jetting methods but may be used in limited site-specific conditions.
- Jetting: 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. Jetting is considered the most efficient method of submarine cable installation. It minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route.
- Trenching (cutting): Trenching (cutting) is used on seabed containing hard materials not suitable for plowing or jetting, as the trenching machine is able to cut through the material using a chain or wheel cutter fitted with picks. Once the cutter creates a trench, the submarine export cable is laid into it.

The final cable burial method(s) will be determined by the FDR/FIR stage. The equipment selected will depend on seabed conditions, the required burial depths, as well as the results of various cable burial studies; more than one installation and burial method may be selected per route and has the potential to be used pre-installation, during installation, and/or post-installation.

Jetting is expected to be the primary method for cable burial along most of the cable installation route. Jetting may be conducted via a device that travels along the seafloor surface or with a vertical injector fixed to a vessel or barge. Both of these methods inject high pressure water into the sediment through a blade, which is inserted into the seafloor to create a trench. Burial of the cable may be either post-lay or simultaneous. During post-lay burial with a jetting tool, the cable would first be laid along the seafloor, and then the post-lay jetting tool would follow and may attempt multiple passes of the area for burial. Alternatively, the cable may be fed from the cable vessel down through a vertical injector and simultaneously buried in the trench during the jetting process. Post-lay burial with jetting is planned along the majority of the export cable route, whereas simultaneous lay and burial with a vertical injector is planned to be used in areas with deep burial requirements (e.g., federally maintained channels). Post-lay and vertical injector jetting are expected to be suitable installation tools along most of the EW 1 and EW 2 export cable routes. Plowing and trenching methods were considered early in the design process but will likely not be used.

Following burial of the cable, displaced sediment would resettle, naturally backfilling the trench. A post burial survey would be performed along the export cable routes to document the burial depth and provide information about how far the natural backfill has progressed at the time of the survey. The need for active backfill or additional surveys would be evaluated based on the results of the post burial survey.

Simultaneous lay and burial with a vertical injector is planned to be used in areas with deep burial requirements (e.g., federally maintained channels).

Submarine cables will be buried to a minimum target burial depth of 6 ft (1.8 m) below the seafloor outside of federally maintained (e.g., anchorages and shipping channels) areas. In locations where the cable must cross federally maintained areas, the cable will be buried to a minimum burial depth of 15 ft (4.6 m) below the current or future authorized depth or depth of existing seabed (whichever is deeper). The EW 1 export cable route variant (see Figure 2-1, above) would intersect the federally maintained Ambrose Channel in the Lower Bay over a length of approximately 1.9 miles (3 km).

In shallow areas, specifically along the Rockaway sandbank in New York Harbor, the submarine export cable may need to be floated into place for burial, as water depths along this stretch are inadequate for the cable lay vessel. Should this floating installation method be implemented, the cable lay vessel will be located approximately 1,312 ft (400 m) from the burial location. The cable burial machine will then assist in lowering and burying the submarine export cable in place, as it moves along these shallower areas. The burial machine may also be run out of a separate construction vessel.

Burial of the interarray and OEC cables will terminate before the OSSs, and J-tubes will be installed to protect the remaining portion of the cable. Depending on the final construction and installation schedule, it is possible that up to 3,000 ft (914 m) of the submarine export cables will need to be wet stored close to the OSS location. This wet storage concept would be required should the OSSs be installed after the submarine export cables are buried along the cable route and would consist of temporarily burying the remainder of the submarine export cables until they could be pulled into the OSSs. Once reaching the OSS location, the submarine export cables would be cut, sealed, and fitted with corrosion resistant rigging. The cables would then be laid and/or buried on the seafloor until they could be pulled into and installed in the OSS. The interarray cables will be installed and buried either before the installation of the wind turbines and J-tubes or at the same time if needed.

Offshore Export Cable Landfall

At the EW 1 export cable landfall location, the submarine export cables will most likely connect directly into the onshore substation, as the onshore substation is proposed to be located at the export cable landfall location. At the export cable landfall location for EW 2, the submarine export cables will be joined to onshore export cables at export cable landfall. As depicted in Figures 2-6 and 2-7, Empire Wind is evaluating the following options for the EW 1 and EW 2 OEC landfalls:

- EW 1: The export cable landfall for the EW 1 export cable will occur at the SBMT site, located along the Brooklyn Waterfront and adjacent to 1st Avenue/2nd Avenue. The parcel is owned by New York City, leased to the New York City Economic Development Corporation, and is the same parcel in which the onshore substation is located.
- EW 2 Landfall A: This export cable landfall for the EW 2 export cable is within the City of Long Beach public ROW at Riverside Boulevard. Horizontal Directional Drilling (HDD) operations will be staged in a vacant, privately owned parcel adjacent to Riverside Boulevard and East Broadway.
- EW 2 Landfall B: This export cable landfall for the EW 2 export cable is at an existing paved parking lot to the north of Shore Road and east of Monroe Boulevard in the City of Long Beach. HDD operations will be staged in a vacant privately owned parcel adjacent to Monroe Boulevard and East Broadway.
- EW 2 Landfall C: This export cable landfall for the EW 2 export cable is at an existing paved parking lot at the Lido West Town Park in Lido Beach, Town of Hempstead. The parking lot is owned by the Town of Hempstead.

- EW 2 Landfall E: This export cable landfall for the EW 2 export cable is within the City of Long Beach public ROW at the corner of Laurelton Boulevard and West Broadway. HDD or Direct Pipe operations may be staged in adjacent vacant privately owned parcels.

Based on the existing conditions at the offshore export cable landfalls, both trenchless (e.g., HDD) and trenched (open cut trench) methods are proposed for the installation of these cables. The final methods for cable installation will be determined by the FDR/FIR stage.

HDD may be used to install cables under sensitive coastal habitats (e.g., dunes, beaches) at the EW 2 export cable landfall. For export cable landfalls, the HDD operations typically start from the onshore landfall location and exit offshore, such that onshore and offshore work areas are required. Target depths of landfall HDD paths vary by the length of the HDD and can be up to approximately 80 feet (24 meters). HDD involves using a rig that drills a horizontal borehole under the surface onshore and exits onto the seafloor. The submarine cables are then floated out to sea, then pulled back onshore within the drilled borehole. At the EW 2 export cable landfall, a joint pit/temporary pull-in pit on the onshore side of the cable landfall will transition the offshore export cables to the onshore export cables. The joint location is expected to be backfilled or installed in a concrete chamber, and may require a manhole; however, the final design will be determined by the FDR/FIR stage.

Open-cut alternatives are currently being considered for the EW 1 landfall because of limitations of HDD methods, like conflicting existing infrastructure, loose soil and sediment, or limited workspace. Open-cut alternatives require open-cut trenching and dredging or jetting to facilitate installation at target burial depth for approach to landside. Dredging excavates or removes sediment, creating a channel to allow the cable to make landfall at the target installation depth. Dredging can be completed through clamshell dredging, suction hopper dredging, or hydraulic dredging. No backfilling is proposed for dredging if used for cable installation at landfall. Jetting uses pressurized water jets to create a trench within the seabed, where the export cable then sinks into the seabed as displaced sediment resettles and naturally backfills the trench.

Additional installation methods are being considered for the EW 1 export cable landfall, including cofferdams, through bulkheads, and over bulkheads. The proposed method for the EW 1 export cable landfall installation is to pull the submarine export cables through angled steel conduits through the bulkhead along the shoreline at SBMT. Empire will demolish the existing relieving platform and construct a new pile supported platform and bulkhead at the cable landfall as part of site preparation activities and will install the conduits for cable landfall. Sheet piling will also be installed in the water to support the conduits.

Direct Pipe® is a trenchless method that can be used when HDD methods present challenges. The method allows for installing conduits beneath sensitive habitat. Direct Pipe is included as an option in the PDE for EW 2 export cable landfalls. Similar to HDD, Direct Pipe operations would originate from an onshore export cable landfall location and exit offshore, using both onshore and offshore work areas. The onshore work areas are typically within the export cable landfall parcels. Target depths of landfall paths vary by the length of the Direct Pipe and can be up to approximately 80 feet (24 meters). The Direct Pipe method involves using a pipe thruster to grip and push a steel pipe with a microtunnel boring machine. Once the microtunnel boring machine 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 previously installed using the Direct Pipe method.

Onshore Export Cable

As depicted in Figure 2-8, a total of six onshore export cable route segments are under review to traverse the island of Long Beach from the landfall options to the Wreck Lead Channel crossing:

- From EW 2 Landfall A, the EW 2 Route LB-A follows Riverside Boulevard for approximately 1,500 ft (457 m), then turns east along East Park Avenue for 870 ft (265 m), and then west to Reverend JJ Evans Boulevard, which turns into Park Place, for approximately 2,740 ft (835 m) to approach the Wreck Lead Channel crossing at Riverside Boulevard.
- From EW 2 Landfall B, the EW 2 Route LB-B follows East Broadway west for approximately 1,500 ft (457 m) to Riverside Boulevard where it joins with and continues as EW 2 Route LB-A.
- From EW 2 Landfall C, the EW 2 Route LB-C follows Lido Boulevard west for approximately 2,300 ft (701 m), where Lido Boulevard changes to East Park Avenue, and continues west along East Park Avenue for an additional 4,119 ft (1,256 m) to join EW 2 Route LB-A. A second alternate under review from EW 2 Landfall C, the EW 2 Route LB-D follows East Broadway for approximately 4,900 ft (1,494 m) then turns north on Lincoln Boulevard for another approximately 2,960 ft (902 m) before turning west on East Harrison Street for an additional approximately 1,260 ft (384 m) to approach Wreck Lead Channel at Long Beach Boulevard.
- From EW 2 Landfall D, the EW 2 Route LB-E travels west on Lido Boulevard for approximately 3,500 ft (1,067 m) to join with and continue as the EW 2 Route LB-C.
- One additional alternative onshore export cable route, EW 2 Route LB Variant, leaves EW 2 Landfall B and continues east approximately 772 ft (235 m) along East Broadway to join the EW 2 Route LB-D at Lincoln Boulevard.

The EW 2 onshore export cable route then crosses Wreck Lead Channel to Island Park. As depicted in Figure 2-8, a total of five onshore export cable route segments are under review to traverse Island Park from Wreck Lead Channel to the onshore substation:

- The EW 2 Route Island Park (IP)-A crosses to the west side of the Long Island Rail Road (LIRR) and follows Long Beach Road north then northeast to join and continue as the EW 2 IP-C route.
- The EW 2 Route IP-B follows along the east side of the LIRR to join and continue as the EW 2 Route IP-C route.
- The EW 2 IP-C traverses north on Austin Boulevard, diverges west to follow Industrial Boulevard for approximately 2,050 ft (625 m) before returning to Austin Boulevard, then continues northwest to approach the EW 2 Onshore Substation B site.
- The EW 2 Route IP-D follows Austin Boulevard, similar to onshore export cable route IP-C, but does not diverge to follow Industrial Boulevard, as does onshore export cable route IP-C.
- The EW 2 Route IP-E continues from the EW 2 Route IP-C through the EW 2 Onshore Substation B site, turning west and traversing parallel to Daly Boulevard and crossing over the LIRR for approximately 1,500 ft (463 m), and then crosses north into the EW 2 Onshore Substation A site.

Two onshore substation sites are currently under review. EW 2 Onshore Substation A is located on a parcel on the corner of Hampton Road and Daly Boulevard. EW 2 Onshore Substation B is located adjacent to the east side of the existing Oceanside Point of Interconnection (POI). The EW 2 Interconnection Cable (IC) routes, EW 2 Route IC-A and EW 2 Route IC-B, are proposed to connect the Oceanside POI and the proposed EW 2 Onshore Substation A and B sites, respectively.

Based on the existing conditions along the onshore export and interconnection cable routes, both trenchless (e.g., HDD and jack and bore) and trenched (open cut trench) methods are proposed for the installation of these cables. The final methods for cable installation will be determined by the FDR/FIR stage.

For inland waterway or wetland crossings, and onshore routing, HDD may be used to install cables under sensitive coastal habitats or major infrastructure, such as railroads and highways. Onshore HDD is similar to landfall HDD but requires two onshore work areas on either side of the avoided habitat. Starting at one onshore location, a borehole is created under the surface and exits to the other onshore location. The ducts and cables are then pulled back within the drilled borehole.

Open-cut alternatives are currently being considered for inland waterway crossings of the EW 2 onshore export cables and interconnection cables because of limitations of HDD methods, like conflicting existing infrastructure, loose soil and sediment, or limited workspace. Open-cut alternatives require open-cut trenching and dredging or jetting to facilitate installation at target burial for approach to landside. Dredging excavates or removes sediment, creating a channel to allow the cable to transit across a waterway or wetland crossing at the target installation depth. Dredging can be completed through clamshell dredging, suction hopper dredging, or hydraulic dredging. No backfilling is proposed for dredging if used for waterway and wetland crossings. Jetting uses pressurized water jets to create a trench within the waterway, where the export cable then sinks into the waterway as displaced sediment resettles and naturally backfills the trench.

The onshore export cables and interconnection cables may also be installed using the jack and bore methodology or other non-HDD trenchless technologies. While jack and bore is not the preferred onshore installation methodology, Empire is proposing it as part of the PDE to be used in the event that HDD and open cut trench methodologies are not technically or commercially feasible to complete installation activities. Jack and bore is completed by installing a steel pipe or casing under existing roads, railways, or other infrastructure. This is completed by excavating a bore (entry) pit and receiving (exit) pit on either side of the crossing. An auger boring machine then jacks a casing pipe through the earth while at the same time removing earth spoil from the casing by means of a rotating auger inside the casing. The onshore cable will then be pulled through the crossing.

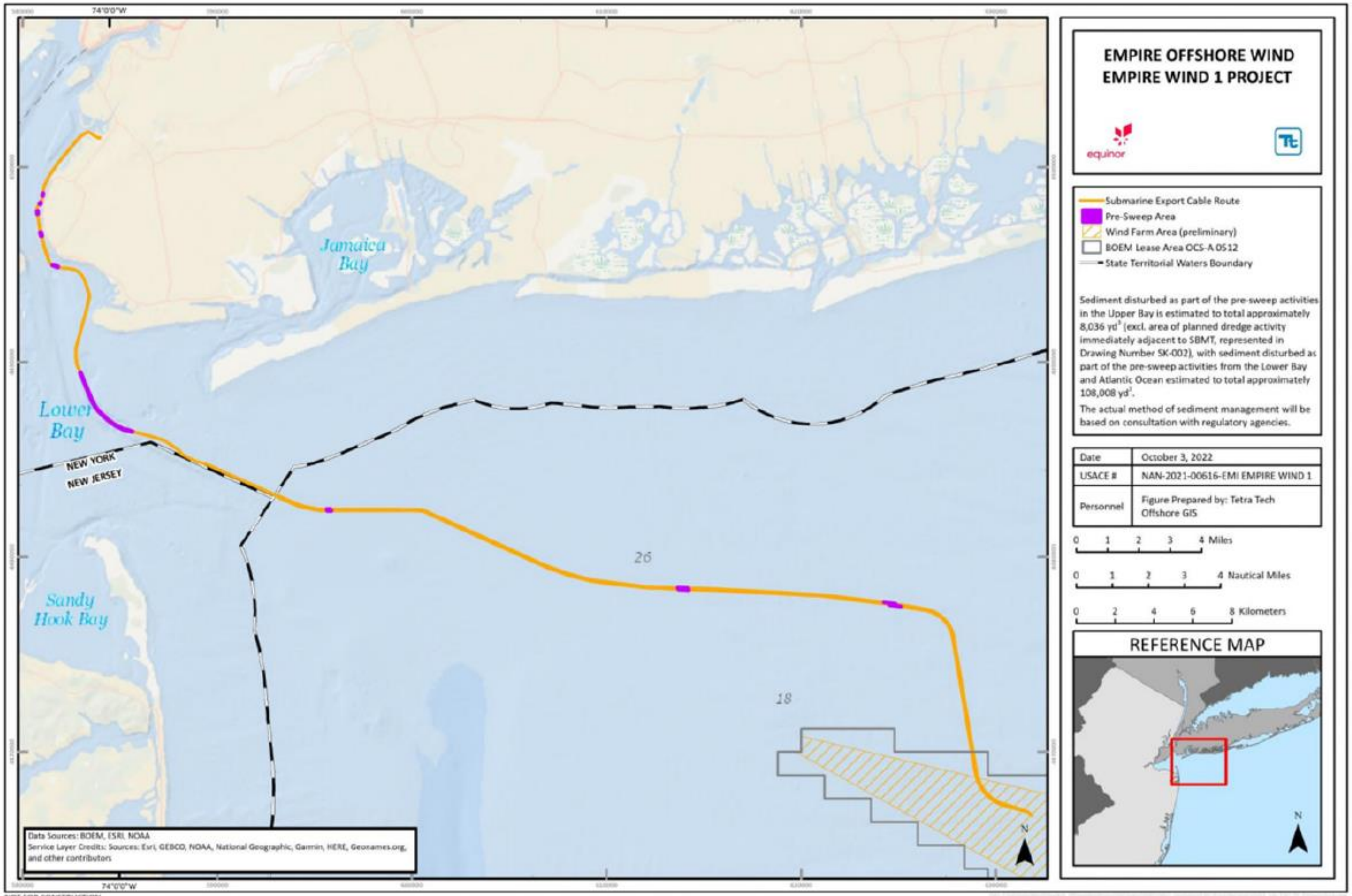

Figure 2-5. Preliminary Locations of Pre-Sweeping for Sand Waves and Megaripples for EW 1

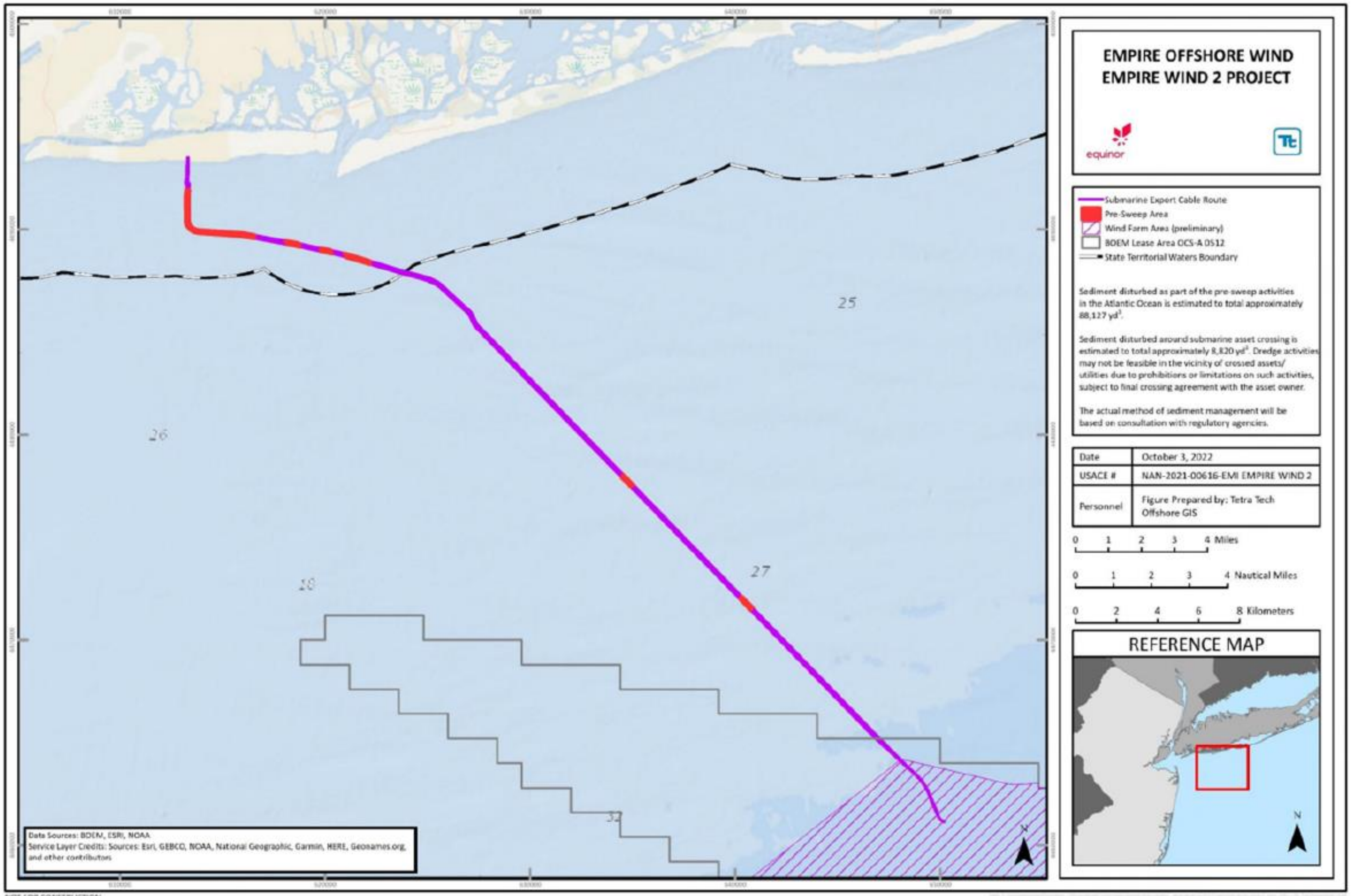

Figure 2-6. Preliminary Locations of Pre-Sweeping for Sand Waves and Megaripples for EW 1

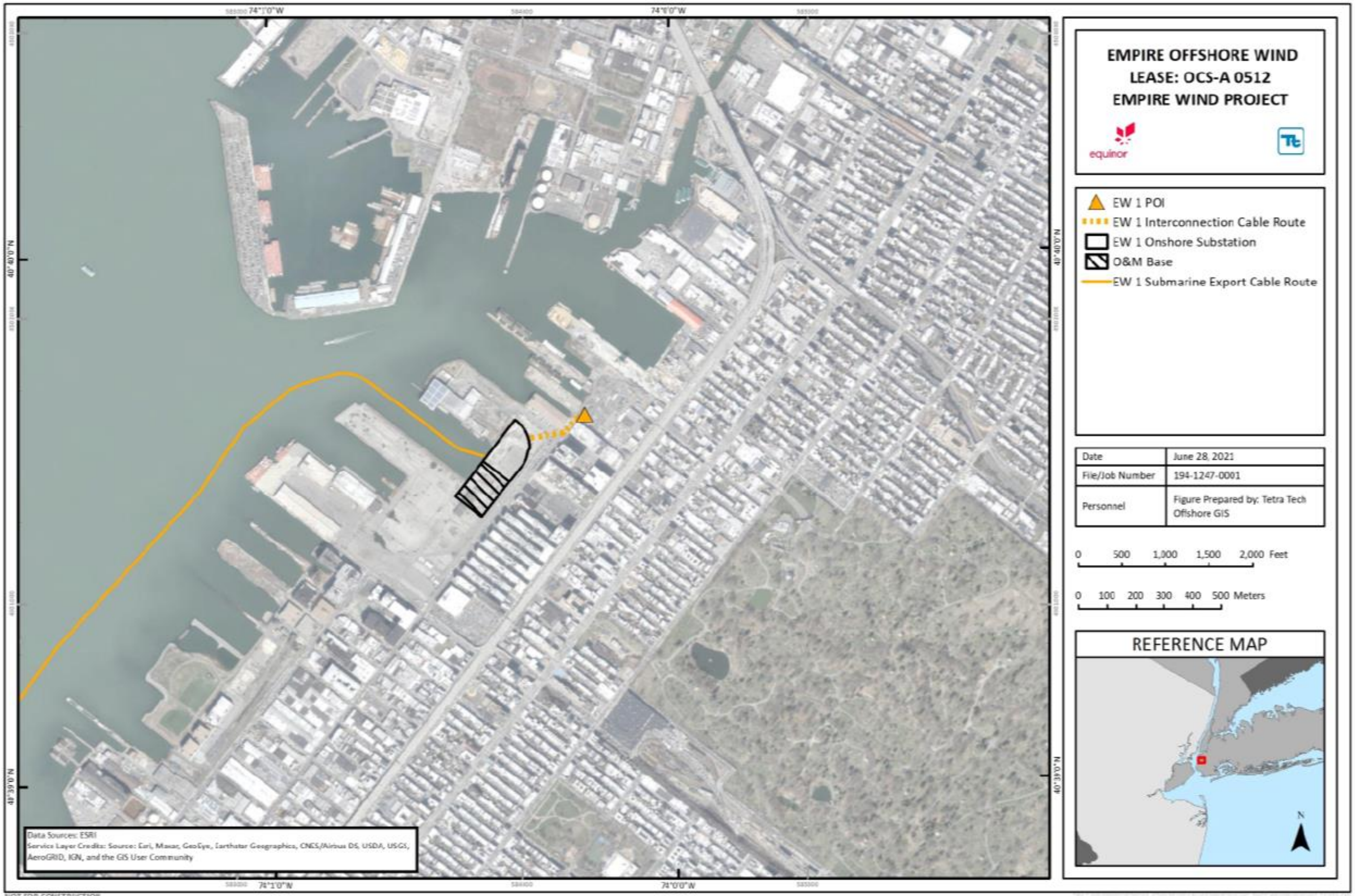

Figure 2-7. EW 1 OEC Landfall and Interconnection Cable Route

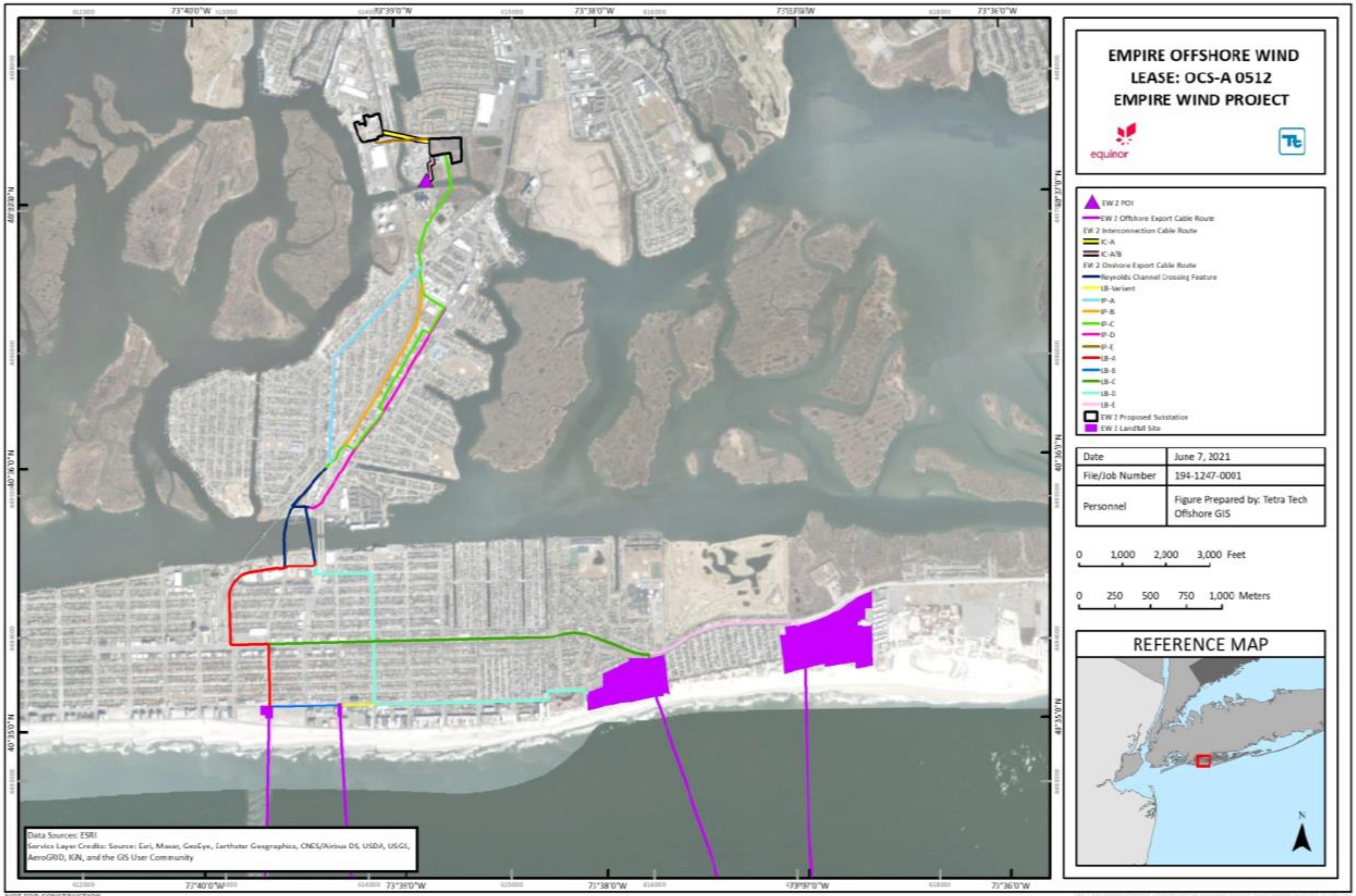

Figure 2-8. EW 2 OEC Landfall and Onshore Export and Interconnection Cable Routes

2.2.2.4. Cable protection

BOEM estimates that burial of cables to the target depth of 6 ft (1.8 m) would not be possible for as much as 10 percent of the length of the interarray and submarine export cables, or as much as 39 miles (62 kilometer) of cable. In areas where burial of the cable to the target depth is not feasible or sufficient burial depth is not achieved, cable protection will be installed as a secondary measure to protect the cables. Cable protection will also be installed at locations along the export cable routes where subsea assets have to be crossed (e.g., cables and pipelines) (Figure 2-9, Figure 2-10). The locations requiring cable protection, the type of protection selected, and the amount placed around each submarine export and interarray cable will be based on a variety of factors, including water flow and substrate type (hydrodynamic scour modeling) and potential conflicting uses (i.e., commercial fishing, maritime traffic). The final locations, types, and amounts of cable protection will be determined by the FDR/FIR stage. Interarray cable protection would extend to a width of 16 ft (5 m) at the base and a depth of 3 ft (1 m), and export cable protection would extend to a width of 15 feet (4.5 meters) and a depth of 5 feet (1.5 meters). Approximately 123 to 127 acres of cable protection would be required for the Proposed Action, including 42 acres for the interarray cables, 42 acres for the EW 1 OECs, and 39 to 43 acres for the EW 2 OECs, depending on the landfall location. Installation of cable protection for the interarray cables is expected to take two to three months each for EW 1 and EW 2. Installation of cable protection for the export cables is expected to take up to six months each for EW 1 and EW 2.

Multiple types of cable protection may be used, including rocks, rock bags, concrete mattresses, and frond mattresses. Empire notes that surficial use of mattresses is not a favored method of cable protection based on feedback during the consultation process; however, this approach may be the preferred solution at certain asset crossings in order to reduce shoaling. A description of these types of cable protection is provided below.

Rocks

Rocks of different grade sizes are placed from a fall pipe vessel over the cable. Initially smaller stones are placed over the cable as a covering layer to protect the cable from larger rocks, followed by larger rocks. The rocks generally form a trapezoid, 4.9 feet (1.5 meters) above the seabed with a 2:1 gradient. This may vary depending on expected scour. The trapezoid shape is designed to protect against anchor drag as well as anchor drop. The length of the protection depends on the length of cable that is not buried or has not achieved target depth. Where rock placement is used for crossing another cable or utility, a separation layer may be laid on the seabed before rock placement.

Rock Bags

Rock bags consist of various sized rocks constrained within a rope or wire netting containment. They are placed using a crane and deployed to the seabed in the correct position. Rock bags are more appropriate for cable stability or trench scour related issues.

Concrete Mattresses

Concrete mattresses generally have dimensions of 19.7 feet by 9.8 feet by 1 foot (6 by 3 by 0.3 meters). They are formed by interweaving concrete blocks with rope and wire. They are lowered to the seabed on a frame. Once positioning over the cable has been confirmed, the frame release mechanism is triggered, and the mattress is deployed. The mattress placement process is repeated over the length of cable that requires additional protection. Mattresses provide protection from anchor drop but are less effective at protecting against anchor drag. Where mattresses are used for crossing another cable or utility, a separation layer must be laid on the seabed before mattress placement.

Frond Mattresses

Frond mattresses are designed to mimic natural seagrass and promote the formation of protective, localized sand berms. Buoyant fronds are built into the mattress and when deployed they float in the water column trapping sand. Frond mattresses are installed following the same procedure as general mattress placement. The fronds floating in the water column can impede the correct placement of additional mattresses.

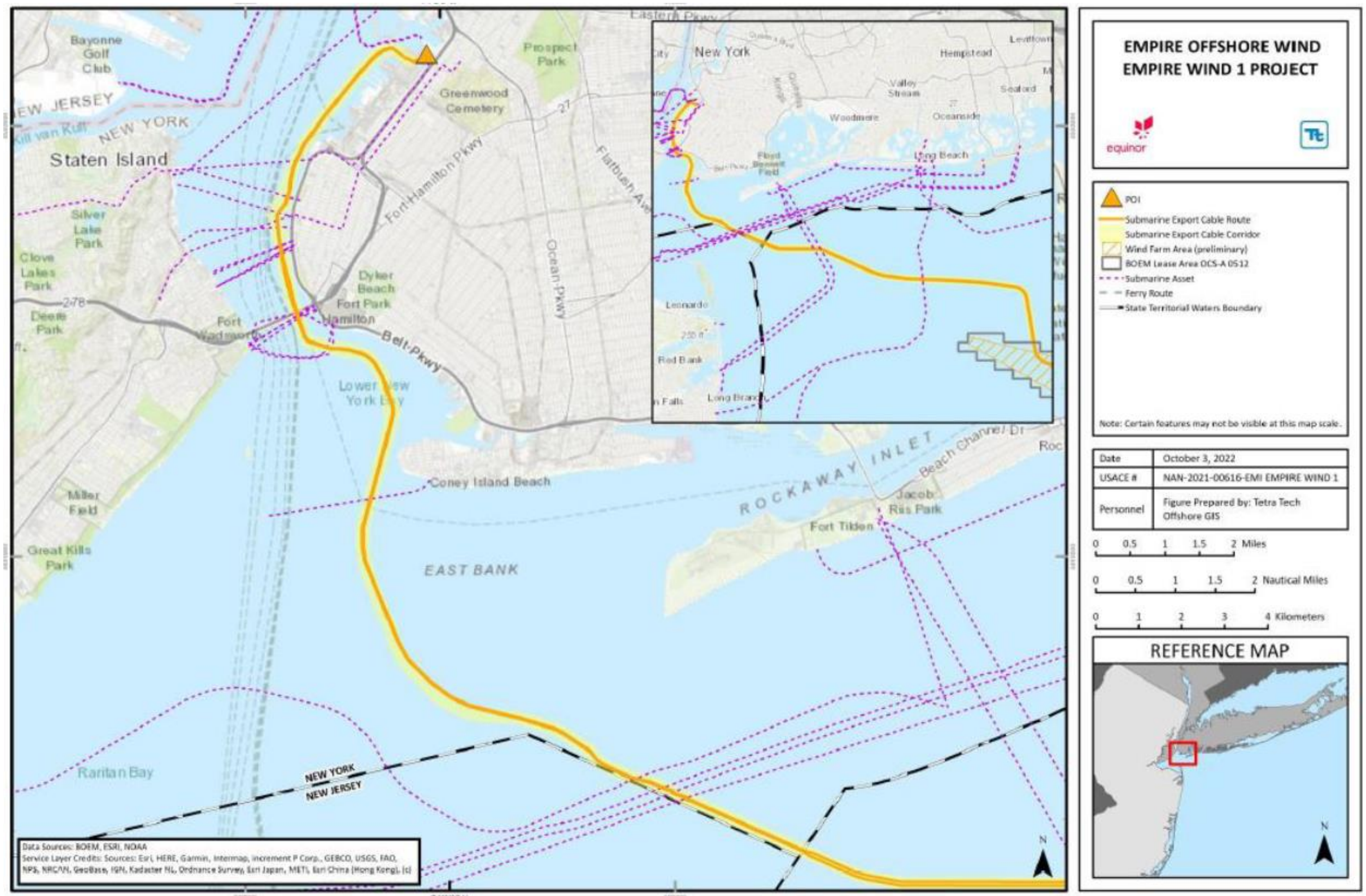

Figure 2-9. Empire Wind 1 Submarine Export Cable and Route and Known Submarine Asset Crossings

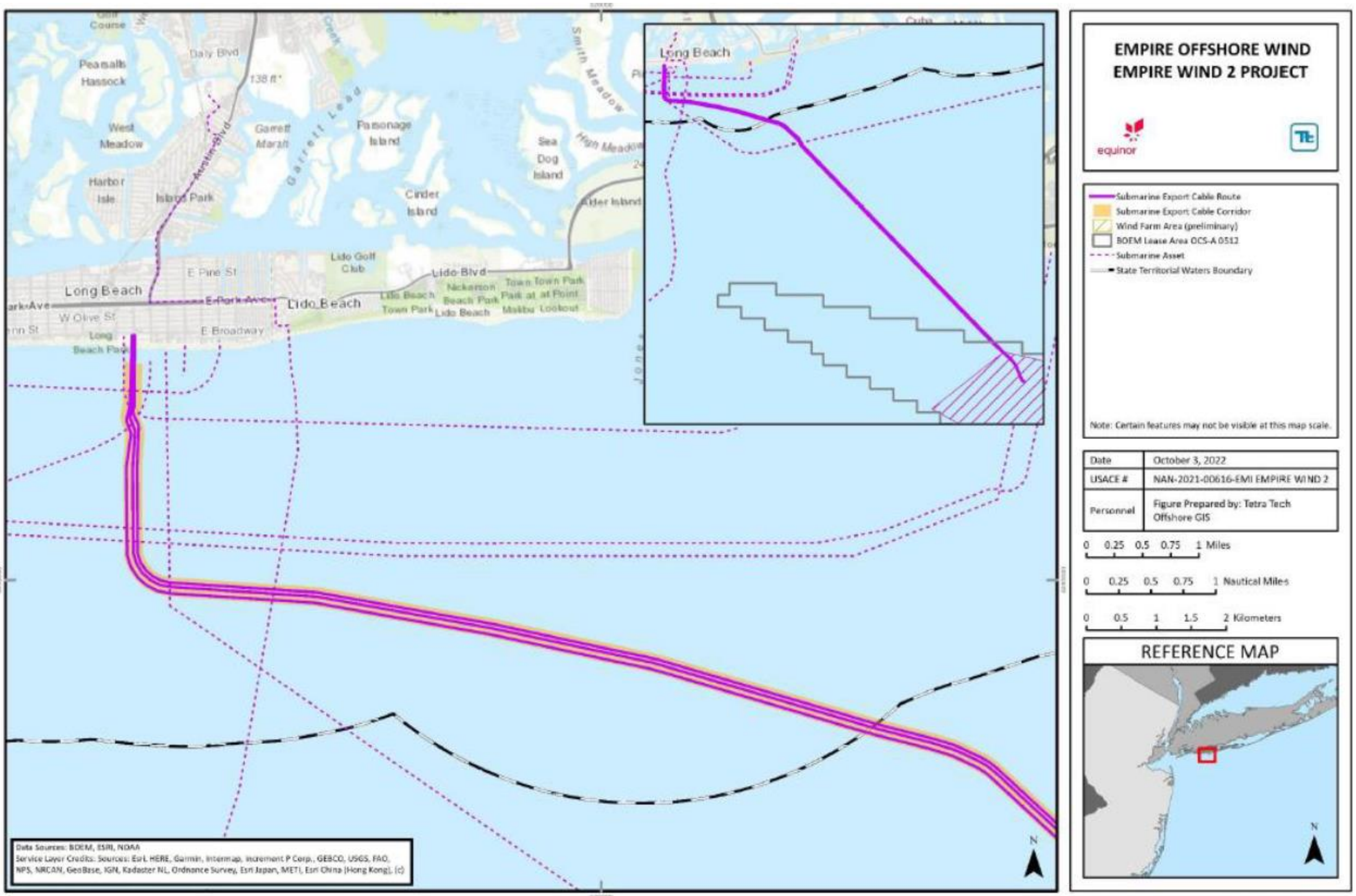

Figure 2-10. Empire Wind 2 Submarine Export Cable and Known Submarine Asset Crossings

2.2.3. Port facilities

Construction and installation activities for the Proposed Action may be based out of more than one port, and Empire Wind has not yet finalized selection of construction ports, staging areas, etc. The final port selection for staging and construction will be determined based upon whether the ports are able to accommodate Empire's schedule, workforce and equipment needs.

SBMT has been selected as a potential location for the export cable landfall and the onshore substation, as well as a potential staging area for wind turbine components (e.g., blades, turbines, nacelles), foundation transition pieces, and other facility parts during construction of the offshore wind farm. Infrastructure improvements have been proposed at SBMT to provide the necessary structural capacity, berthing facilities, and water depths to operate as an offshore wind hub for several proposed offshore wind projects, including the Proposed Action. These improvements include in-water activities (i.e., dredging and dredged material management, replacement and strengthening of existing bulkheads, removal of existing cofferdams, regrading a portion of riprap slope, installation of new pile-supported and floating platforms, installation of new fenders), as well as some upland activities. These port improvements at SBMT are not being undertaken by Empire Wind but are considered a Connected Action for the Proposed Action and are therefore described in this section.

The in-water work activities associated with SBMT would include the following:

- Dredging and dredged material management of approximately 189,000 cubic yards of sediments spanning an area of 14.2 acres;
- Installation of 9,033 cubic yards of sand cap fill;
- Replacement and strengthening of existing bulkheads, including installation of approximately 3,383 cubic yards of fill and 123 cubic yards of new structure below Mean High Water (MHW);
- Removal of existing cofferdams and removal of approximately 5,500 cubic yards below MHW of existing fill to mitigate filling as part of other fill installation;
- Regrading of a portion of existing unvegetated riprap slope within the tidal zone, with replacement of identical material, resulting in excavation and application of 10,532 cubic yards below MHW of riprap and fill.
- Installation of new pile supported and floating platforms; and
- Installation of new fenders.

In-water work associated with the Connected Action is described in detail in Sections 2.2.3.1 through 2.2.3.5.

2.2.3.1. Dredging

Dredging of the "inter-pier" channels and basins adjacent to the seaward bulkheads is required to accommodate the range of vessels that would use SBMT. Existing water depths in the proposed 14.2-acre dredging footprint range from 9 to 32 feet below MLLW (-14 to -37 ft MHW). The bottom habitat in the dredging footprint is predominantly unconsolidated silt. Sediments will be dredged to depths of up to 20 feet below the existing mudline to a final water depth of -38.1 ft MLLW (-43.0 ft MHW) to accommodate drafts of vessels required to install offshore WTGs.

Table 2-2 summarizes the proposed areas and volumes of dredging, and Figure 2-11 depicts the areas where dredging would occur. All dredged material estimates for uncapped areas include two feet of allowable "over-depth" to account for variance in dredging operations and seafloor composition (e.g., large boulders that would have to be removed beyond dredge depth). An additional three feet of dredging would be required to install a sediment cap over new dredged surfaces in Areas 2.1A and 2.3 (one foot for the sediment cap and two feet to prevent damage to the sediment cap from maintenance dredging). The additional "over-depth" described above is limited to one foot for sediment-capped areas. Additional detail on sediment capping is provided in in Section 2.2.3.2, below.

Table 2-2. Approximate proposed dredging areas and volumes

Dredging Area	Location	Basin Area of Dredging (acres)	Volume to Design Depth (cubic yards)	Volume Dredged for Capping (cubic yards)	Volume in Over-depth (cubic yards)	Depth of Over-depth (feet)	Total Dredged Material (cubic yards)
1.0	35N	2.9	10,300	0	8,000	2	18,300
2.1A	39W	2.2	28,300	16,200	3,500	1	48,000
2.1B	39W	0.6	5,700	0	2,400	2	8,100
2.2.1	39N	3.9	11,000	0	12,900	2	23,900
2.2.2	35W	1.3	4,100	0	3,700	2	7,800
2.3	39S	3.4	65,300	14,300	3,300	1	82,900
	Total	**14.2**	**124,700**	**30,500**	**33,800**	**--**	**189,000**

Dredging would be conducted using a clamshell dredger with a closed environmental bucket, which would be operated using a crane on a barge. The dredge would be slowly withdrawn through the water column to minimize generation of turbidity. Dredged sediments would be deposited into scows, allowed to settle for 24 hours prior to onsite decanting, and then transported to an appropriately permitted upland disposal site. Dredged material would potentially be beneficially reused, depending on its suitability for such uses.

Dredging is anticipated to occur 24 hours a day over a period of 140 days during the summer and fall of 2024 and fall of 2025. Consistent with permit conditions, best management practices (BMPs) to control turbidity would be used, including avoiding barge overflow, avoiding draining of the bucket into the water column, careful placement of the dredge material onto the scows, and use of turbidity curtains for a large proportion of the dredge area. A turbidity curtain would be installed from the 35th Street "Pierhead" to the 39th Street "Pierhead" prior to dredging Area 2.2, as available infrastructure and existing river currents allow; a similar approach would be used in Area 1 and Area 2.3. However, turbidity curtain use is not practical for 35W and 39W because of fast currents in Upper New York Bay. In addition to the previously described BMPs, the use of a clamshell dredge with a closed environmental bucket would minimize movement of turbidity beyond the dredge footprint. Further, dredging would not be conducted from March 1 to June 30 and October 1 to November 30 in accordance with time-of-year restrictions to avoid periods of anadromous fish migrations.

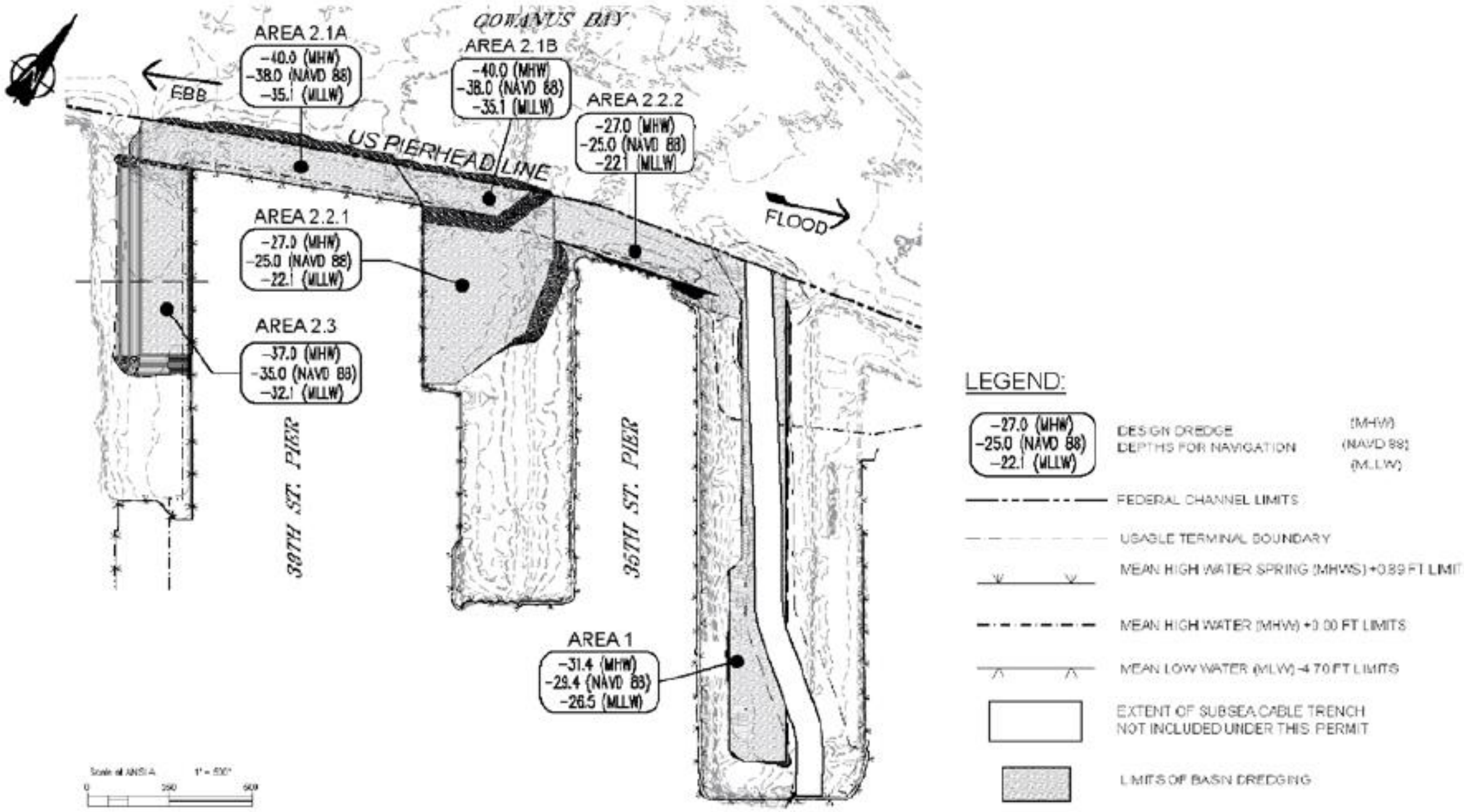

Figure 2-11. Footprint of proposed dredging

2.2.3.2. Sediment Capping

Sediment capping of newly dredged surfaces would be conducted to minimize resuspension of contaminants. A one-foot clean sand cap would be placed post-dredging in Areas 2.1A and 2.3 where dioxin concentrations exceed thresholds. An approximately 5.6-acre area would receive one foot of clean sand, amounting to 9,033 cubic yards of material. Once dredging has been completed, the target depth would be confirmed by multibeam echosounder imaging. Clean sand would then be barged onsite, and sand would be applied to the dredged footprint using a clamshell dredger with a closed environmental bucket, lowered slowly through the water column to minimize generation of turbidity. It is anticipated that capping operations would be conducted 12 hours a day for 14 days and would occur immediately following dredging of the respective areas. Turbidity curtains and other applicable BMPs would be employed in a manner similar to that as described for dredging. The proposed footprint of sediment capping is depicted in Figure 2-12.

2.2.3.3. Bulkhead Replacement / Improvement

Existing bulkheads were evaluated by engineers based on the loading requirements required to support the use of SBMT by the OSW industry. Components of OSW facilities are substantially heavier than the containers that SBMT was built to accommodate, and there has been deterioration of bulkheads because of the age of the structures. Several bulkheads at SBMT were identified as requiring replacement or reinforcement to improve stability and to support the increased loads of associated with OSW activities, including the south side of 39th Street “Pier” (39S), the west side of 39th Street “Pier” (39W), a portion of the bulkhead along the bulkhead line between 32nd and 33rd Streets (32-33), and an upland bulkhead on the north side of 35th Street “Pier” (35N). A total of 1,744 linear feet of new bulkhead or sheet pile toe wall would be installed at SBMT.

39th Street “Pier” South Bulkhead Replacement

Approximately 1,055 feet of bulkhead would be replaced along the southern bulkhead of the 39th Street “Pier” South (39S). New sheet piles would be installed to create a new bulkhead surface approximately 72 inches in front of the existing bulkhead surface. The 39S bulkhead replacement would be a single structure comprised of two sections: Southwest (39SW) and Southeast (39SE). Section 39SW is adjacent the proposed heavy lift crane pad and would have attached cone fenders. During installation, 468 27.6-inch diameter sheet piles would be installed from a crane-equipped construction barge by using a vibro-hammer to drive the piles to design depth. The new bulkhead would then be backfilled with clean gravel and concrete fill to approximately MLW before capping with concrete on the top of the new deck. Finally, new cone fenders would be installed over the new 39SW bulkhead. BMPs would be used during the bulkhead replacement to prevent wet concrete or concrete leachate from entering the water column.

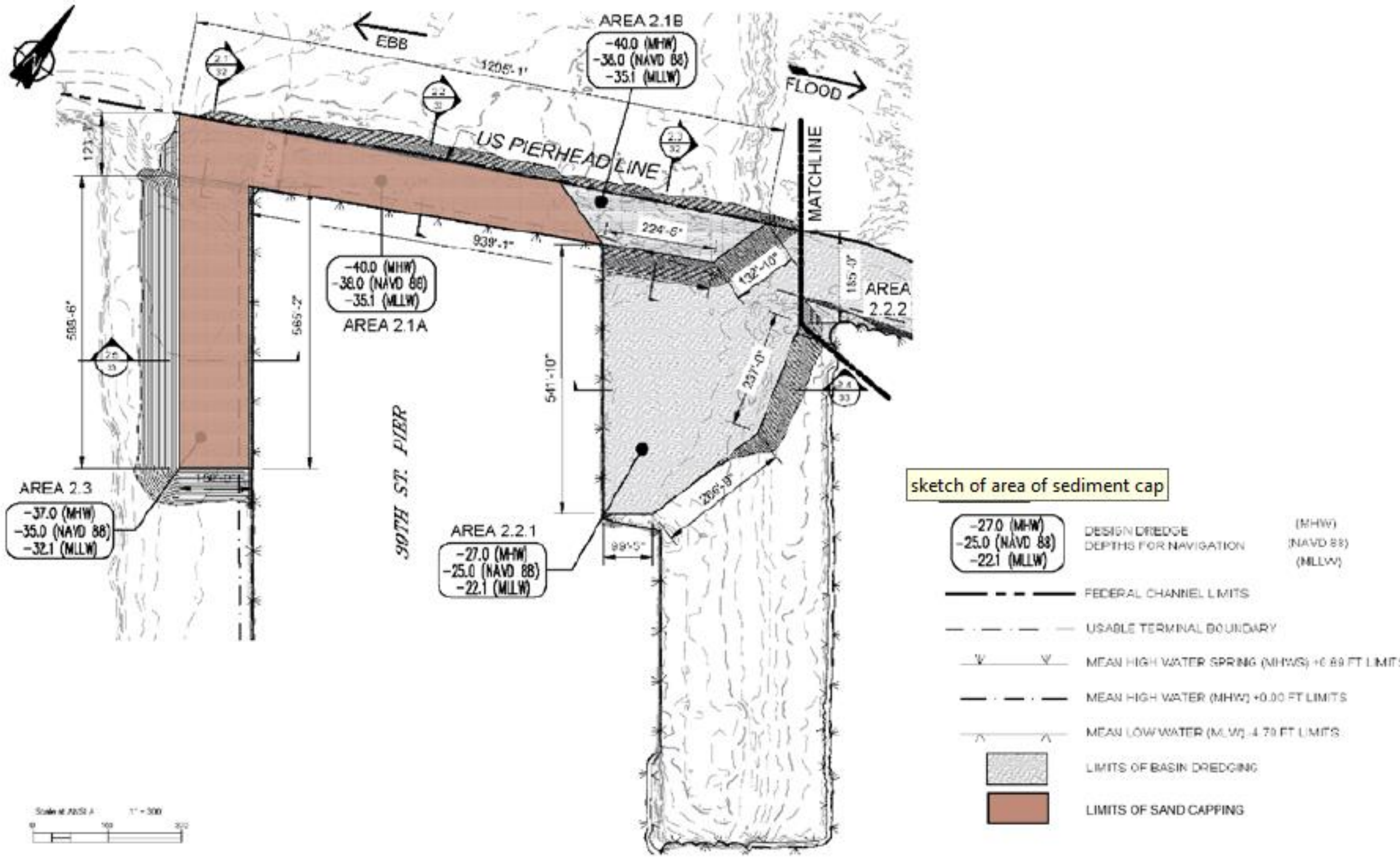

Figure 2-12. Footprint of proposed sediment capping

39th Street "Pier" West Toe Wall

An evaluation of the existing bulkhead at the 39th Street "Pier" West (39W) determined that the existing sheeting does not extend sufficiently deep, such that the proposed dredging of Area 2.1 may undermine the bulkhead and cause it to fail. To address this, a new sheet pile toe wall is proposed to be installed immediately seaward of the existing bulkhead. The toe wall would be 689-feet long and would be comprised of AZ-38 sheet piles with a diameter of 27.6 inches. This wall would be installed such that the bottom of the new sheeting would extend to -70 feet (NAVD 88), and the installed sheet piles would sit approximately 40 feet below the existing mudline. During installation of the 39W toe wall, 302 sheet piles would be installed from a crane-equipped construction barge by using a vibro-hammer to drive the pile to design depth. Following installation, the sheet piles would be cut and trimmed to a height of 5 feet above the mudline. The area above the mudline between the new toe wall and the existing bulkhead would then be filled with concrete via a tremie to prevent exposure of the concrete to saltwater prior to curing. During installation, BMPs would be used to prevent wet concrete or concrete leachate from entering the water column. New cone fenders would then be installed at 39W.

32-33 Bulkhead Replacement and Enforcement

The existing structure north of the 35th Street "Pier" consists of a gravity wall and a low-level relieving platform connected to a combined sewer outfall structure. The relieving platform, which is soil-filled and supported by timber piles, is in degraded condition as existing support from timber piles has been determined to be unsalvageable. The relieving platform would be removed from land via removal of the pavement, excavation of remaining soil fill, and removal of the lower concrete deck. The existing timber piles supporting the demolished relieving platform would be cut to the mudline and removed. A stone armor layer would be installed as part of the seabed slope up to the timber bulkhead to act as scour protection. To provide lateral support of the upland fill, a new steel sheet pile wall would be driven on the landside of the existing timber pile bulkhead, connected towards the gravity wall to the south and the combined sewer outfall structure to the north. The existing platform structure would then be replaced with a new concrete high-level relieving platform supported by hollow 20-inch diameter steel pipe piles. The new structure would be elevated above the tidal zone. This new structure is required to facilitate OSW activities, including access to the new dock for crew transfer vessels (CTVs).

The replacement high-level relieving platform would be positioned above MHWS, as opposed to the existing relieving platform which occupies the water column above approximately MLW. Thirty-nine, 20-in diameter steel pipe piles would be installed to an approximate tip elevation of -67 ft below MHW to support the new composite platform. New precast concrete pile caps of 36-in width and 21-in thickness would be installed on top of the pipe piles. A composite platform deck comprised of precast planks and in-situ top slab would be installed on top of the pile cap. The new platform would meet the existing upland surfaces and would provide the structural capacity for the increased loads required of the new functions of the SBMT facility. No work would take place seaward of the existing gravity wall bulkhead. BMPs would be used to prevent wet concrete or concrete leachate from entering the water column.

35th Street "Pier" North Localized Bulkhead Replacement

A 90-foot section of recessed bulkhead upland of the slope on the northern edge of the 35th Street "Pier" North (35N) would be replaced with a new sheet pile wall to provide structural connection from the landside portion of 35N to a proposed Service Operation Vessel (SOV) loading wharf. The sheet pile wall would be 90 feet long and would consist of AZ-24 sheet piles driven to an elevation of -48.0 feet (NAVD 88). This sheet pile wall is intended to reinforce the existing earthen "pier" to support design loads that will approach and transfer over the proposed SOV loading wharf (detailed in Section 2.2.3.4). The bulkhead replacement would take place entirely in the upland area of 35N. Pipe piles would be installed using a vibro-hammer for the majority of the length and then an impact hammer would be used over the last 10 to 15 feet to ensure the piles are fully seated in the load bearing soil / stratum.

35th Street "Pier" West Removal of Existing Cofferdam

An evaluation of the existing cofferdam at 35th Street "Pier" West (35W) determined that this structure has insufficient live loading capacity to be of use in future SBMT activities. Therefore, the removal of the cofferdam is being proposed to mitigate the placement of fill for other elements of the Connected Action. Prior to removal of the cofferdam, a new sheet pile wall would be installed landward of the area to be excavated, to act as a bulkhead to provide support to the remaining "pier" structure. All perimeter cells would be internally excavated down to the existing adjacent mudline before being cut back. After excavation, traditional under water cutting methods would be applied to cut back the obsolete cell structure. The exposed surface would be graded to a 2:1 (horizontal:vertical) slope, and a 1-foot thick layer of bedding stone would be installed, followed by a 3-foot layer of armor stone to stabilize the new shoreline. Removal of the cofferdam and associated fill would reduce the volume of existing fill occupying the water column and the area of mudline disturbance, thereby creating new marine habitat and new unvegetated tidal wetland habitat.

2.2.3.4. Installation of New Wharves

Three new platforms would be installed over water to enable the SBMT to berth and onload/offload specialized vessels. One pile-supported platform would extend west off of 35W for transport and construction barges, one pile-supported platform would extend north off of 35N to accommodate berthing of SOVs, and one floating platform would be installed off of the new 32-33 platforms to accommodate berthing of CTVs.

Construction Barge Wharf

A wharf would be installed extending from the new 35W sheet pile wall to support the loading and unloading of construction vessels. This wharf would be a pile-supported concrete platform with an enhanced capacity relative to the existing cofferdam structure at 35W. The proposed design of the wharf minimizes environmental impacts by using hollow steel pipe piles for support and extending the platform surface approximately 40 feet from the existing cofferdam surface, thereby minimizing dredging for access to the new wharf. A total of 216, 48-inch diameter hollow steel pipe piles would be installed, including 104 piles in marine habitat and 5 piles in tidal wetland habitat. The piles would support a 322- by 196-foot platform, two dolphins, and a 17- by 199-foot foot walkway, which would comprise a total deck area of 66,397 square feet. The dolphins would consist of four-pile clusters connected to the wharf by a grated metal access walkway.

Piles seaward of the cofferdam would be installed in the sediment without pre-installation excavation. Steel pipe piles located in marine areas seaward of the existing cofferdam that are beyond the reach of the upland crane would be installed from a crane barge by using a vibro-hammer to drive piles over the majority of the length and then using an impact hammer to drive piles over the last 10 to 15 feet to ensure the piles are fully seated in the load bearing soil/stratum. Slow starts would be used during impact pile driving in the marine environment to minimize potential noise impacts. After installation to design depth, piles would be topped with a concrete cap, and the deck surface would be installed upon the cap. BMPs would be used during installation to prevent wet concrete or concrete leachate from entering the water column.

Service Operations Vessel Loading Wharf

A new wharf for SOVs would be installed at the new 35N bulkhead to support the operations and maintenance of OSW facilities. This pile-supported concrete wharf would support a 100- by 100-foot platform, 266 feet of 3-foot-wide walkways, and four 16- by 16-foot dolphins, amounting to a total platform area of 9,640 square feet. The wharf would be designed to accommodate the berthing of SOVs in all relevant ocean conditions and is dimensioned for loading / offloading of an SOV by the vessel's onboard crane or by a shore-based telehandler-type forklift. The design lifting capacity would be 20-foot containers with a weight of up to 12 metric tons. Personnel transfer to and from the vessels would be facilitated from the platform over the vessel's gangway. Shore power would be provided to vessels to avoid running the onboard engines while berthed.

Prior to the installation of the SOV loading wharf, a 421- by 110-foot area (46,310 square feet) centered on the proposed wharf would be excavated and regraded to create a stable foundation for the wharf in an area adjacent to the required dredging footprint. Approximately 10,532 cubic yards of material consisting of riprap and fill would be excavated below MHW. The slope would be regraded at 3:1 (vertical:horizontal), and a one-foot depth of bedding stone would be laid throughout, followed by a five-foot depth of scour protection riprap, amounting to a total depth of 6 feet of stone. The regrading would temporarily disturb 0.75 acres of marine habitat and 0.31 acres of tidal wetland habitat, replacing it with similar material. All excavation, grading, and installation of material would be done to the extent possible via excavators from land, with remaining work being done via excavators upon barges. Dewatering procedures would be identical to those described for dredging (see Section 2.2.3.1, above).

The SOV loading wharf would be supported by steel pipe piles. Prior to installing of the piles, selected sections of the riprap would be temporarily removed and dry-stored to enable pile driving. Thirty-six, 36-inch diameter steel pipe piles would be installed to support the main deck via crane barge using a vibro-hammer for the majority of the length and an impact hammer over the last 10 to 15 feet to ensure the piles are fully seated in the load bearing soil/stratum. Sixteen, 36-inch diameter pipe piles would be installed to support four separate dolphins in a similar manner. In total, 52 piles would be installed, 46 of which would be in-water. During impact hammer use on the crane barge, slow starts would be used to minimize potential noise impacts. Piles would be left unfilled except for a concrete pile plug for the upper 5 feet. BMPs would be used to prevent wet concrete or concrete leachate from entering the water column.

Crew Transfer Vessel Wharf

A wharf would be installed off of the basin area between 32nd and 33rd Streets to provide docking for CTVs transporting crews to and from OSW sites. The CTV wharf would be a 15- by 224-foot floating concrete dock, which would be moored to 14, 30-inch diameter hollow steel pipe spud piles. Access to the dock would be provided via an 8- by 30-foot tidally adjusted walkway, which would be supported by and anchored to the adjacent installed platform. The piles would be installed via crane barge using a vibro-hammer for the majority of the length and an impact hammer over the last 10 to 15 feet to ensure the piles are fully seated in the load bearing soil/stratum. Slow starts would be used during impact hammer operations on the crane barge to minimize potential noise impacts. The spud piles would not be filled but would prevent access to approximately 78 square feet of marine habitat. The floating concrete deck would occupy approximately 750 cubic yards of the water column during all tidal phases and would have a footprint of 3,360 square feet. The walkway would shade approximately 204 square feet of marine habitat underneath it.

2.2.3.5. Vessel Activity

The Connected Action would result in a small increase in vessel traffic. During construction, less than 1 vessel per day is expected to be used. Vessels that are expected to be used during construction include a barge with a mounted crane to install pilings or dredge sediments, and tugs and barges to transport materials or receive and transport dredging material. All construction vessels would have a large below-water envelope and would operate at a slow speed.

During operation, up to 9 vessels may transit to and from SBMT per week. Vessels visiting SBMT during operation are expected to include cargo carrying vessels (CCVs), barges, SOVs, and CTVs. Pursuant to analyses of infrastructure and site conditions, vessels would berth in the following arrangement:

- CCVs would berth along the west (offshore) and south faces of the 39th Street “Pier” (39W, 39S);
- Barges would berth along the north and west face of the 39th Street “Pier” (39N, 39W) and along the west face of 35th Street “Pier” (35W);
- SOVs would berth along a proposed wharf off of the northeastern edge of the 35th Street “Pier” (35N); and
- CTVs would berth along a proposed floating wharf platform extending from the existing bulkhead located between 32nd and 33rd Street (32-33).

The characteristics of the vessels that would use the berths at SBMT are summarized in Table 2-3.

Table 2-3. Design vessel characteristics for vessels berthing at SBMT

Vessel Type	Length (feet)	Beam (feet)	Maximum Draft (feet)
Barge	400	105	19.2
CCV	508	88	31.2
SOV	262	64	22.3
CTV	90	40	6.5

2.3. Operations and Maintenance

The operational lifespan of EW 1 and EW 2 is expected to be 35 years, based on the design life of the Project components. The operational parameters of EW 1, EW 2, and the OECs that are pertinent to this assessment are summarized in Table 2.1, above. The permanent impacts on the environment resulting from Project operations, including the presence of structures, EMF and heat effects from the transmission cables, and underwater noise, are quantified in Section 5, below.

The Project will be designed to operate with minimal day-to-day supervisory input, with key systems monitored from a central location, 24 hours a day. Empire Wind intends on constructing and maintaining a staffed O&M Base consisting of up to two enclosed buildings on an approximately 4.5-acre (1.8-hectare) portion of SBMT. This O&M Base will monitor operations and include office, control room, warehouse, shop, and pier space. The final selection will be determined upon whether the facility will be able to accommodate Empire’s workforce and equipment needs.

All offshore components will require routine maintenance and inspections. It is anticipated that service operations vessels and crew transfer vessels will be used to support O&M activities offshore. Helicopters are currently being considered to support the Project; Empire is continuing to evaluate logistics, and the relevant impact assessments will be updated pending the final decision.

Generally, offshore O&M activities will include:

- Inspections of offshore components for signs of corrosion, quality of coatings, and structural integrity of the wind turbine components;

- Inspections of up to 10 percent of foundation scour protection in order to monitor and document habitat disturbance and recovery, every three years starting at year three;
- Inspections and maintenance of the wind turbine and OSS electrical components/equipment;
- Surveys of the submarine export cables and interarray cables routes, to confirm the cables have not become exposed or that the cable protection measures have not worn away. Following the full coverage as-built survey, annual, risk-based inspections will be conducted for the first three years. For the remainder of the Operations Term, risked-based bathymetric surveys will be conducted every two years. Risk-based burial depth surveys will be conducted every five years, with coverage to be determined through the use of Distributed Temperature and Distributed Acoustic/Vibration Sensing (DAS/DVS) systems. Additional survey activities will be completed on an as-needed basis, determined based upon various factors, such as extreme weather events.;
- Sampling and testing (including of lubricating oils, etc.);
- Replacement of consumable items (such as filters, and hydraulic oils);
- Repair or replacement of worn, failed, or defective systems (such as wind turbine blades, gearboxes, bolts, corrosion protection systems, protective coatings, cables, etc. including cleaning off subsea marine growth, realigning machinery, renewing cable protection using additional rock dumping or mattress placement, etc.);
- Updating or improving systems (such as control systems, sensors, etc.); and
- Disposal of waste materials and parts (in line with best practice and regulatory requirements).

The WTGs will be remotely monitored from an onshore facility through the Supervisory Control and Data Acquisition (SCADA) system. The SCADA system acts as an interface for a number of sensors and controls throughout the wind farm, allowing the status and performance to be monitored, and for systems to be controlled remotely, where required. The submarine export cables will be monitored through Distributed Temperature Sensing and DAS/DVS equipment. The Distributed Temperature Sensing system will be able to provide a real time monitoring of temperature along the submarine export cable route, alerting Empire should the temperature change, which often is the result of scouring of material and cable exposure. The DAS/DVS system will provide real time acoustic/vibration monitoring indicating potential dredging activities or anchor drag occurring close to the submarine export cables.

In the event of a fault or failure of the offshore components, Empire will repair and replace the Project component in a timely manner. Unplanned maintenance and repair of the wind turbines and OSSs will occur within the component. Should the submarine export or interarray cables fault, the portion of the cable will be spliced and replaced with a new, working segment. This will require the use of various cable installation equipment, as described in Section 2.2.2.3, above.

2.4. Project Decommissioning

In accordance with BOEM requirements, Empire Wind will be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions when these facilities reach the end of their 35-year designed service life. A separate EFH consultation will be conducted for the decommissioning phase of the project.

The decommissioning process for the WTGs, foundations, and OSSs is anticipated to be the reverse of installation, with Project components transported to an appropriate disposal and/or recycling facility. All foundations/Project components will need to be removed 15 ft (4.6 m) below the mudline, unless other methods are deemed suitable through consultation with the regulatory authorities, including BOEM. Submarine export and interarray cables will be removed in accordance with a Decommissioning Plan or retired in place; Empire would need to obtain separate and subsequent approval from BOEM to retire any portion of the Project in place. Project components will be decommissioned using a similar suite of vessels, as described in Sections 2.2, above.

Although EW 1 and EW 2 have an assumed a lifetime of approximately 35 years, some installations and components may remain fit for continued service after such time, where Empire Wind may seek to repower such installations if extension is authorized by BOEM. Upon initiation of decommissioning activities, Empire Wind will complete decommissioning within two years of termination of the Lease and either reuse, recycle, or responsibly dispose of all materials removed, unless otherwise authorized by BOEM.

3. Existing Environment

The existing environment consists of existing EFH conditions in the Project area. To support the characterization of fish and invertebrate resources, Empire conducted extensive site-specific surveys, compiled data from publicly available databases (e.g., NMFS EFH Mapper; Northeast Regional Ocean Council; Mid-Atlantic Ocean Data Portal), regional surveys, and resource reports (e.g., Battista et al. 2019; NYSERDA 2017; Guida et al. 2017; NEFMC 2017; NMFS 2017; MAFMC 2016, 2017), and incorporated relevant peer-reviewed literature.

Site-specific geophysical, geotechnical, and benthic surveys were conducted across the Lease Area and a large proportion of the submarine export cable siting corridors from March 2018 to November 2018 using multibeam echo sounder (MBES), side scan sonar (SSS), digital imagery, and sediment grab samples. Site-specific and Project-specific geophysical survey data (multibeam echo sounder and side-scan sonar) were used to support the characterization of seabed conditions. Sediment grab samples were analyzed for grain size distribution, total organic carbon, and benthic infauna and were used to ground truth the sediment types observed in digital imagery. Digital imagery was reviewed to aid in identification of key habitat types, macroinvertebrates, and fish.

Additional surveys were conducted along the proposed cable corridors in spring 2019 using sediment profile imagery (SPI) and plan-view imaging supplemented by grab samples. To augment the 2019 survey data and characterize previously unsurveyed portions of the EW 2 submarine export cable siting corridor, Empire conducted additional benthic surveys from October 2020 to May 2021. The 2020/2021 surveys collected MBES, SSS, ultra-short baseline, sound velocity profiler, magnetometer, sub-bottom profiler, water quality profiler, digital imagery, and grab sample data.

3.1.1. Lease area

Sediments in the Lease Area are typical of the Mid-Atlantic Bight, dominated by medium-sized sand and gravel; mean grain size generally diminishes with distance from shore (MAFMC 2016). Softbottom substrate includes unconsolidated material ranging from gravel (> 2000 micrometers [µm]) to sand (62.5 to 2,000 µm), silt (4 to 62.5 µm), and clay (< 4 µm) (Williams et al. 2006), as well as empty shells and shell fragments of various sizes. Empire’s geotechnical and geophysical survey of the Lease Area from March to December 2018 (Figure 3-1) demonstrated that habitat in the Lease Area is generally homogenous, with unconsolidated sediment grain sizes ranging from gravelly muddy sand to sandy gravel. Analysis of sonar data together with environmental samples and photographs collected during the survey revealed predominant seabed sediments to comprise sand. Regions of higher reflectivity predominantly towards the west of the survey site were interpreted from the sonar data to comprise sand with gravel and areas of shell fragments. Linear debris items were interpreted throughout the survey area (Figure 3-2). Among 67 stations where sediment grab samples were collected during Empire’s benthic survey of the Lease Area, most of the stations (n=44) were classified as medium sand, while the remaining stations varied from very coarse silt to very coarse sand. All habitat in the WTA was classified by NOAA Habitat Complexity Category based on analysis of benthic grab samples (Figure 3-3). The classified habitat in the WTA includes 60,684 acres of soft bottom habitat, 4,051 acres of complex habitat, and 57 acres of heterogeneous complex habitat.

Empire's geophysical surveys corroborated the characterization of the Lease Area in other reports as relatively flat, unconsolidated softbottom dominated by sand and ripples, with small areas of sandy mud and pebbles (NYSERDA 2017; Guida et al. 2017; Battista et al. 2019). Three composite habitat types were identified based on the approximately 400 samples collected and analyzed by NMFS to support benthic characterization; most of the Lease Area was characterized as rippled sand or megaripple sand with high occurrence of faunal beds (Figure 3-4, Battista et al. 2019). Independently derived visual characterization of sediment by UMASS SMAST supported these observations (Guida et al. 2017). Relict (not currently active) megaripple bedforms are present within the eastern Lease Area, measuring less than 1 m in height with wavelength 50-70 m (164-229 ft) and generally orientated north-northwest / south-southeast. The southeast portion of the Lease Area is within a ridge-and-swale zone. The ridges found here measure <1.5 m (4.9 ft) height, wavelength 1 km (0.6 mi) with orientation west-southwest/east-northeast and are thought to be shoreface deposits left during shoreline transgression at the last rise in sea level. The smaller scale megaripple bedforms are superimposed on sand ridges and can be more mobile than the sand ridge itself.

Sessile and slow moving epifauna observed along transects in the Lease Area are characteristic of this type of habitat (e.g., sand dollars, mobile crustaceans, burrowing anemones, tube-building fauna). In 67 sediment grab samples collected along three transects in the Lease Area between August and November 2018, a total of 186 infaunal taxa were identified. The species assemblage and the ranked taxonomic dominance varied across stations, indicating that stations were dissimilar from one another. About 30 percent of the taxa were arthropods and 30 percent were mollusks. The most numerically abundant taxon by a wide margin was the Polygordiidae polychaete family, which occurred in all but two samples; this family represented about 39 percent of the nearly 67,000 individuals collected in all Lease Area. Each grab sample was classified using Coastal and Marine Ecological Classification Standard (CMECS); the distribution of CMECS Biotic Groups based on grab samples is shown on Figure 3-5. Empire collected more than 3,000 digital images along 1,970-ft (600-m) transects and at each of the benthic grab locations. The most frequently observed benthic invertebrate in the images was the common sand dollar; 52 stations were categorized as Sand Dollar Beds using CMECS (Figure 3-6). Seven stations had relatively high densities of faunal tubes (CMECS Small Tube-Building Fauna), three stations were categorized as Burrowing Anemones, and four stations as Mobile Crustaceans on Soft Sediments. One station at the extreme western end of the Lease Area was categorized as Large Tube-Building Fauna. Of the managed species with EFH designated in the Lease Area, the ocean quahog, winter skate, and various flounder and hake species were observed throughout the Lease Area in video and image assessments (see Appendix T, Attachment T-2 of Empire 2021); more individuals of these species were observed in the deeper waters of the southeastern portion of the Lease Area. No soft coral, lobster, seagrass, or squid eggs were observed during any of the benthic surveys.

No hardbottom, other than areas of pebbles, muddy sandy gravel, and sandy gravel, was observed in the 2018 surveys of the Lease Area. However, the 2019 and 2020 geotechnical surveys of the Lease Area identified 932 new natural features, namely cobbles and boulders. Cobbles and boulders range between 0.1 m (0.3 ft) x 0.1 m (0.3 ft) x 0.1 m (0.3 ft) and 2.6 m (8.5 ft) x 1.1 m (3.6 ft) x 0.2 m (0.7 ft) in size. Cobbles and boulders are scattered with a higher density being observed in association with areas of coarser sediment (slightly gravelly sand) in the north and west of the Lease Area. Some objects identified in the surveys were interpreted to be manmade features, likely associated with fishing activity. A total of

287 such debris items were observed ranging from 0.1 m 0.3 ft) x 0.2 m (0.7 ft) x 0.1 m (0.3 ft) to 5.8 m (19 ft) x 1.3 m (4.3 ft) x 0.8 m (2.6 ft) in size. In addition, 233 items of linear debris up to 201 m (659 ft) in length were interpreted. Artificial hardbottom in the form of shipwrecks and intentionally placed artificial reefs also provides substantial hard structure in the Lease Area. Six known shipwrecks are mapped in the deeper two-thirds of the Lease Area. New York and New Jersey have programs to place and manage artificial reefs in state waters to enhance fish habitat. The distribution of charted recreational diving shipwrecks and state-managed artificial reefs within or adjacent to near the Project area is shown on Figure 3-7.

Numerous gradiometer anomalies identified in the geotechnical surveys were interpreted to be cables crossing the Lease Area. Nine cable crossing were identified in the Lease Area, seven of which were confirmed using the NOAA database, and two of which were interpreted as unknown cables (Figure 3-8).

All waters from the surface to the ocean floor are pelagic. The entire Lease Area is in the photic zone (i.e., top 600 ft [200 m]), the top layer of the pelagic environment where sunlight supports photosynthetic phytoplankton (Karleskint et al. 2006). Water depth influences surface and bottom temperatures, light penetration, sediment movement, and other physical and chemical habitat parameters that define EFH. In the Lease Area, water depths are relatively uniform, ranging from 65 to 147 ft (20 to 45 m) and increasing with distance from shore; about 76 percent of the Lease Area is between 98 and 131 ft (30 and 40 m) deep (Figure 3-9). Oceanic currents, temperature, conductivity, pH, dissolved oxygen, and other features of the water column influence the occurrence and abundance of marine fishes in the Lease Area. The pelagic environment is particularly important for planktonic eggs and larvae, planktivorous or filter-feeding species/life stages, and migratory pelagic species (NMFS 2017; NEFMC 2017). The water column serves dual functions as EFH: it supports the phytoplankton that sustain marine food webs, and it provides a dispersal mechanism for planktonic larvae of many managed species. Phytoplankton (e.g., diatoms, dinoflagellates) thrive where nutrients and sunlight are abundant, such as along the coast of New Jersey where abundant phytoplankton are sustained by nutrients carried to the well-lit surface waters by upwelling. Phytoplankton are consumed by zooplankton (i.e., tiny animals such as copepods and larval forms of crustaceans, bivalves, and other invertebrates) and ichthyoplankton (fish larvae). The most numerically abundant component of the pelagic fish community in the open waters of the Lease Area is the ichthyoplankton assemblage. Buoyant eggs and larvae of most marine fishes in Southern New England can remain in the plankton for weeks to months (Walsh et al. 2015). Plankton were prevalent in acoustic surveys in the Lease Area in 2018, where strong evidence of diel vertical migrations of both plankton and small fish were reported (Battista et al. 2019). The assemblage of species represented in the ichthyoplankton varies seasonally and is strongly influenced by water temperature; patterns of ichthyoplankton assemblages have changed in recent decades, likely in response to climate change (MAMFC 2017; Walsh et al. 2015).

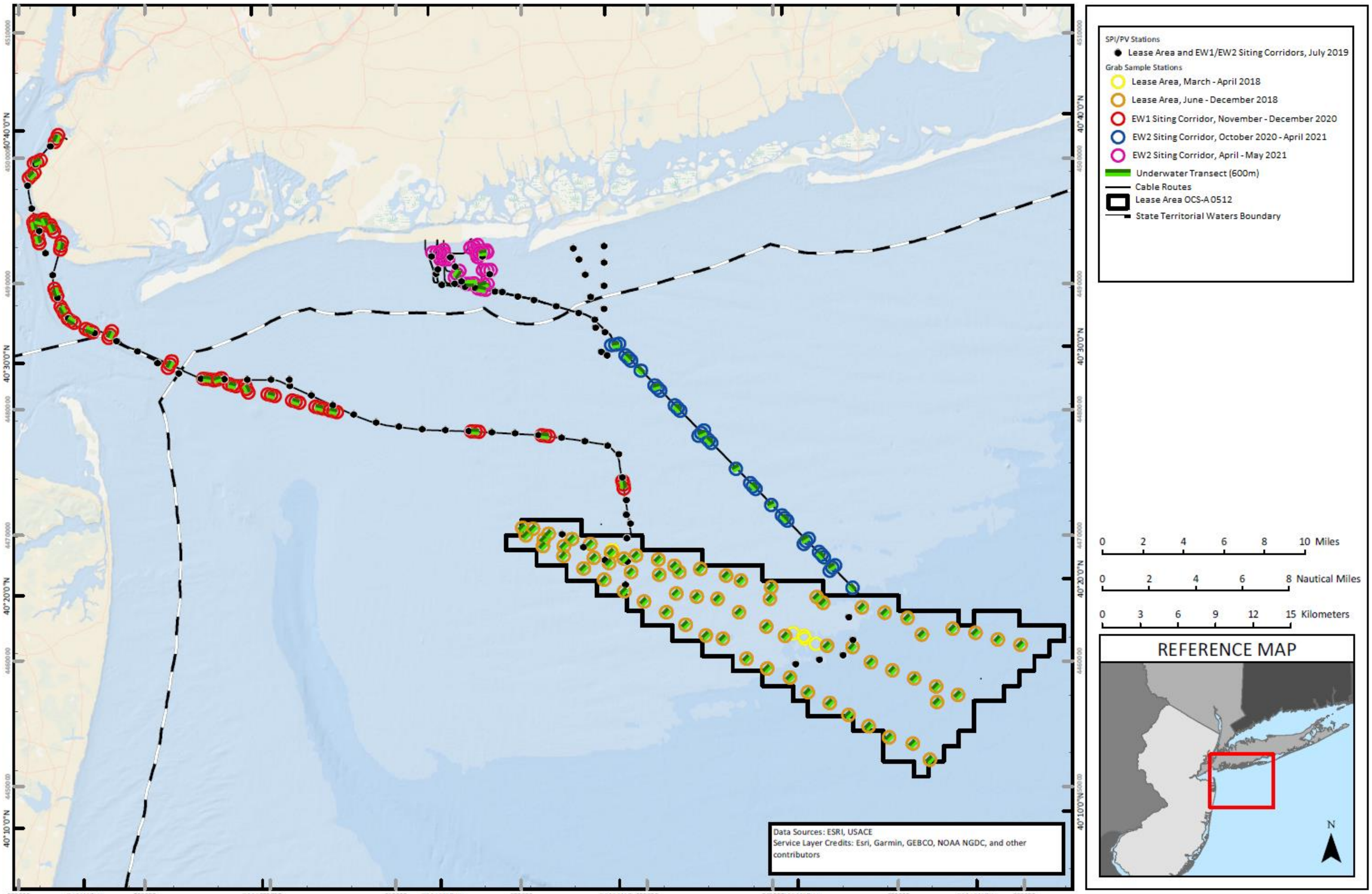

Figure 3-1. Benthic sampling locations during site-specific surveys of the Project area and Connected Action area from March 2018 through May 2021

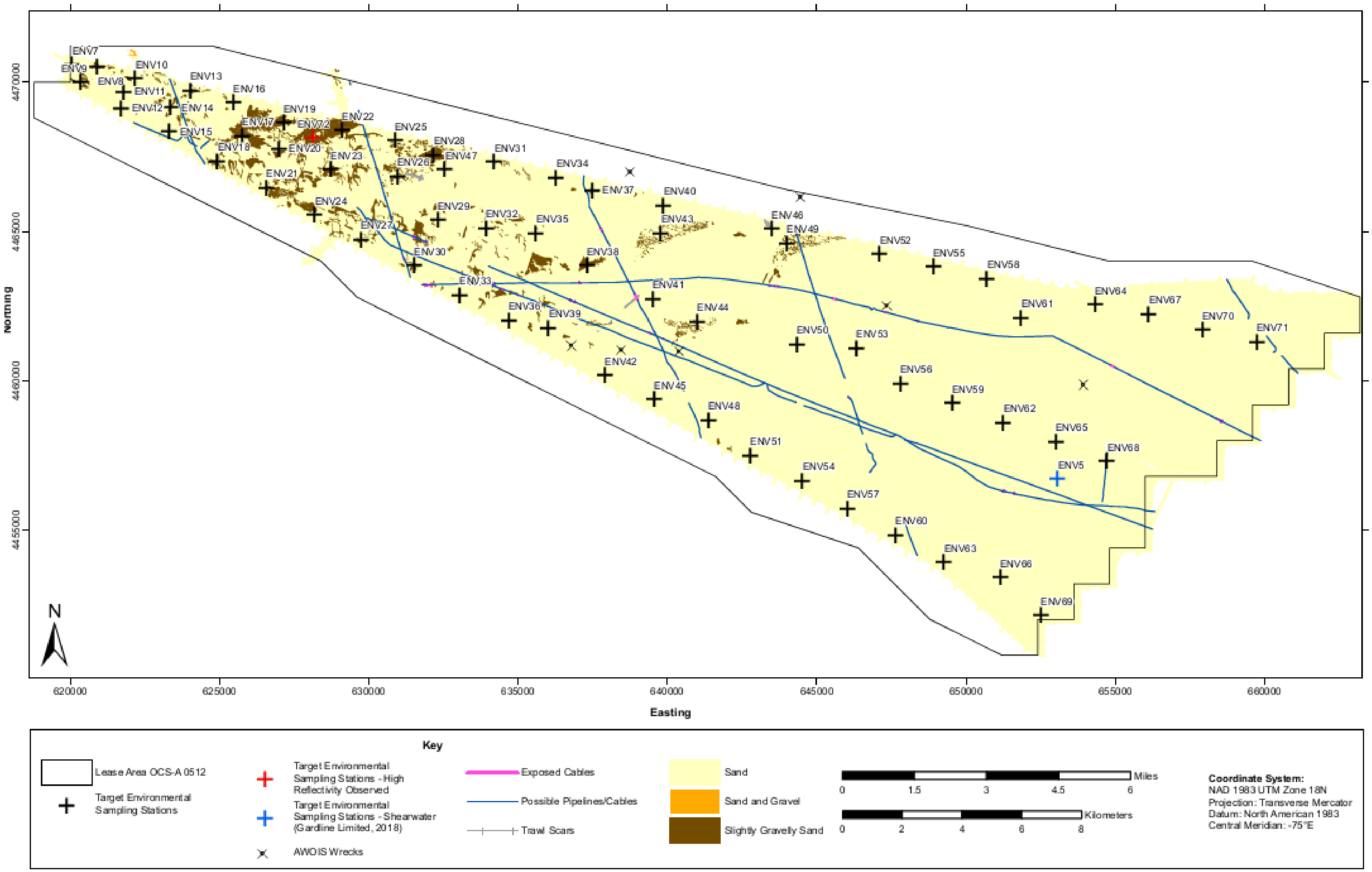

Figure 3-2. Seabed features in the Lease Area

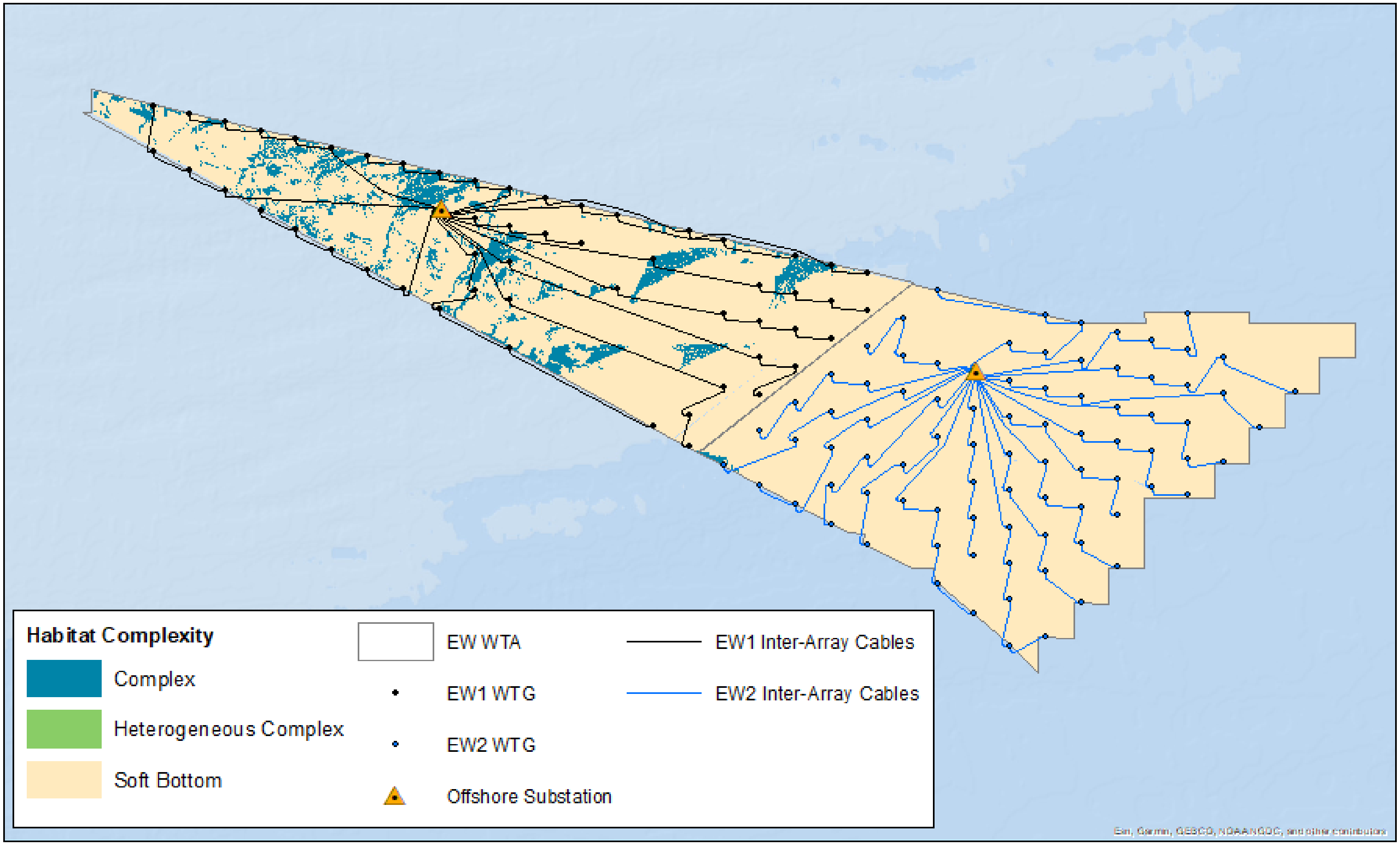

Figure 3-3. Benthic habitats classified by NOAA complexity category in the Wind Turbine Area in relation to 138 potential WTG locations, 2 OSS foundation locations, and associated inter-array cables

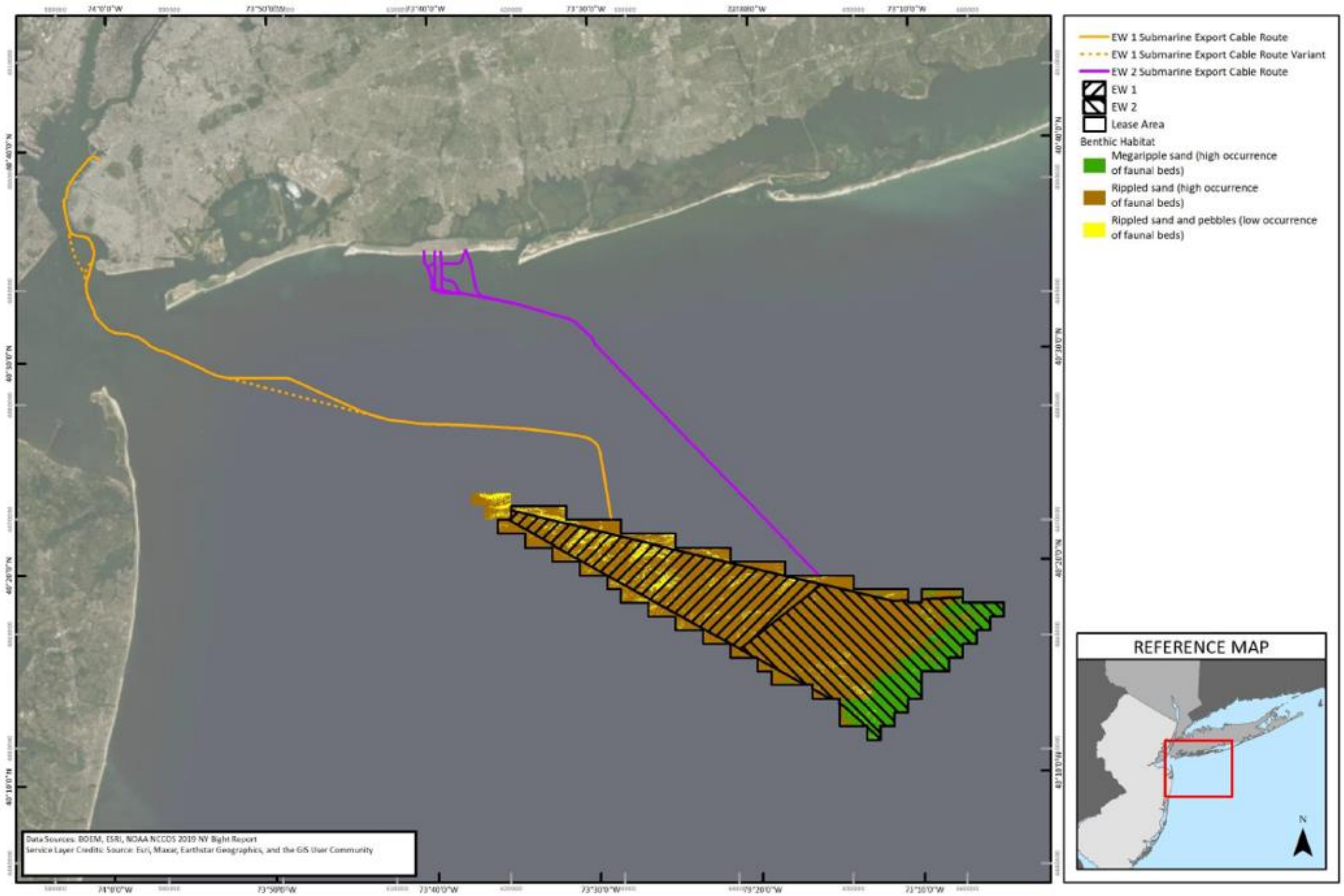

Figure 3-4. Benthic habitat types in Lease Area (Battista et al. 2019)

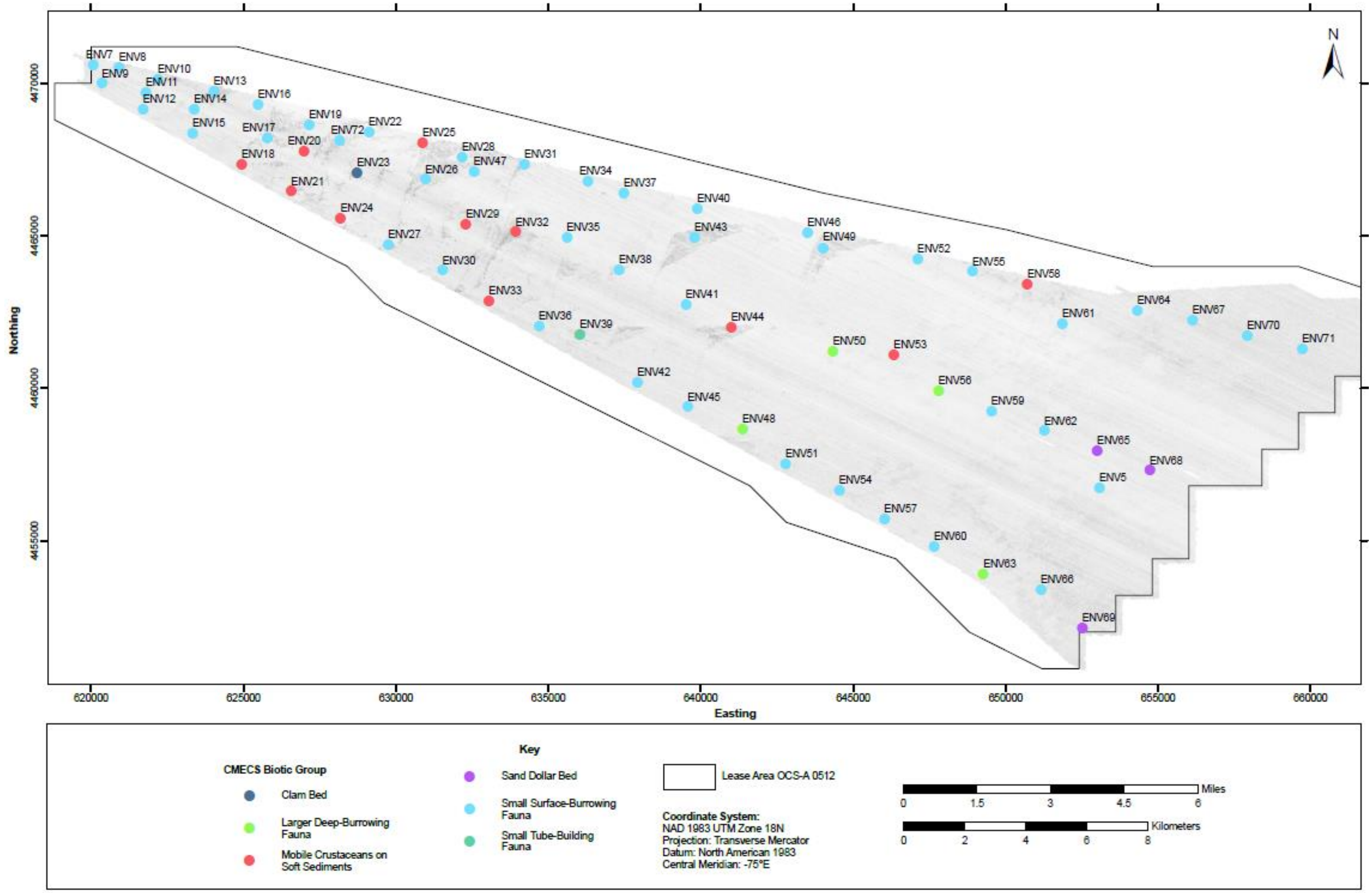

Figure 3-5. CMECS biotic groups based on sieved infauna (Empire Survey, Aug – Nov 2018)

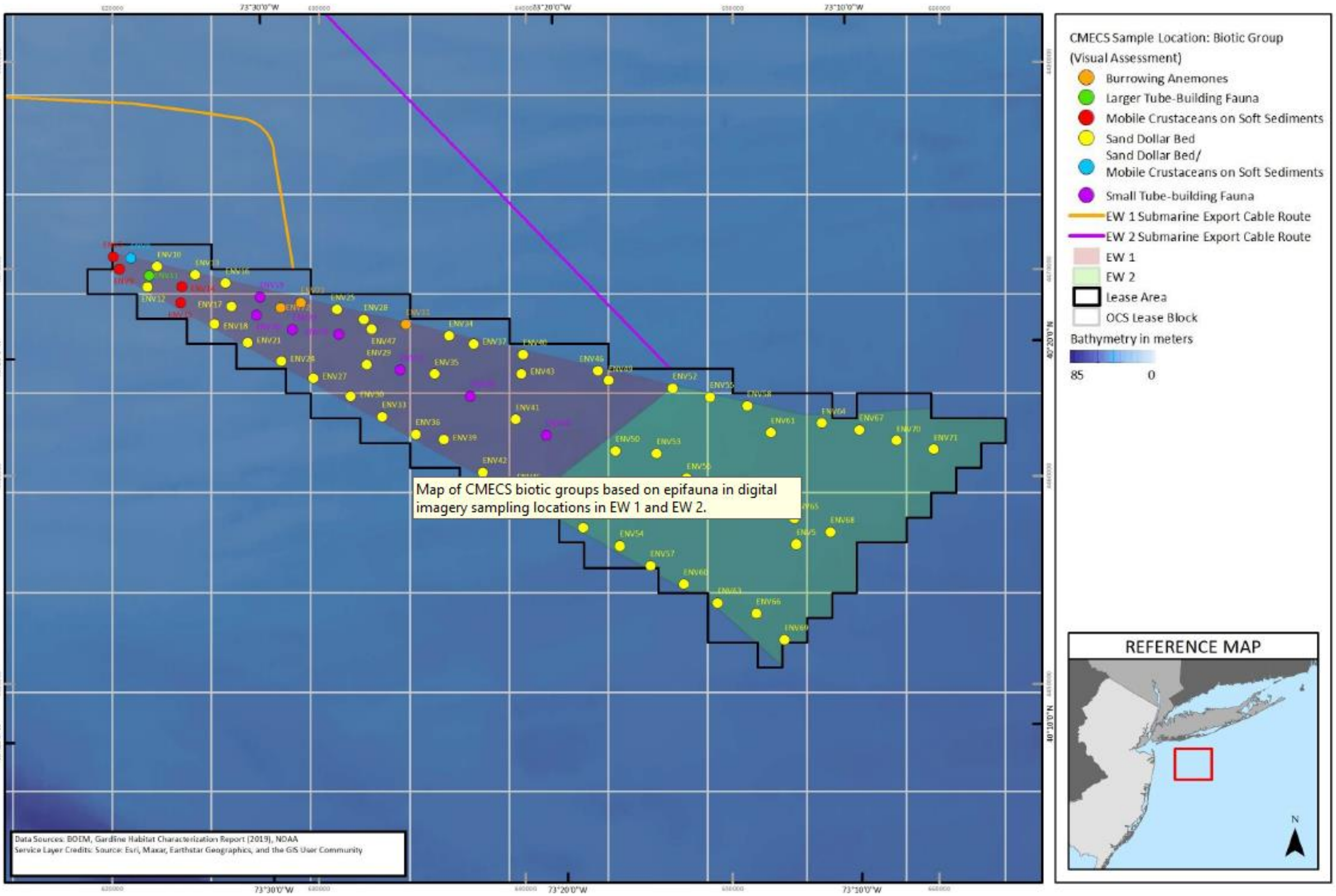

Figure 3-6. CMECS biotic groups based on epifauna in digital imagery (Empire Survey, Aug – Nov 2018)

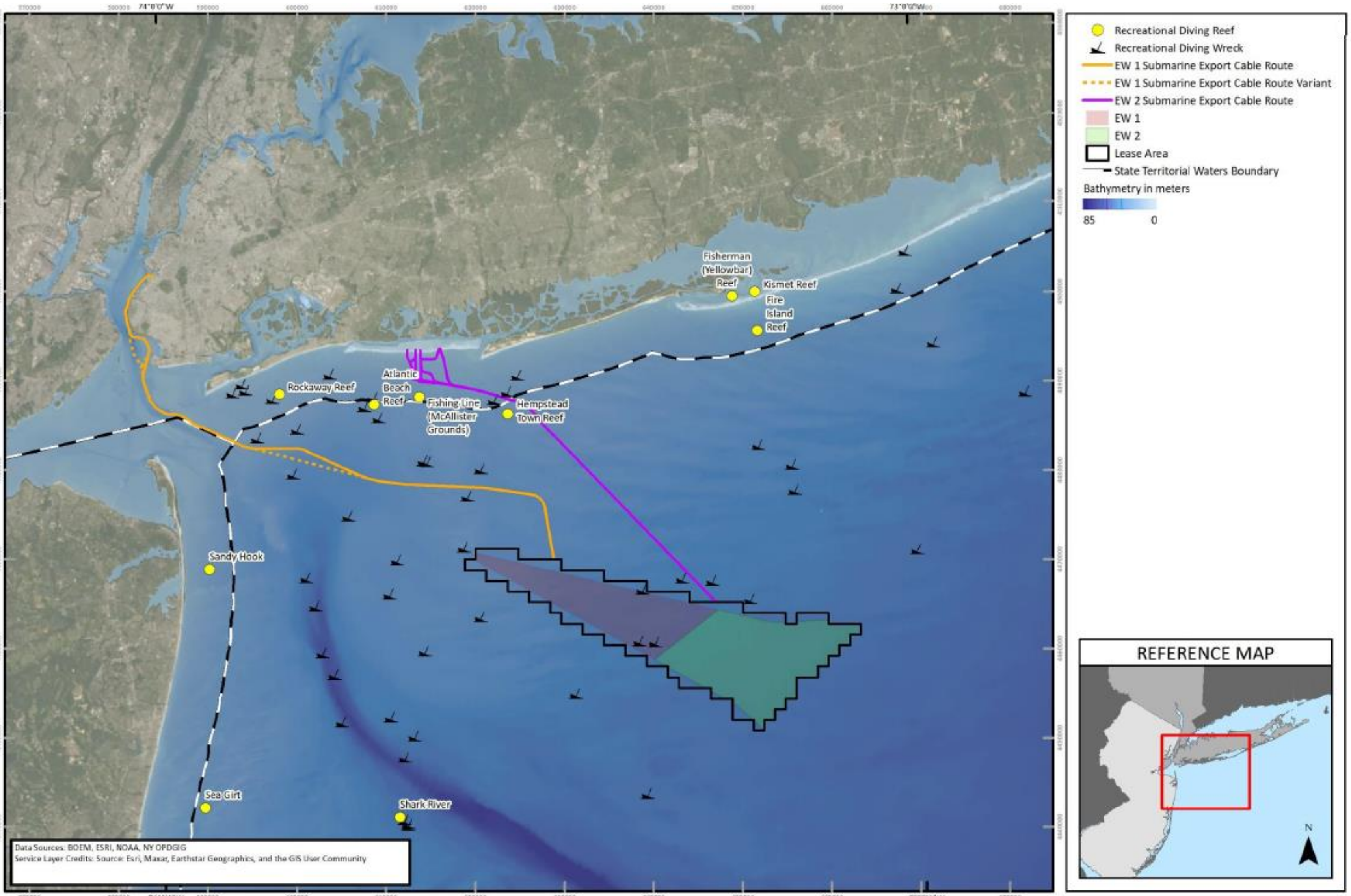

Figure 3-7. Shipwrecks and artificial reefs within and near the Project area

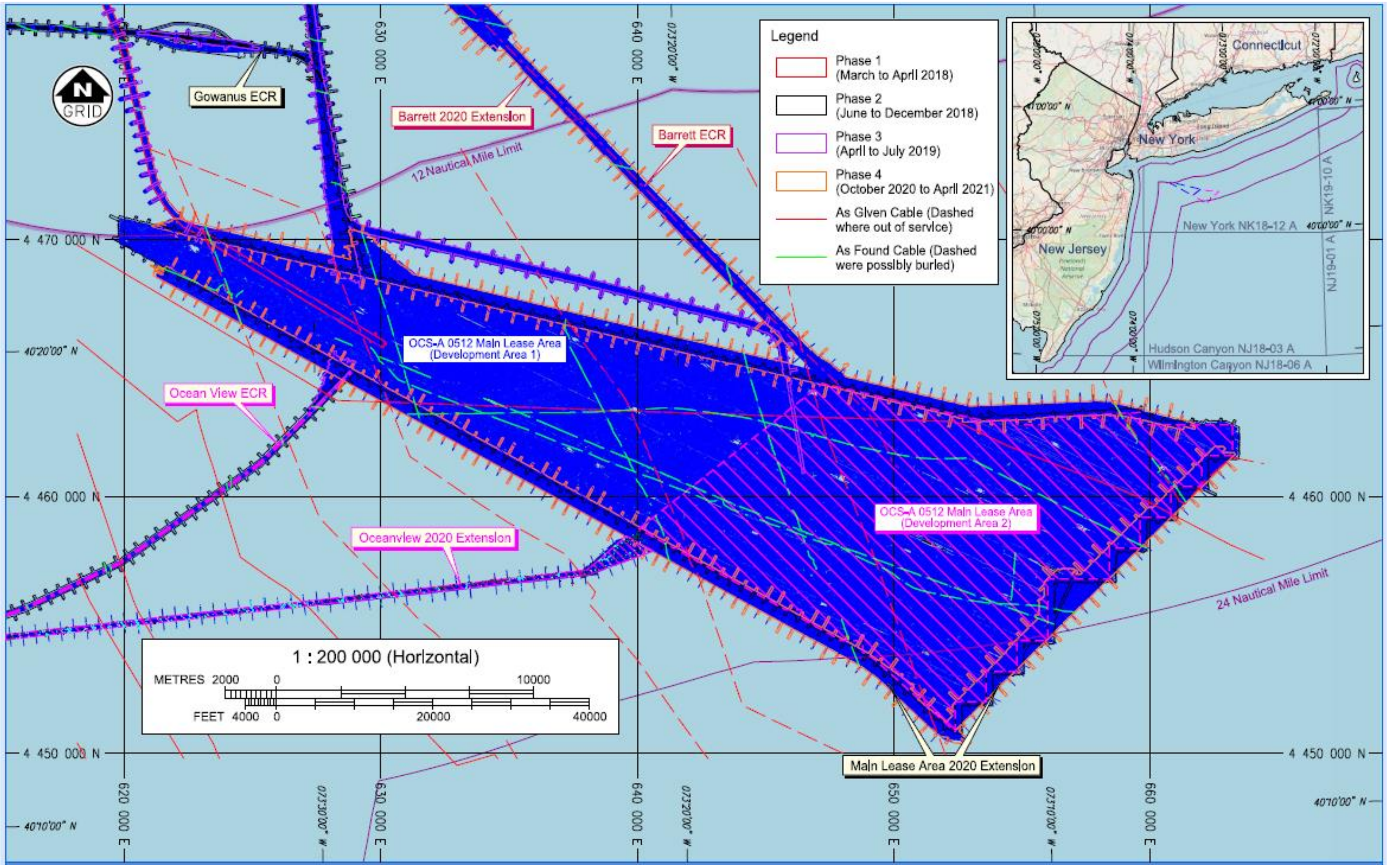

Figure 3-8. Lease Area cable overview

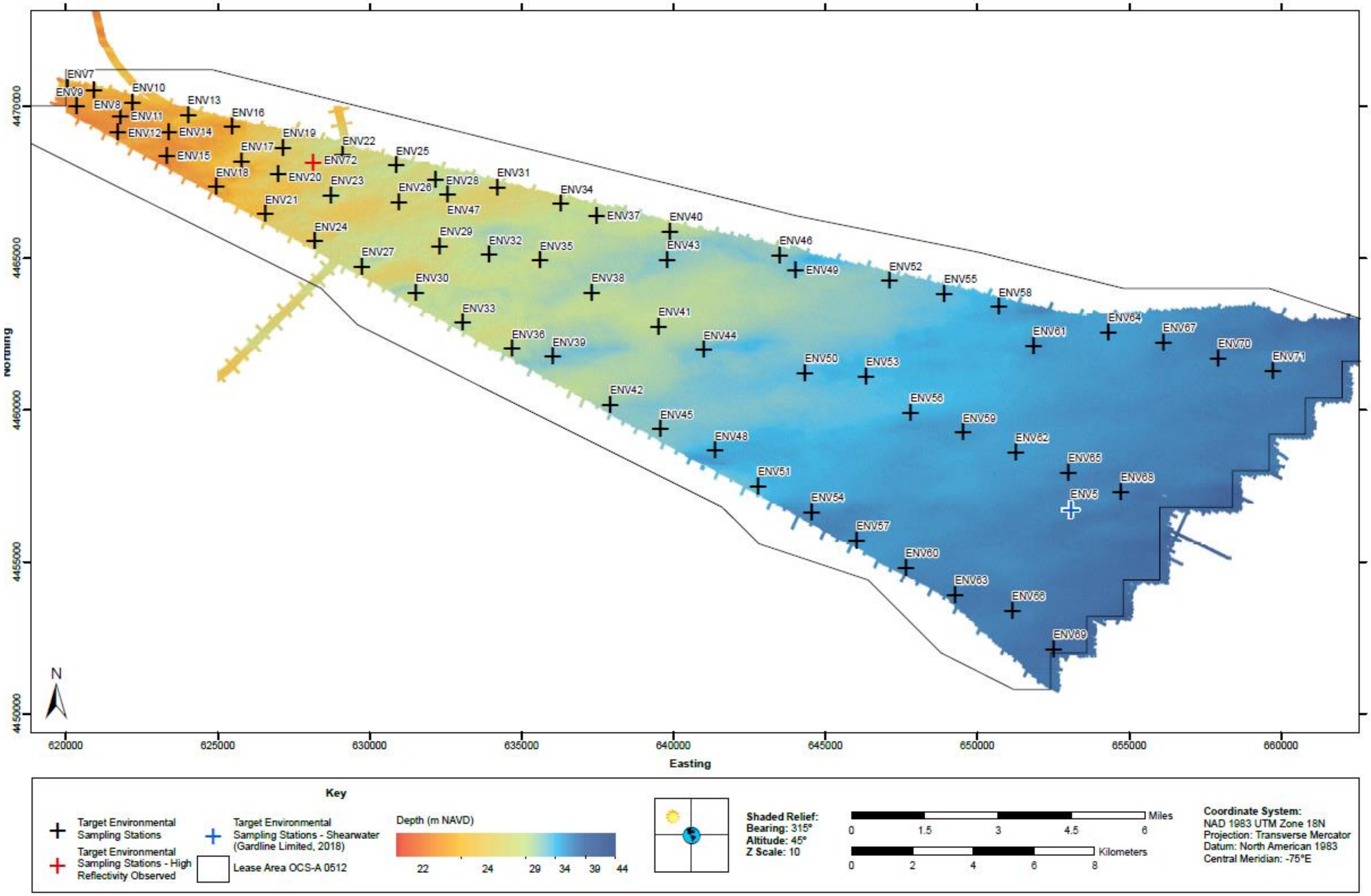

Figure 3-9. Bathymetry in the Lease Area

3.1.2. Offshore/onshore export cable

3.1.2.1. Export cable routes

EW 1 export cable route

The route for the EW 1 OEC would depart the Lease Area along its northern boundary, continue north-northwest across the outbound lane of the Ambrose to Nantucket Traffic Separation Scheme, and then enter the Separation Zone between the traffic lanes before turning west. The route would continue through the Traffic Separation Zone toward New York Harbor, reaching a Precautionary Area at the end of the traffic lanes. Prior to reaching the Precautionary Area, the route would enter a charted Danger Area, and Empire has proposed an alternate route variant to traverse this section of the route. Approaching Gravesend Bay, Empire has proposed route variants for the EW 1 OEC that would either route the cable within the Ambrose Channel or through the charted Anchorage #25 area. North of the Anchorage #25 area, the route would turn northeast and follow the Bay Ridge Channel to the landfall at SBMT.

Water depths in the EW 1 corridor generally become shallower between the OSSs and the export cable landfall (Figure 3-10, Figure 3-11). Minimum and maximum water depths along the EW 1 OEC corridor are 6.0 m (19.7 ft) and 31.6 m (103.7 ft) respectively. About 78 percent of the EW 1 OEC corridor is less than 49-ft (15-m) deep. Most waters of the EW 1 OEC route are pelagic, except in the shallowest waters approaching landfalls. The bathymetry of the inshore section of the OEC corridor is heavily influenced by numerous dredging campaigns, United States Army Corps of Engineers (USACE) posted public notice of work for deepening of the Ambrose Channel in 2011 and the Anchorage Channel in 2014. Public notice was also posted in 2021 for maintenance dredging at the northern end of the Bay Ridge Channel. The EW 1 OEC route variant passes through the dredged Ambrose Channel. All waters of the EW 1 OEC route are in the photic zone (i.e., top 600 ft [200 m]), the top layer of the pelagic environment where sunlight supports photosynthetic phytoplankton (Karleskint et al. 2006). Section 3.1.1 provides a description of the pelagic environment and its importance.

Benthic habitat in the EW 1 corridor is like the Lease Area and consists primarily of mobile, rippled sand with unevenly distributed gravels, and slightly gravelly sand in topographic lows between bedforms, with finer sediment grains in the nearshore portions of the corridors. A 172–station SPI/PV benthic survey was conducted in July 2019 along the proposed export cable routes and at three pre-determined reference areas (see Figure 3-1, above). Per BOEM guidelines, stations were spaced at 1.9 km along the proposed cable routes, and reference locations were determined based on USGS backscatter data (Figure 3-12). Analysis of SPI images collected during the benthic survey demonstrated that sediment types varied along the EW 1 OEC corridor, with observed grain size classes ranging from silt-clay to granules and pebbles, with boulders present at one station (Figure 3-13). Most stations along the EW 1 OEC corridor were predominantly composed of very fine and fine sand. All silt-clay sediments observed along the EW 1 OEC corridor were in New York state waters and were frequently associated with overlying mussel beds, whereas stations with coarser sediment types were primarily located on and adjacent to Cholera Bank where coarse and very coarse sand, pebbles and granules, and boulders were observed. A summary of the sediment distribution along the EW 1 OEC corridor is presented in Table 3-1. All habitat in the EW 1 OEC corridor was classified by NOAA Habitat Complexity Category based on analysis of benthic grab samples (Figure 3-14). The classified habitat in the EW 1 OEC corridor includes 2,636 acres of soft bottom habitat, 240 acres of heterogeneous complex habitat, and 728 acres of complex habitat.

Table 3-1. EW 1 export cable route seabed sediment distribution

Distance along route (km)	Sediment Type

From	To	
0.0	4.8	Silt and mud
4.8	8.9	Sand
8.9	11.7	Silt and mud
11.7	19.8	Sand
19.8	24.5	Slightly gravelly sand with rare patches of sand
24.5	29.6	Sand with rare pockets of gravel
29.6	32.2	Sand with bands of gravel
32.2	34.9	Sand with rare pockets of gravel
34.9	49.5	Sand
49.5	51.9	Sand with pockets of slightly gravelly sand
51.9	57.9	Slightly gravelly sand with patches of sand
57.9	75.5	Sand with pockets of slightly gravelly sand

Bedforms are present along some sections of the EW 1 OEC corridor. In the portion of the OEC corridor from km 5.8 to 21.1, megaripples were observed in patches where sand is present at seabed and are up to 0.5 m (1.6 ft) in height with wavelengths of between 4 m (13.1 ft) and 15 m (49.2 ft). From km 21.1 to 75.5, megaripples are common where slightly gravelly sand occurs, generally with a wavelength of 1 m (3.2 ft), height of <0.1 m (<0.3 ft) and variable orientation. Relict (not currently active) bedform features occur between km 29.6 and 32. National Centers for Environmental Information (NCEI) background data indicates these features are part of a wider area of sand ridge bedforms with height approximately 1.6 m (52.4 ft), wavelength 300 m (984 ft), orientation north-northwest/south-southeast and gentle gradients of up to 1.5°. Relict bedform features also occur between km 49.4 and 60.0. NCEI background data indicates these features are part of a wider area of sandwave bedforms of height approximately 0.5 m (1.6 ft), wavelength 200 m (656 ft), orientation north/south and very gentle gradients of up to <1° superimposed on to of larger sand ridge bedforms of height approximately 2 m (6.5 ft), wavelength 1100 m (3608 ft), with orientation east/west and very gentle gradients of up to <0.5°. The rounded crestless shape of the features at this scale suggests that they are no longer actively moving with sediment flow. Mobility investigations completed in the Lease Area demonstrated that no movement had occurred in most areas.

Epifauna observed in the EW 1 OEC corridor during Empire's benthic survey included sand dollars and mussel beds, mobile crustaceans, burrowing anemones, attached hydroids, and tube-building fauna. The only managed species observed in the corridor during the benthic surveys was the Atlantic sea scallop. The analysis of SPI images collected during Empire's benthic survey demonstrated variation in the Dominant CMECS Biotic Groups along the corridor. There was no specific spatial trend along the corridor, but Tube-Building Fauna (both small and larger) were the most prevalent biotic groups observed overall, and Mussel Beds and Attached Mussels were prevalent at the stations in New York state waters just before the "Narrows" (Figure 3-15). Other observed biotic groups included Mobile Crustaceans on Hard or Mixed Substrates, Burrowing Anemones, and Sand Dollar Beds.

The USACE New York District surveyed portions of the New York/New Jersey Harbor in 2005 as part of a pre-dredging baseline characterization. Most of the samples were collected from within or adjacent to the channel, which had not been dredged for 22 years (USACE 2006). Ambrose Channel, the main vessel route in the Lower Bay, contained mostly sand with some fine sand. Samples were also collected from the Bay Ridge Channel, which overlaps with the inshore portion of the EW 1 OEC corridor. The sediments near the terminus of the EW 1 OEC corridor consisted of very fine-grained particles (mud, clay, and silt) (USACE 2006). Several of Empire's 2019 SPI samples were collected in the EW 1 OEC corridor to the north of the USACE channel sampling locations. The 2019 Empire samples indicated that this portion of the EW 1 OEC corridor was dominated by relatively stable sand inhabited by soft-bodied infauna (e.g., polychaetes), hard-bodied mollusks (e.g., blue mussel), and mobile crustaceans (crabs). Both the Empire and USACE surveys identified blue mussel beds in the area just outside the Lower Bay.

Limited hardbottom was encountered within the EW 1 OEC corridor during the survey of the initial EW 1 OEC corridor in 2018; one sampling location north of the northwestern tip of the Lease Area was classified as patchy cobbles / boulders on sand, whereas all other sampling stations were classified as sand with mobile gravel or sand sheet (Figure 3-16). However, subsequent sampling of the likely EW 1 OEC corridor in 2019 and 2020 identified numerous boulders and debris between km 0 and 8.4, with peak concentrations of debris occurring between km 0.0 and 3.5, along the eastern edge of the route corridor where current/disused piers are present, and between km 7.0 and 8.0, in The Narrows where the channel thins and passes under the Verrazano-Narrows bridge. A total of 765 natural features, namely cobbles and boulders, were identified in the EW 1 OEC corridor. Cobbles and boulders range between 0.1 m (0.3 ft) x 0.1 m (0.3 ft) x 0.1 m (0.3 ft) and 2.8 m (9.2 ft) x 4.9 m (16.1 ft) x 1.8 m (59 ft) in size. Cobbles and boulders are scattered throughout the route with a higher density being observed in association with areas of outcropping till in the west where numerous cobbles and boulders are present. Some objects are interpreted to be manmade features such as debris, or buoys. NOAA nautical charts show that the Lower New York Bay contains fish trap areas, indicating that although the route does not enter these areas, some items of debris may be fishing related. A total of 3,518 debris items were identified in the EW 1 OEC corridor ranging from 0.1 m (0.3 ft) x 0.1 m (0.3 ft) x 0.1 m (0.3 ft) to 32.5 m (106.6 ft) x 3.8 m (118 ft) x 3.0 m (9.8 ft) in size.

Numerous shipwrecks and artificial reefs are located within or around the EW 1 OEC corridor. There are 29 known wrecks and obstructions, identified from NOAA nautical charts, expected within the EW 1 OEC corridor. Of these, 26 are identified from the survey data on SSS, MBES bathymetry or magnetometer data. Additionally, NJDEP manages 17 artificial reefs that cover about 25 square miles (65 km^2) of sea floor and support recreational harvest of black sea bass, tautog, scup, and American lobster (NJDEP 2019). Artificial reefs in coastal New York waters are known for these species as well as summer flounder, cod, and several species of edible crab. The distribution of charted recreational diving shipwrecks and state-managed artificial reefs within or adjacent to near the Project Area is shown on Figure 3-7, above.

A total of 11,452 gradiometer anomalies were interpreted within the EW 1 OEC corridor. Some are associated with debris items mapped in SSS or bathymetry data. It should be noted that there is a possibility that magnetic anomalies and SSS contacts may potentially represent MEC/UXO within the Project area. While these magnetometer and SSS targets have been identified as physical hazards, additional work to assess site-specific risks of MEC has not been completed at present. Numerous anomalies are interpreted to be cable or pipeline crossings. Along the EW 1 OEC corridor, fourteen cable and five pipeline crossings were expected using the NOAA database. Nine of these cables and five pipelines were identified by numerous magnetic anomalies, as well as four unknown cable crossings.

EW 2 export cable route

The route for the EW 2 OEC corridor would exit the Lease Area from the central north edge and travel in a relatively straight, northwestern direction, then turn west seaward of the New York state water boundary before making landfall in the vicinity of Long Beach or Lido Beach.

Water depths in the EW 2 OEC corridor become shallower between the OSSs and the export cable landfalls (Figure 3-17). Minimum and maximum water depths along OEC corridor are 6.5 m (21.3 ft) and 38.0 m (124.6 ft) respectively. Approximately 92 percent of the EW 2 OEC corridor is less than 49-ft (15-m) deep. Water depths gradually increases from 6.5 m (21.3 ft) to 31.6 m (124.6 ft) between km 0 and

31.6. Gradients are typically very gentle (<1°) along the EW 2 OEC corridor. Most of the waters of the EW 2 OEC corridor are pelagic, except in the shallowest waters approaching landfalls. All waters of the EW 2 OEC corridor are in the photic zone (i.e., top 600 ft [200 m]).

Benthic habitat in the EW 2 OEC corridor is like the Lease Area and consists primarily of mobile, rippled sand with unevenly distributed gravels, and slightly gravelly sand in topographic lows between bedforms, with finer sediment grains observed in the nearshore portions of the corridor. Analysis of SPI images from the July 2019 survey along the nearshore portion of the EW 2 OEC corridor demonstrated that stations were primarily very fine sand or fine sand with a few stations composed of granules or pebbles (Figure 3-13). Additional sampling conducted along the offshore portion of the EW 2 OEC corridor from October 2020 through April 2021 (see Figure 3-1, above) corroborated characterizations of softbottom habitat in previously surveyed portions of the corridor and detected novel hardbottom (e.g., cobbles, boulders) in previously unsurveyed portions of the corridor. Seabed sediments were confirmed by CPTs and vibracores to comprise sand and slightly gravelly sand. Sediment patches indicated that discrete areas of one sediment type were present within a wider extent of the other. A summary of the sediment distribution along the EW 1 OEC corridor is presented in Table 3-2. All habitat in the EW 2 OEC was classified by NOAA Habitat Complexity Category based on analysis of benthic grab samples (Figure 3-14). The classified habitat in the EW 2 OEC corridor includes 2,834 acres of soft bottom habitat and 1,708 acres of complex habitat.

Table 3-2. EW 2 export cable route seabed sediment distribution

Distance along route (km)		
From	**To**	**Sediment Type**
0.0	12.1	Sand with pockets of slightly gravelly sand
12.1	13.6	Sand
13.6	18.4	Sand with pockets of slightly gravelly sand
18.4	19.1	Slightly gravelly sand
19.1	20.6	Sand
20.6	28.6	Slightly gravelly sand with patches of sand
28.6	30.1	Sand with pockets of slightly gravelly sand
30.1	32.6	Slightly gravelly sand with patches of sand
32.6	34.6	Slightly gravelly sand
34.6	35.6	Slightly gravelly sand with patches of sand
35.6	36.6	Slightly gravelly sand
36.6	38.1	Sand and slightly gravelly sand
38.1	39.4	Slightly gravelly sand with patches of sand
39.4	40.6	Slightly gravelly sand
40.6	41.1	Sand and slightly gravelly sand
41.1	42.1	Slightly gravelly sand
42.1	45.6	Sand and slightly gravelly sand
45.6	49.0	Sand

Relict bedforms are present throughout the EW 2 OEC corridor. NCEI background data indicates these features are part of a wider area of sandwave bedforms with height approximately 0.3 m (1.0 ft), wavelength 70 m (230 ft), orientation NNE/SSW and gradients of <1°. Generally, topographic lows between bedforms are interpreted as areas or pockets of slightly gravelly sand. Ripples generally coincide with these areas, with heights of approximately <0.2 m (0.7 ft), wavelengths of approximately 1 m (3.3 ft), mainly NNE/SSW orientation and gradients <1°. The rounded crestless shape of the features at this scale suggests that they are no longer actively moving with sediment flow. Mobility investigations completed in the Lease Area demonstrated that no movement had occurred in most areas.

Sessile and slow moving epifauna observed within the EW 2 OEC corridor during Empire's benthic survey included sand dollars and mussel beds, mobile crustaceans, burrowing anemones, attached hydroids, and tube-building fauna. Of the managed species with EFH designated in the corridor, ocean quahog, spiny dogfish, and winter skate were observed in the 2020/2021 survey video and image assessments. These species were primarily observed in the offshore portion of the corridor at depths of 92 to 112 ft (28 to 34 m) over fine to gravelly sand. The analysis of SPI images collected during Empire's benthic survey along the portion of the EW 2 OEC corridor in state waters, the only portion sampled, demonstrated that there were a variety of dominant biotic groups. Tube-Building Fauna, both small and large, were the most common groups observed in this portion of the corridor, while Tracks and Trails, Mobile Crustaceans on Soft Sediments, and Mobile Crustaceans on Hard or Mixed Substrates were also prevalent (Figure 3-15).

No hardbottom habitat was observed in the 2019 benthic surveys of the EW 2 OEC corridor (Figure 3-16); similarly, no hardbottom habitat was observed in the 2021 MBES and SSS surveys at or in the vicinity of the EW 2 landfall locations. The 2019 benthic surveys did not sample most of the offshore portion of the proposed EW 2 OEC corridor, but that portion was sampled in 2020 and 2021, as mentioned above. Up to six hundred cobbles and scattered boulders were detected during the 2020/2021 MBES and SSS surveys in nearshore portions of the EW 2 OEC corridor approaching state waters. Lengths and widths of rocks ranged from approximately 0.3 to 6.2 ft (0.1 to 1.9 m) and heights above seabed were up to approximately 3 ft (0.9 m). Cluster of cobbles and boulders overlaid areas of slightly gravelly sand in transects characterized by sand dollar beds, burrowing anemones, and tube-building fauna. Sea lettuce (*Ulva lactuca*) was observed growing on shell hash and pebbles and can be reasonably assumed to also colonize larger boulders. The complex, three-dimensional cobble/boulder/gravelly sand habitat is likely to attract structure-associated managed species, such as black sea bass and scup, as well as attaching life stages, such as longfin inshore squid eggs or Atlantic sea scallop spat. One winter skate was observed over softbottom in a transect located within a boulder aggregation. These observations are consistent with other descriptions of the regional geology, which report that most of the natural rocky subtidal bank habitat of the United States Atlantic Coast occurs north of Massachusetts (Aquarone and Adams 2018; Davis 2009; Roman et al. 2000).

Numerous shipwrecks and artificial reefs are located within or near the EW 2 OEC corridor, including the Hempstead and McAllister Grounds artificial reefs that are located on the south shore of Long Island (see Figure 3-7).

A total of 814 magnetic anomalies were identified within the EW 2 OEC corridor. Of these, sixteen anomalies were interpreted to be associated with cables and one was interpreted to be associated with an item of debris mapped in the SSS and/or MBES data. The remaining 797 magnetic anomalies do not correlate with any known infrastructure or interpreted seabed contacts. There are six known cables in the NOAA database that cross the EW 2 OEC corridor, identified primarily from magnetometer anomalies. One further cable in the NOAA database was expected to cross the route but was not identified. Two additional sets of magnetic anomalies orientated in a linear arrangement were interpreted from the magnetometer data only. These were not observed in the available background information and were interpreted to represent unknown cables.

3.1.2.2. Landing area

The proposed location of the EW 1 export cable landfall is at the SBMT, a paved commercial shipping terminal (Figure 3-18). Any hard- or soft-bottom habitats located in the vicinity are heavily impacted. According to the U.S. Fish and Wildlife Service National Wetlands Inventory (NWI), the EW 1 submarine export cable siting corridor and export cable landfall do not intersect tidal wetlands (USFWS 2019). However, two of the four landfalls (Landfalls C and D) proposed for EW 2 intersect NWI tidal wetlands, classified as estuarine and marine wetland with an unconsolidated bottom, covering a combined area of 2.64 acres (1.07 hectares) (Table 3-3, Figure 3-19). Natural Heritage Database inquiries were submitted to the New York State Department of Environmental Conservation (NYSDEC), Division of Fish and Wildlife, and results indicated that two significant natural communities, both comprising sensitive beach habitats, were identified at Landfall C, Landfall D, and the temporary work areas associated with the landfall sites; however, EW 2 would not be located within a New York State Significant Coastal Fish and Wildlife Habitat (Empire 2021).

3.1.2.3. Interior coastal

As described in Section 2.2.2.3, above, the EW 1 export cable will directly connect to an onshore substation at SBMT, and then an interconnection cable will travel from the onshore substation to a point of interconnection (see Figure 2-7, above). The EW 1 interconnection cable route is located within urbanized landscapes in the New York metropolitan area, primarily along or within existing roadway corridors. The EW 1 interconnection cable route and onshore substation would intersect < 0.01 acres and 0.08 acres of NWI tidal wetlands, respectively (Table 3-3, Figure 3-18). The EW 1 interconnection cable route is above the bank of Upper New York Bay. Upper New York Bay, in the vicinity of the onshore portions of the Project, is classified by NWI as an excavated subtidal estuarine system with an unconsolidated bottom and by the NYSDEC tidal wetland database as a littoral zone. NWI mapping indicates that a small portion of Upper New York Bay enters the interconnection cable route and the onshore substation. NYSDEC mapping indicates that the littoral zone of Upper New York Bay partially enters the onshore substation. However, the bank is mainly comprised of industrial properties with bulkheaded marine terminals and Upper New York Bay terminates at the bulkhead. Based on desktop analysis and observations made during the preliminary site reconnaissance, field delineations were not completed for the EW 1 onshore interconnection cable route and the onshore substation because of the developed nature of the area and lack of wetland and waterbody resources identified within the area.

As described in Section 2.2.2.3, above, the EW 2 export cable will be joined to onshore export cables at a landfall location in either Long Beach or Lido Beach (see Figure 2-8, above). The onshore export cables will then traverse the island of Long Beach along one of six routes from the landfall to the Wreck Lead Channel crossing, before following one of five routes from Wreck Lead Channel to one of two onshore substations. Overall, the EW 2 onshore export cable and onshore substations would be situated within developed lands of variable development intensity. The onshore export cable crossing at Wreck Lead Channel would intersect 1.93 acres (0.78 hectares) of NWI tidal wetlands, and the EW 2 onshore export cable route from Wreck Lead Channel to the onshore substation would intersect up to 0.68 acres (0.28 hectares) of NWI tidal wetlands (Table 3-3, Figure 3-19). Wreck Lead Channel is classified by NWI as a subtidal estuarine feature with an unconsolidated bottom and by the NYSDEC tidal wetland database as a littoral zone. NYSDEC also maps a portion of the southern bank of Wreck Lead Channel as mudflats. Based on a review of aerial imagery, the banks of Wreck Lead Channel are highly modified with the southern bank comprising of a mix of riprap and natural shoreline that quickly transitions to industrial properties, and the north bank comprising of bulkheading and docks associated with an active marina. NWI and NYSDEC mapping indicates that tidal wetlands exist to the south and west of EW 2 Onshore Substation A site and to the east of the EW 2 Onshore Substation B site. NWI classifies these wetlands as subtidal estuarine with an unconsolidated bottom with intertidal estuarine wetlands along select banks. The NWI mapped wetlands at these locations are approximately consistent with NYSDEC tidal wetlands mapping, which indicated littoral zone with intertidal wetlands and mudflats along the banks.

The Billion Oyster Project has been working since 2014 to restore the Eastern oyster (*Crassostrea virginica*) to the New York/New Jersey Harbor. One of the seven restored reefs is at Bush Terminal Park, approximately 0.6 miles southwest of the EW 1 export cable landfall. The oyster was once abundant in the harbor, but since the early 1900s populations have declined by more than 99 percent in response to wastewater discharges, oyster disease, overharvesting, and dredging for shipping channels. The Nature Conservancy provides support with monitoring restored oyster reefs at seven sites in the New York/New Jersey Harbor, including the Bush Terminal Park Community Reef adjacent to the EW 1 landfall in the Upper New York Bay. Nearly one million 2 mm oysters were installed in 2016 to create the Bush Terminal Park Community Reef; additional culch was placed on the reef in 2018. Oysters at the Bush Terminal Reef grew more quickly than at other sites and began cementing together to form a reef. Some individuals appeared to have spawned in summer 2017; however, no recruits were observed the following spring. To date, the incidence of oyster diseases has been low at this reef and water quality had been generally good, with adequate dissolved oxygen. Long-term monitoring studies of biodiversity, reproduction, growth, and other parameters at this restored reef are ongoing (McCann 2018).

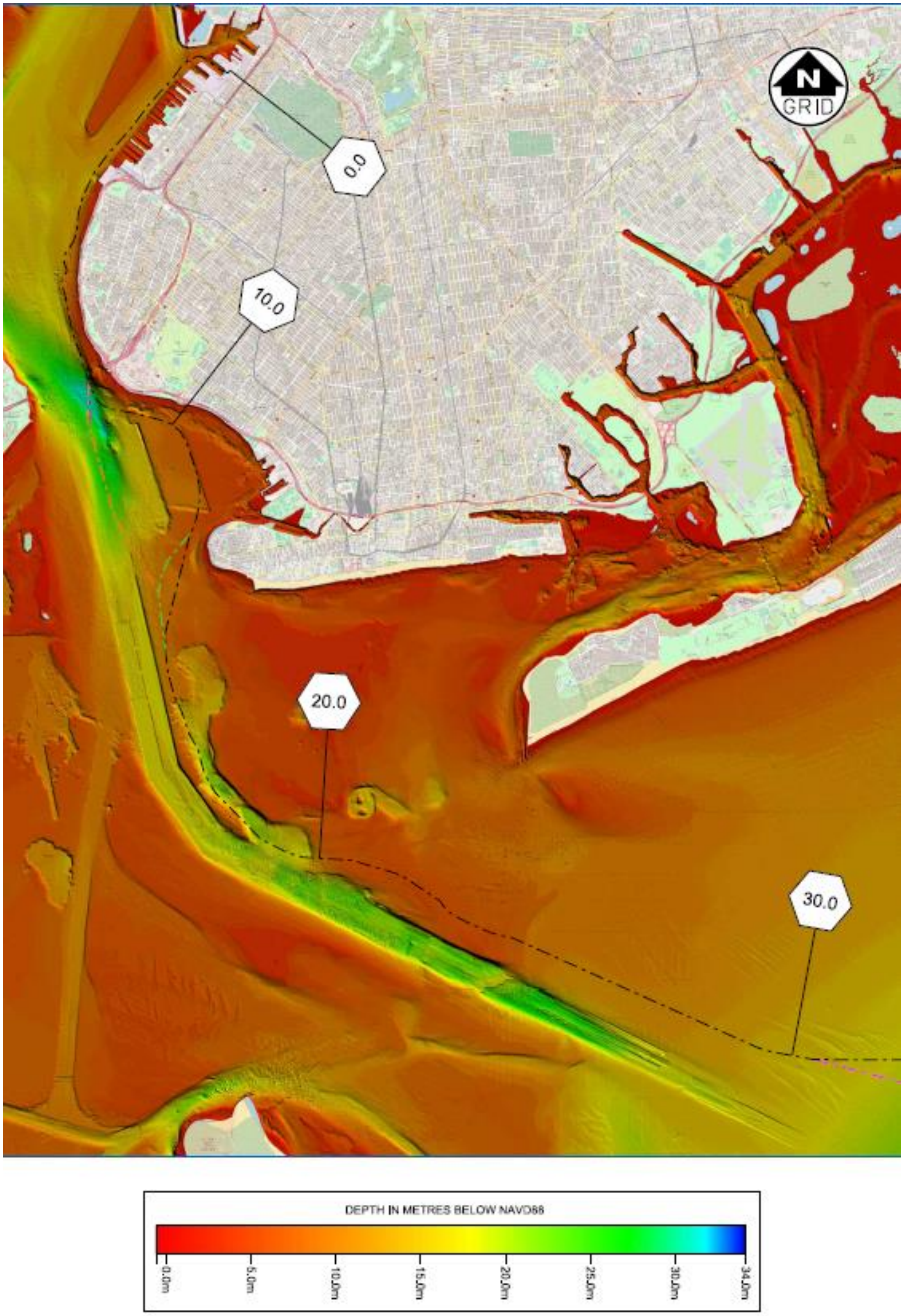

Figure 3-10. Bathymetry overview of EW 1 export cable route

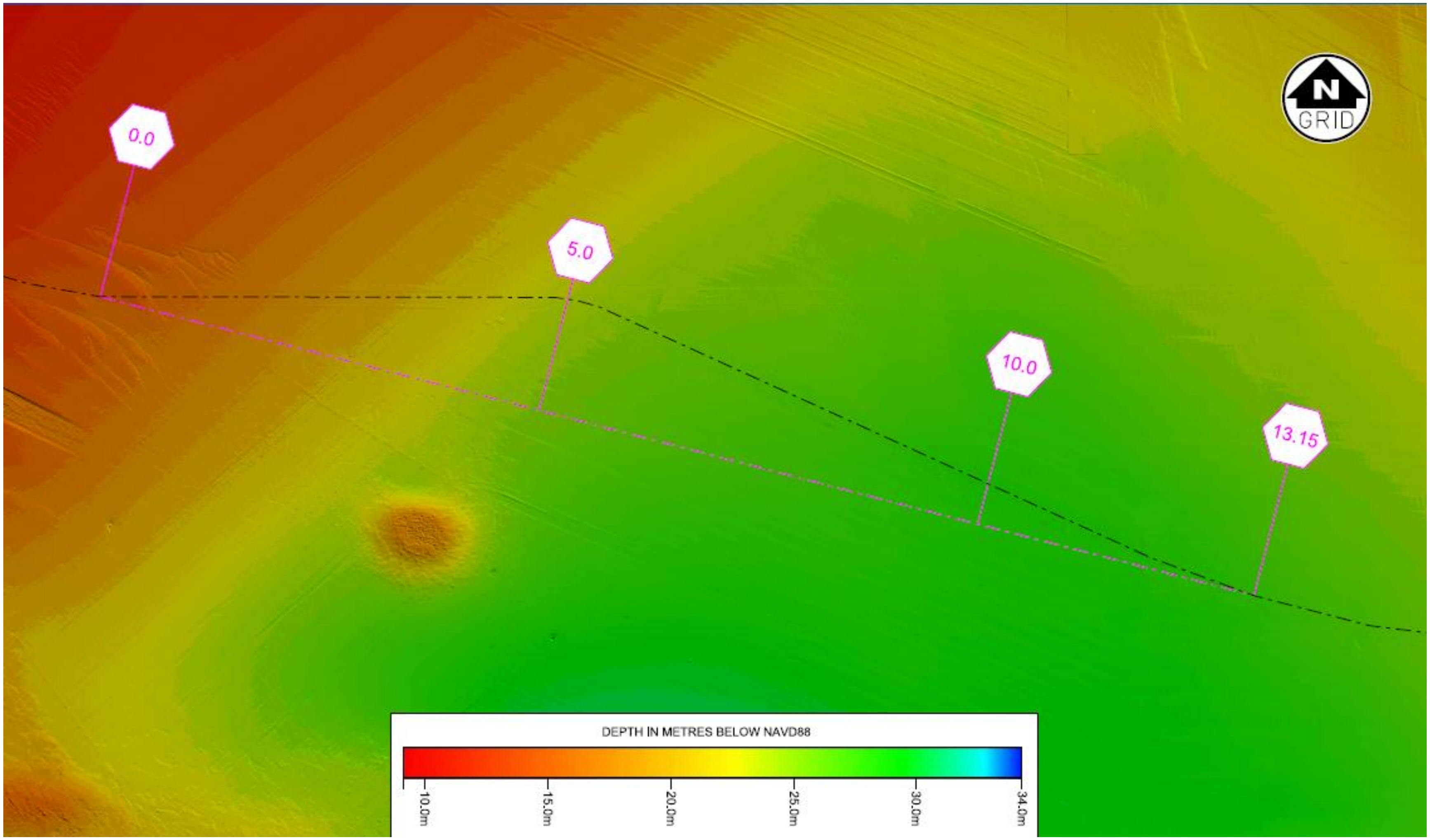

Figure 3-11. Bathymetry overview of EW 1 export cable route in offshore waters

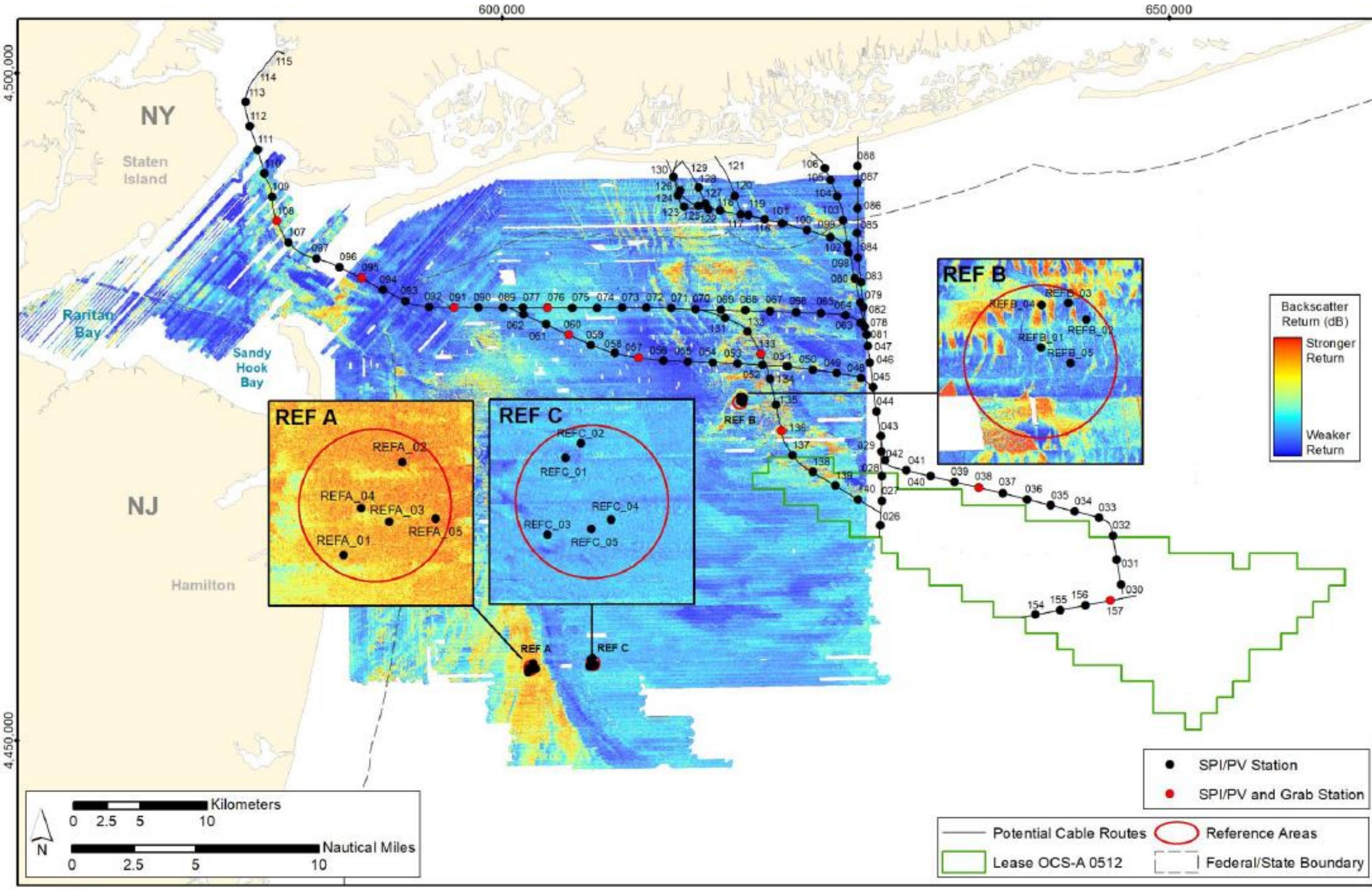

Figure 3-12. Station locations sampled for SPI, PV, and grabs over USGS backscatter data along the export cable routes

Note: The stations do not include the portion of the current proposed EW 2 export cable route in federal waters.

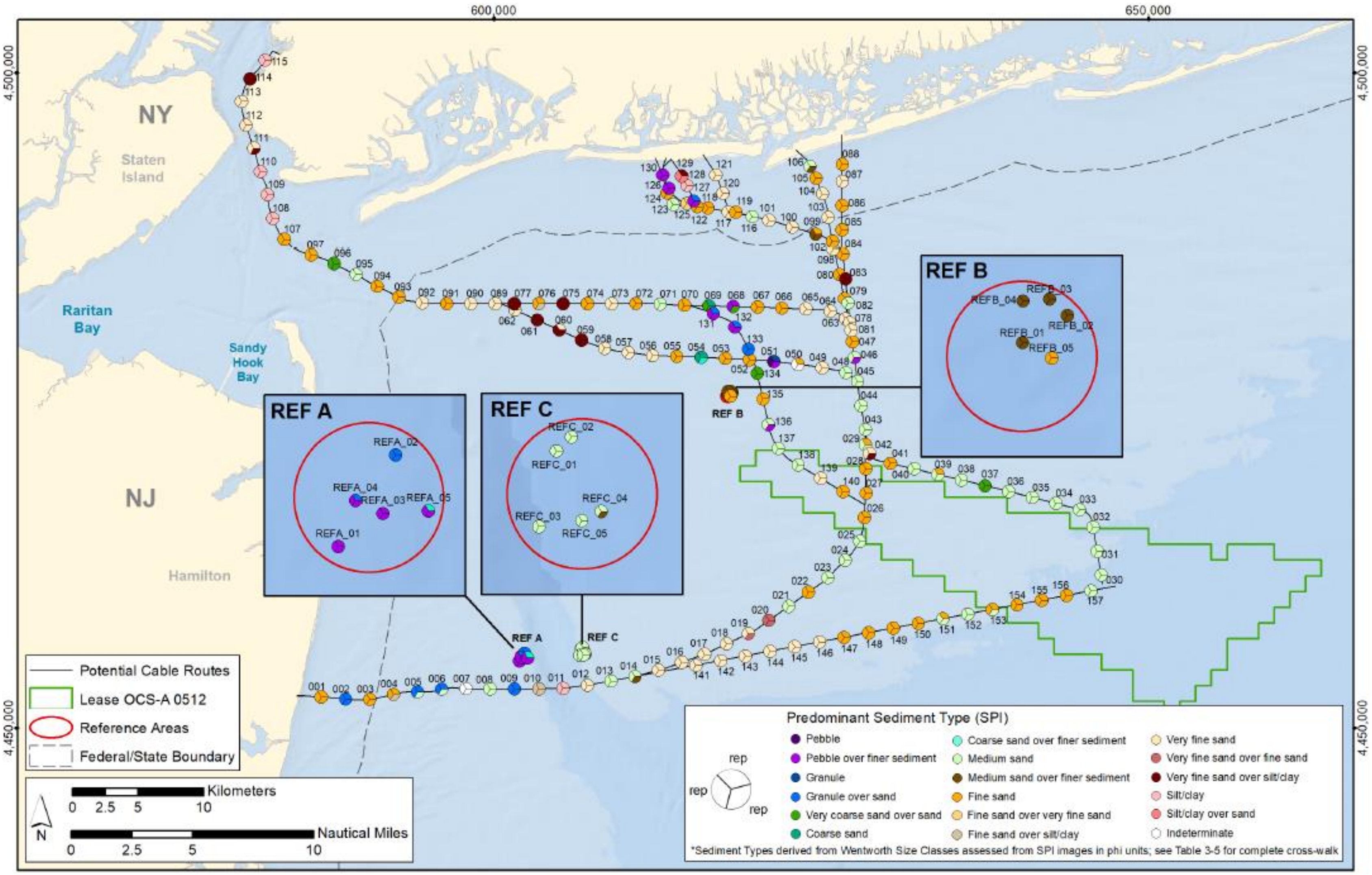

Figure 3-13. Predominant sediment types derived from SPI images along the export cable routes and Connected Action area.

Note: The export cable route option exiting south from the Lease Area and to Jones Beach, New York, as reflected in this figure, has been removed from the PDE since Inspire collected these data and prepared its analysis. The sample locations did not include the portion of the current proposed EW 2 export cable route in federal waters.

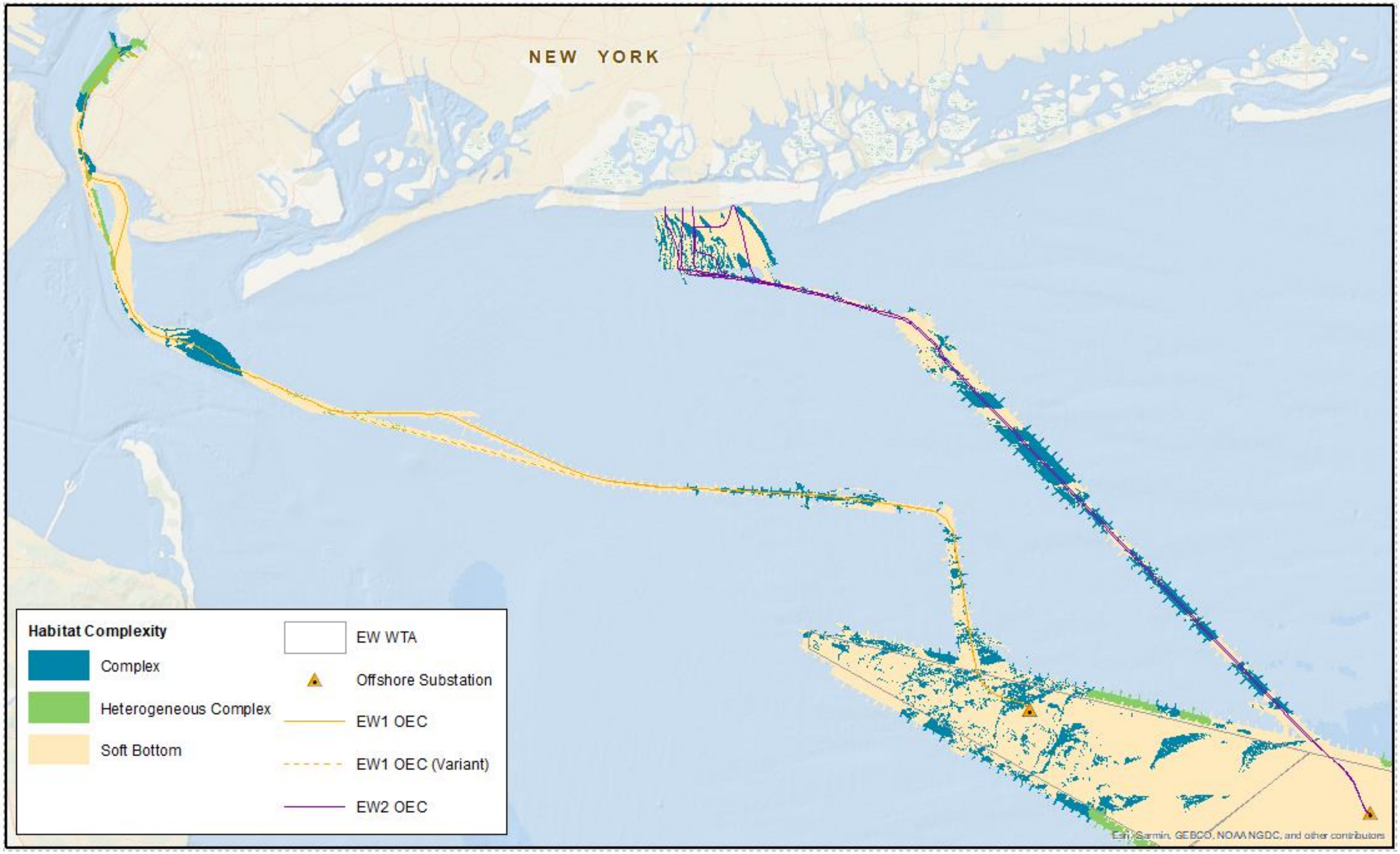

Figure 3-14. Benthic habitats classified by NOAA complexity category along the EW 1 and EW 2 OECs and Connected Action area.

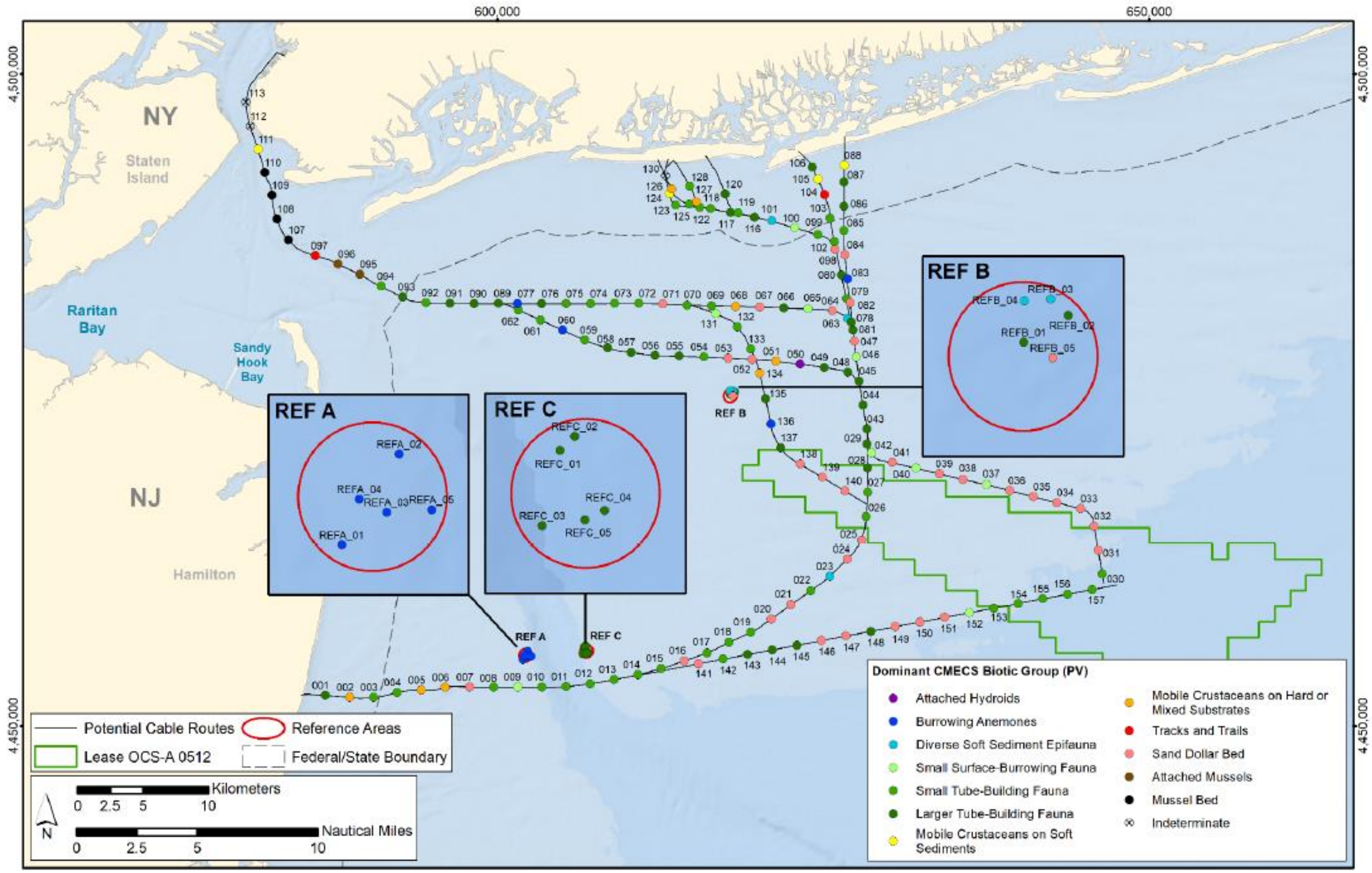

Figure 3-15. Dominant CMECS biotic groups derived from SPI images along the export cable routes

Note: The export cable route option exiting south from the Lease Area and to Jones Beach, New York, as reflected in this figure, has been removed from the PDE since Inspire collected these data and prepared its analysis. The sample locations did not include the portion of the current proposed EW 2 export cable route in federal waters.

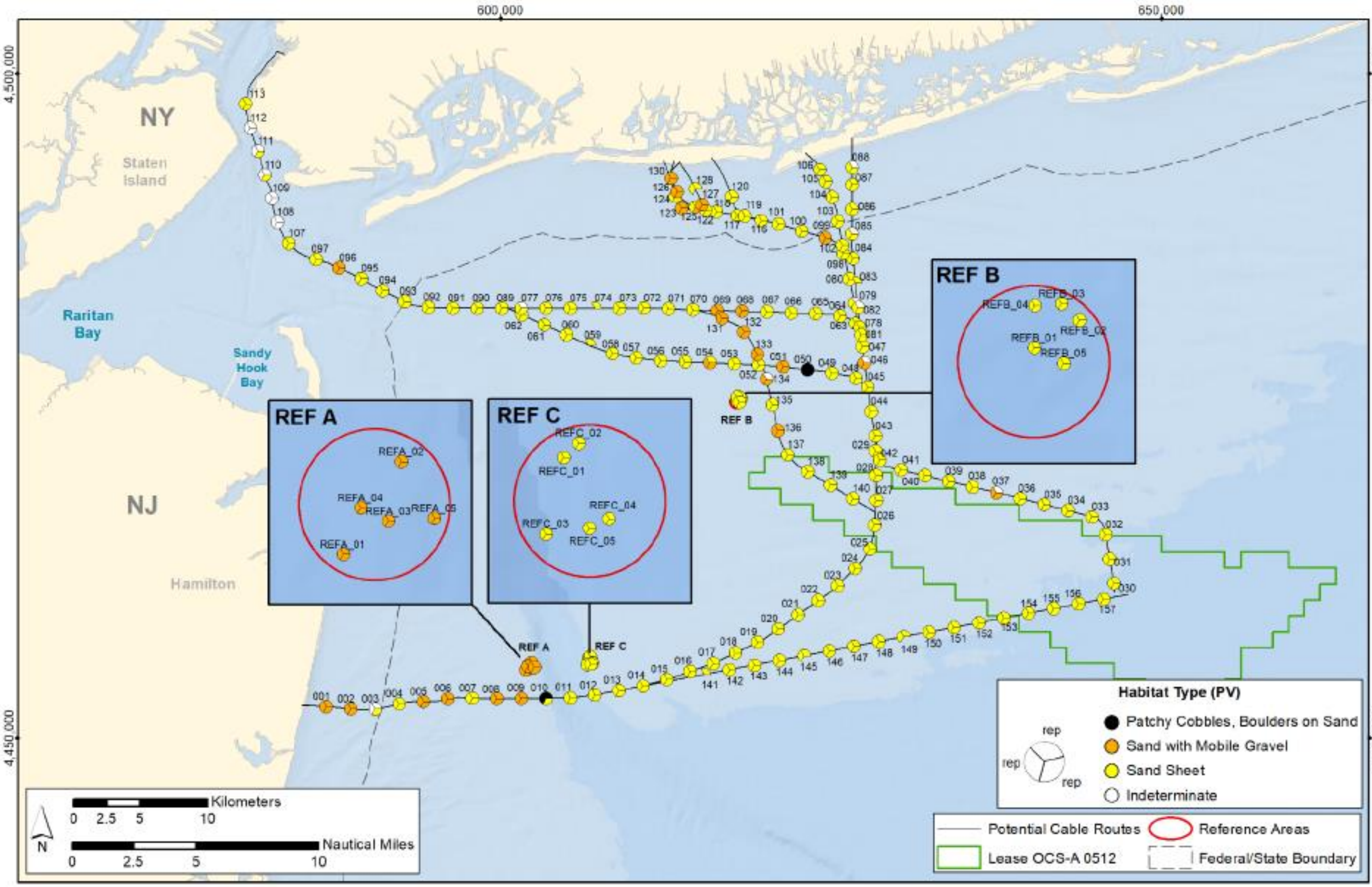

Figure 3-16. Occurrence of hard-bottom habitat along the EW 1 and EW 2 offshore export cable corridors

Note: The export cable route option exiting south from the Lease Area and to Jones Beach, New York, as reflected in this figure, has been removed from the PDE since Inspire collected these data and prepared its analysis. The sample locations did not include the portion of the current proposed EW 2 export cable route in federal waters.

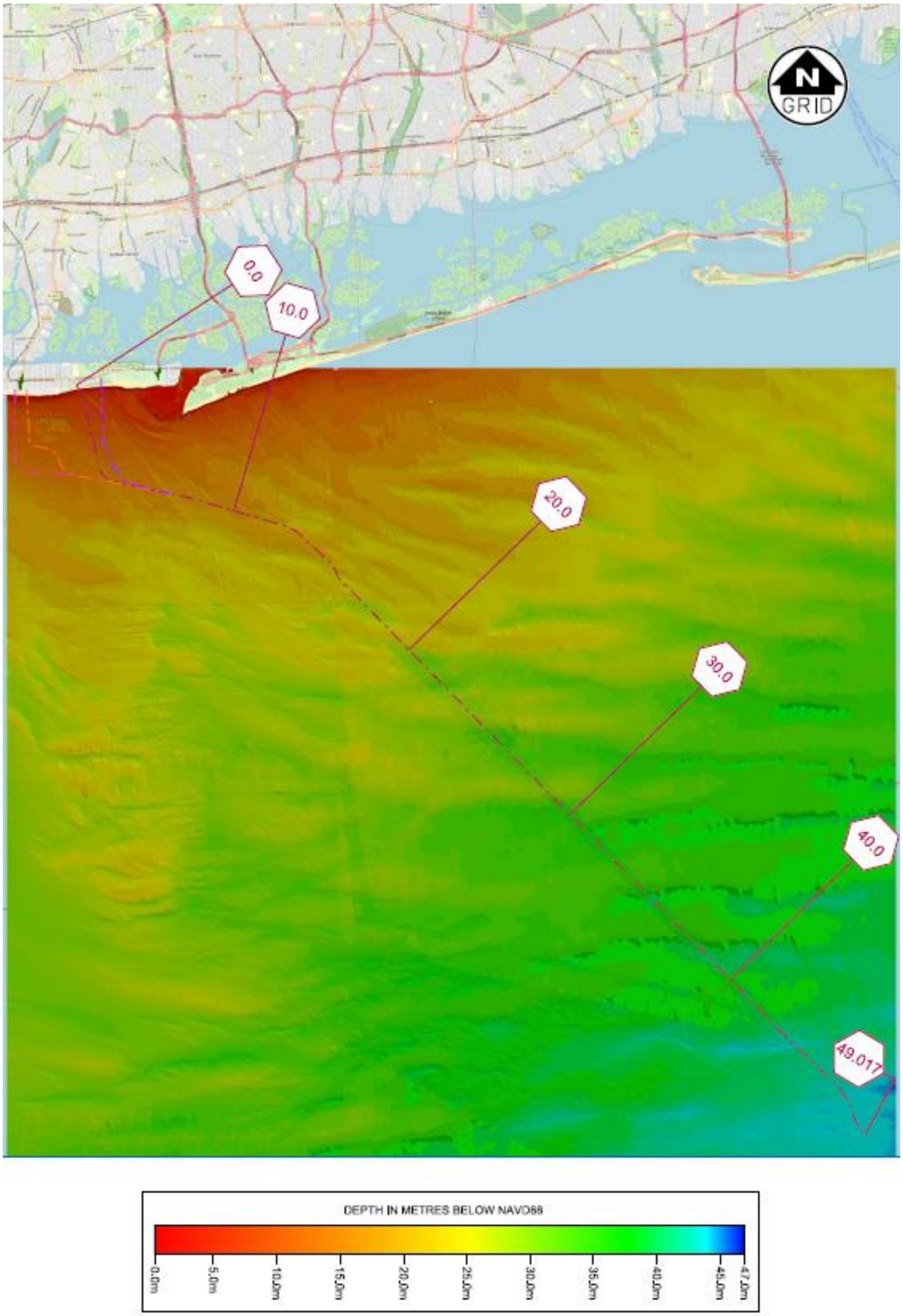

Figure 3-17. Bathymetry overview of the EW 2 OEC corridor

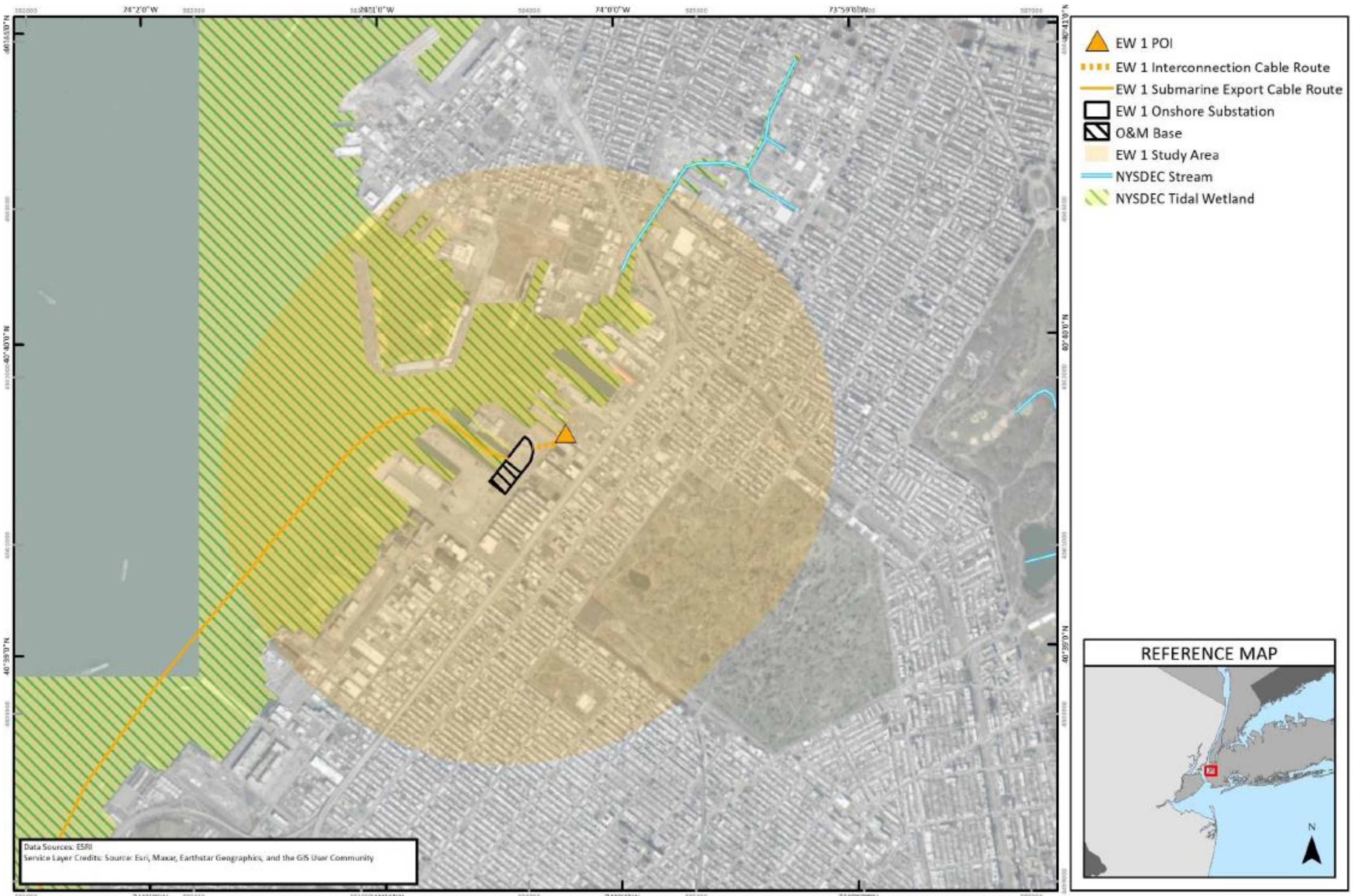

Figure 3-18. Mapped wetland along EW 1 interconnection cable route and onshore substations and Connected Action area.

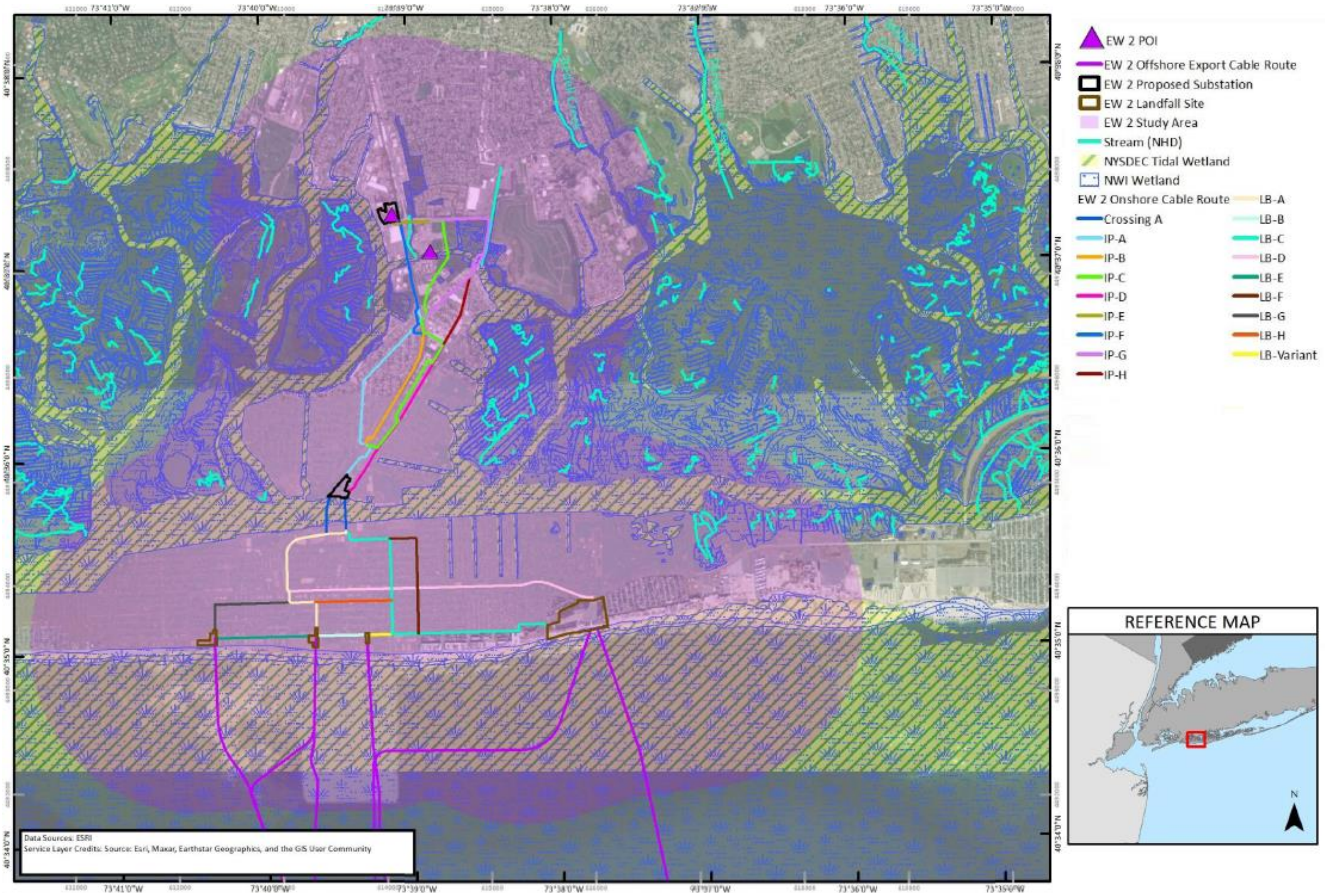

Figure 3-19. Mapped wetland along EW 2 interconnection cable route and onshore substations

3.1.3. Port modifications and O&M Facility (SBMT)

An O&M facility that will support operation of EW 1 and EW 2 will be built at SBMT and is considered a Connected Action to the Project. The scope of the Proposed action does not include any port modifications; however, the NYSDEC has separately filed a joint permit application to USACE and NYSDEC for planned improvements at SBMT (AECOM 2021a). The purpose of the SBMT port infrastructure improvement project is to upgrade SBMT to serve as a staging facility and O&M facility for the offshore wind industry. The SBMT project is considered a Connected Action for the Proposed Action (see Section 2.2.3).

Water samples collected at the SBMT project area indicate relatively low dissolved oxygen (DO) levels (74 % in open water, 32-54% in the “interpier” basins), with salinity near 24 parts per thousand throughout the SBMT project area when the DO was sampled (AECOM 2022a).

The SBMT project area would intersect 0.2 acres of NWI tidal wetlands classified as Estuarine and Marine Deepwater. There are no vegetated tidal wetlands in the SBMT project area. (Table 3-3). See also Section 3.1.2.2 of this document. The benthic habitat in the SBMT project area has been routinely disturbed to maintain the industrial marine terminal. The benthic substrate is classified by NOAA complexity category as softbottom (Figure 3.12), with small patches of riprap and broken concrete debris from development of the marine terminal. Sediment sampling conducted by NYSDEC showed unconsolidated silt or sandy silt with high organic content and low dissolved oxygen and sediments are contaminated with industrial pollutants. The benthic invertebrate community in the SBMT project area is typical of the degraded conditions described above. Additional information on site conditions can be found in AECOM 2022a and in AECOM 2022b.

Bay Ridge Channel, immediately adjacent to SBMT, is regularly dredged by the USACE to maintain navigation depth. The waters of Bay Ridge Channel are recognized as providing overwintering habitat for federally managed winter flounder and for striped bass, a prey species for federally managed bluefish, summer flounder, and windowpane. Additionally, the waters of Bay Ridge Flats, approximately 2,000 feet offshore of SBMT, and the waters surrounding the piers where SBMT is located provide spawning EFH for winter flounder (i.e., estuarine waters less than 6 meters deep).

Table 3-3. NWI and NYSDEC mapped wetlands within the EW 1 and EW 2 Project areas for the Proposed Action

Route Feature	NWI Classification	Area (acres)	NYSDEC Classification	Area (acres)
EW 1 interconnection cable	Estuarine and Marine Deepwater	< 0.01	None	0
EW 1 onshore substation	Estuarine and Marine Deepwater	0.08	Littoral Zone	0.01
EW 1 O&M base[1]	Estuarine and Marine Deepwater	0.2	Littoral Zone	0.01
EW 2 Landfall C	Estuarine and Marine Deepwater	1.59	None	0
EW 2 Landfall D	Estuarine and Marine Deepwater	1.05	Littoral Zone	2.48
EW 2 Wreck Lead Channel	Estuarine and Marine Deepwater	1.87	Littoral Zone	1.97
	Estuarine and Marine Wetland	0.06	Shoals, Bars, Mudflats	0.05
EW 2 Route IP-C	Estuarine and Marine Deepwater	0.12	Littoral Zone	0.11
	Estuarine and Marine Wetlands	< 0.01	Shoals, Bars, Mudflats	0.10
EW 2 Route IP-E	Estuarine and Marine Deepwater	0.03	Littoral Zone	0.05
	Riverine	0.03	Shoals, Bars, Mudflats	0.01
EW 2 Route IC-A	Estuarine and Marine Deepwater	0.03	Littoral Zone	0.03
	Estuarine and Marine Wetlands	0.02	Shoals, Bars, Mudflats	0.02

[1]The area for the EW 1 O&M base does not include the Connected Action. See Section 5.1.3.3 for a discussion of wetlands impacted by the Connected Action.

3.1.4. Adjacent Habitats

For the purposes of discussing adjacent habitats that may be indirectly impacted by construction, this section discuses resources within both a 10-mile (12.4-kilometer) radius/buffer around the Lease Area and a 1,640-foot (500-meter) buffer around the export cable route corridors. This buffer is based upon where the most widespread indirect impacts associated with the wind turbines (i.e., pile driving noise) and the OECs (i.e., sediment suspension) from the proposed Project could affect benthic resources.

Six artificial reefs were identified near the Project area; however, only one was within the buffers around the Project area, Hempstead Town Reef (Figure 3-20). This reef areas represent approximately 1.93 square miles (4.97 square kilometers) of seafloor that has been extensively modified by the placement of structures such as ships, tanks, railroad cars, concrete debris, and reef balls. Further, as described in Section 3.1.2, Bush Terminal Park Community Reef, a restored oyster reef, is located approximately 0.6 miles southwest of the EW 1 export cable landfall. The Bush Terminal Park Community Reef was created by installing nearly one million 2 mm oysters in 2016, and additional culch was placed on the reef in 2018. Additionally, there are three New Jersey Prime Recreational Fishing Areas that are within the buffers around the Lease Area (i.e., Angler’s Bank, Cholera Bank, and HA Buoy) and two that are within the buffers around the EW 1 OEC (i.e., Cholera Bank and Ambrose Channel) (Figure 3-20).

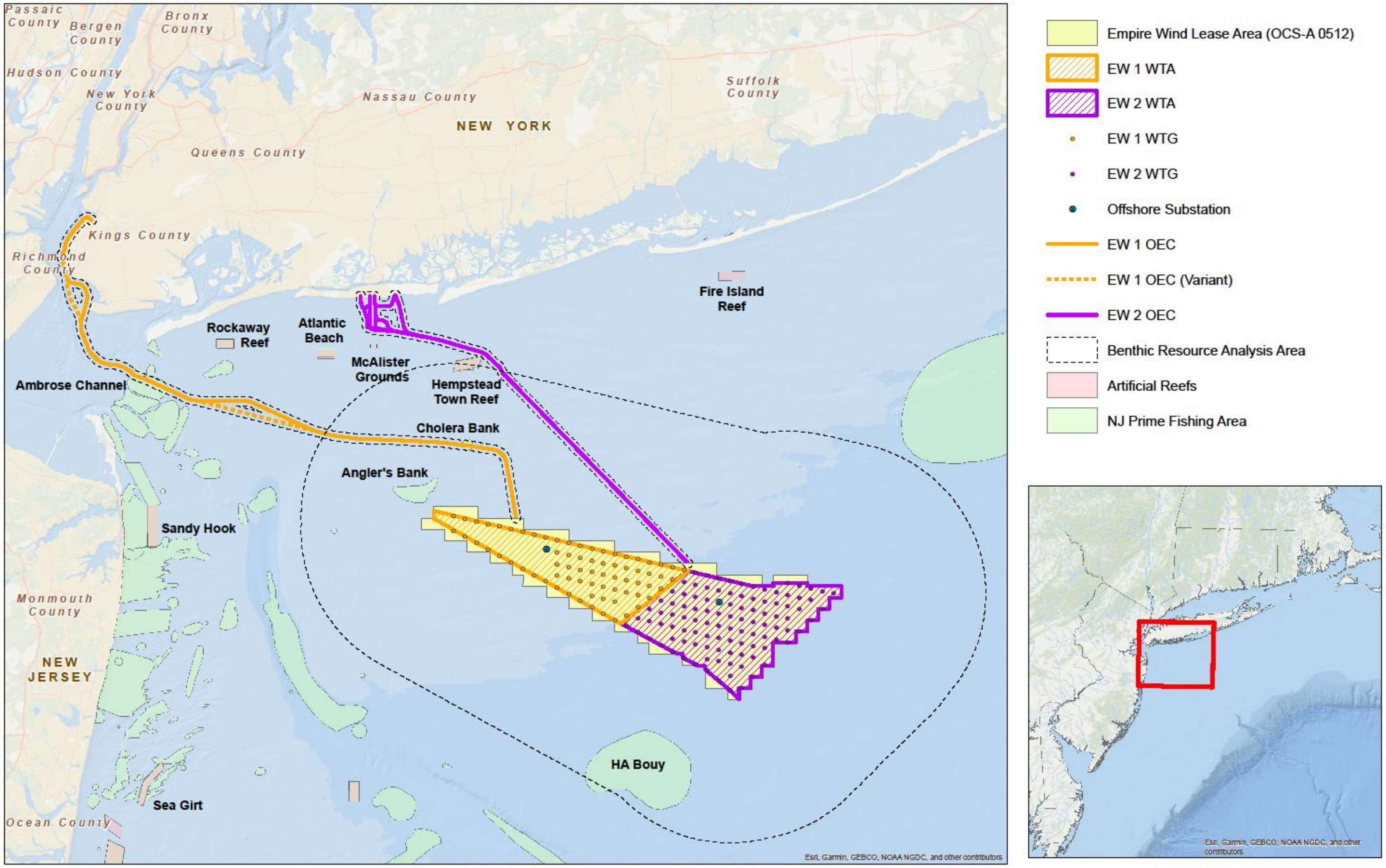

Figure 3-20. Artificial reefs and New Jersey Prime Fishing Areas in proximity to the Project area

4. Designated EFH

The Project area and Connected Action include EFH designations developed by the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. The management councils and NMFS designate EFH for species in association with a mapped grid of 10- by 10-minute squares covering all marine habitat along the U.S. coast. The quadrangles are used are used by the NEFMC and the MAFMC to delineate specific areas for the purpose of EFH designations. The site of the Proposed Action lies within 10 of the 10-by-10-minute squares within the New York Bight, Long Island, and Hudson-Raritan Estuary regions. Species and life stages with EFH in the Project area were identified with the NMFS EFH Mapper (NMFS 2022). Descriptions and habitat designations for EFH-designated species and life stages were primarily developed from NMFS EFH source documents, the Final Omnibus Essential Fish Habitat Amendment 2 (NEFMC 2017), and the Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species FMP (NMFS 2017).

The Project area and Connected Action include designated EFH for 40 fish and invertebrate species, with varying species and life stage distribution throughout the Project area. Resources are managed under various FMPs. NEFMC FMPs include Northeast Multispecies; Sea Scallop; Monkfish; Atlantic Herring; Skate, Small-Mesh Multispecies; and Spiny Dogfish. MAFMC FMPs include Summer Flounder, Scup, Black Sea Bass; Mackerel, Squid, Butterfish; Surfclam, Ocean Quahogs; Bluefish; Spiny Dogfish; and Monkfish. NMFS FMPs include the Highly Migratory Species. Designated EFH occurrence by taxonomic grouping, individual species, and life stage is summarized in Tables 4-1 and 4-2.

Table 4-1. EFH-designated fish and invertebrate species within the Project area. Information for the Connected Action is under the O&M heading.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Gadids													
Atlantic cod *Gadus morhua*	●	●	--	●	●	--	--	--	--	●	●	--	**Eggs/Larvae**: Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, and in the high-salinity zones of certain bays and estuaries. **Adults**: Sub-tidal benthic habitats in the Gulf of Maine, south of Cape Cod, and on Georges Bank, between 30 and 160 meters, including high salinity zones in certain bays and estuaries. Structurally complex hard bottom habitats composed of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae are essential habitats for adult cod. Adult cod are also found on sandy substrates and frequent deeper slopes of ledges along shore. South of Cape Cod, spawning occurs in nearshore areas and on the continental shelf, usually in depths less than 70 meters.
Haddock *Melanogrammus aeglefinus*	--	--	--	●	●	--	●	●	--	--	--	--	**Larvae:** Pelagic habitats in coastal and offshore waters in the Gulf of Maine, the Mid-Atlantic, and on Georges Bank. **Juveniles**: Sub-tidal benthic habitats between 40 and 140 meters in the Gulf of Maine, on Georges Bank and in the Mid-Atlantic region, and as shallow as 20 meters along the coast of Massachusetts, New Hampshire, and Maine. Essential fish habitat for adult haddock occurs on hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel. Young-of-the-year juveniles settle on sand and gravel on Georges Bank but are found predominantly on gravel pavement areas within a few months after settlement. As they grow, they disperse over a greater variety of substrate types on the bank. Young-of-the-year haddock do not inhabit shallow, inshore habitats.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Pollock *Pollachius virens*	--	●	--	●	●	--	--	●	--	--	--	--	**Eggs**: Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in southern New England, including certain bays and estuaries. **Larvae:** Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, including certain bays and estuaries. **Juveniles:** Inshore and offshore pelagic and benthic habitats from the intertidal zone to 180 meters in the Gulf of Maine, in Long Island Sound, and Narragansett Bay, between 40 and 180 meters on western Georges Bank and the Great South Channel, and in mixed and full salinity waters in several bays and estuaries north of Cape Cod. Essential fish habitat for juvenile pollock consists of rocky bottom habitats with attached macroalgae (rockweed and kelp) that provide refuge from predators. Shallow water eelgrass beds are also essential habitats for young-of-the-year pollock in the Gulf of Maine. Older juveniles move into deeper water into habitats also occupied by adults.
Red hake *Urophycis chuss*	●	●	--	●	●	--	●	●	--	●	●	--	**Eggs and Larvae:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, and in certain bays and estuaries. **Juveniles:** Intertidal and sub-tidal benthic habitats throughout the region on mud and sand substrates, to a maximum depth of 80 meters, including certain bays and estuaries. Bottom habitats providing shelter are essential for juvenile red hake, including: mud substrates with biogenic depressions, substrates providing biogenic complexity (e.g., eelgrass, macroalgae, shells, anemone and polychaete tubes), and artificial reefs. Newly settled juveniles occur in depressions on the open seabed. Older juveniles are commonly associated with shelter or structure and often inside live bivalves. **Adults:** Benthic habitats in the Gulf of Maine and the outer continental shelf and slope in depths of 50 – 750 meters and as shallow as 20 meters in several inshore estuaries and embayments as far south as Chesapeake Bay. Shell beds, soft sediments (mud and sand), and artificial reefs provide essential habitats for adult red hake. They are usually found in depressions in softer sediments or in shell beds and not on open sandy bottom.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Silver hake *Merluccius bilinearis*	●	●	--	●	●	--	●	--	--	--	●	--	**Eggs and Larvae:** Pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays. **Juveniles:** Pelagic and benthic habitats in the Gulf of Maine, including certain coastal bays and estuaries, and on the continental shelf as far south as Cape May, New Jersey, at depths greater than 10 meters in coastal waters in the Mid-Atlantic and between 40 and 400 meters in the Gulf of Maine, on Georges Bank, and in the middle continental shelf in the Mid-Atlantic, on sandy substrates. Juvenile silver hake are found in association with sand-waves, flat sand with amphipod tubes, and shells, and in biogenic depressions. Juveniles in the New York Bight settle to the bottom at mid-shelf depths on muddy sand substrates and find refuge in amphipod tube mats. **Adults:** Pelagic and benthic habitats at depths greater than 35 meters in the Gulf of Maine and certain coastal bays and estuaries, between 70 and 400 meters on Georges Bank and the outer continental shelf in the northern portion of the Mid-Atlantic Bight, and in some shallower locations nearer the coast, on sandy substrates. Adult silver hake are often found in bottom depressions or in association with sand waves and shell fragments. They have also been observed at high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs in the southwestern Gulf of Maine. This species makes greater use of the water column (for feeding, at night) than red or white hake.
White hake *Urophycis tenuis*	--	--	--	--	--	--	--	●	--	--	--	--	**Juveniles:** Intertidal and sub-tidal estuarine and marine habitats in the Gulf of Maine, on Georges Bank, and in southern New England, to a maximum depth of 300 meters. Pelagic phase juveniles remain in the water column for about two months. In nearshore waters, essential fish habitat for benthic phase juveniles occurs on fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats. In the Mid-Atlantic, most juveniles settle to the bottom on the continental shelf, but some enter estuaries, especially those in southern New England. Older young-of-the-year juveniles occupy the same habitat types as the recently-settled juveniles, but move into deeper water (>50 meters).

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Flatfish													
Summer flounder *Paralichthys dentatus*	●	●	--	●	●	--	●	●	●	●	●	●	**Eggs:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ). In general, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles of shore off New Jersey and New York. Eggs abundance is highest at depths of 30 to 360 ft. **Larvae:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ). Inshore, EFH is all estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database, in the “mixing” (defined in ELMR as 0.5 to 25.0 ppt) and “seawater” (defined in ELMR as greater than 25 ppt) salinity zones. In general, summer flounder larvae are most abundant nearshore (12-50 miles from shore) at depths between 30 to 230 ft. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February, and in the southern part from November to May. **Juveniles:** North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ). Inshore, EFH is all estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the “mixing” and “seawater” salinity zones. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37 °F and salinities from 10 to 30 ppt range. **Adults:** 1) North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ). Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the “mixing” and “seawater” salinity zones. Generally, summer flounder inhabit shallow coastal and estuarine waters ranging in depths from 1 to 82 feet, with an extensive range of salinities, during warmer months and move offshore on the outer continental shelf at depths of 500 ft in colder months.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Winter flounder *Pseudopleuronectes americanus*	--	●	●	●	●	●	●	●	●	●	●	●	**Eggs:** Sub-tidal estuarine and coastal benthic habitats from mean low water to 5 meters from Cape Cod to Absecon Inlet, and as deep as 70 meters on Georges Bank and in the Gulf of Maine, including mixed and high salinity zones in certain bays and estuaries. The eggs are adhesive and deposited in clusters on the bottom. Essential habitats for winter flounder eggs include mud, muddy sand, sand, gravel, macroalgae, and submerged aquatic vegetation. Bottom habitats are unsuitable if exposed to excessive sedimentation. **Larvae:** Estuarine, coastal, and continental shelf water column habitats from the shoreline to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet, and including Georges Bank, including mixed and high salinity zones in certain bays and estuaries. Larvae hatch in nearshore waters and estuaries or are transported shoreward from offshore spawning sites where they metamorphose and settle to the bottom as juveniles. They are initially planktonic but become increasingly less buoyant and occupy the lower water column as they age. **Juveniles:** Estuarine, coastal, and continental shelf benthic habitats from the Gulf of Maine to Absecon Inlet, and including Georges Bank, and in mixed and high salinity zones in certain bays and estuaries. Essential fish habitat for juvenile winter flounder extends from the intertidal zone to a maximum depth of 60 meters and occurs on a variety of bottom types, such as mud, sand, rocky substrates with attached macroalgae, tidal wetlands, and eelgrass. Young-of-the-year juveniles are found inshore on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks. They settle to the bottom in soft-sediment depositional areas where currents concentrate late-stage larvae and disperse into coarser-grained substrates as they age. **Adults:** Estuarine, coastal, and continental shelf benthic habitats extending from the intertidal zone to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet, and including Georges Bank, and in mixed and high salinity zones in certain bays and estuaries. Essential fish habitat for adult winter flounder occurs on muddy and sandy substrates, and on hard bottom on offshore banks. In inshore spawning areas, essential fish habitat includes a variety of substrates where eggs are deposited on the bottom.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Windowpane flounder *Scophthalmus aquosus*	●	●	--	●	●	--	●	●	●	●	●	●	**Eggs/Larvae**: Pelagic habitats on the continental shelf from Georges Bank to Cape Hatteras and in mixed and high-salinity zones of coastal bays and estuaries throughout the region. **Juveniles:** Intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida, including mixed and high salinity zones in bays and estuaries. Essential fish habitat for juveniles occurs on mud and sand substrates and extends from the intertidal zone to a depth of 60 meters. **Adults:** Intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to Cape Hatteras, including mixed and high salinity zones in bays and estuaries. Essential fish habitat for adults occurs on mud and sand substrates and extends from the intertidal zone to a depth of 70 meters.
Witch flounder *Glyptocephalus cynoglossus*	●	●	--	●	●	--	--	--	--	●	--	--	**Eggs and Larvae**: Pelagic habitats on the continental shelf throughout the Northeast region. **Adults:** Sub-tidal benthic habitats between 35 and 400 meters in the Gulf of Maine to 1500 meters on the outer continental shelf and slope, with mud and muddy sand substrates.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Yellowtail flounder *Limanda ferruginea*	●	●	--	●	●	--	●	●	--	●	●	●	**Eggs:** Coastal and continental shelf pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region as far south as the upper Delmarva peninsula, including high salinity zones of certain bays and estuaries. **Larvae:** Coastal marine and continental shelf pelagic habitats in the Gulf of Maine, and from Georges Bank to Cape Hatteras, including high salinity zones of bays and estuaries. **Juveniles:** Sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic, including the high salinity zones of certain bays and estuaries. Essential fish habitat for juvenile yellowtail flounder occurs on sand and muddy sand between 20 and 80 meters. In the Mid-Atlantic, young-of-the-year juveniles settle to the bottom on the continental shelf, primarily at depths of 40-70 meters, on sandy substrates. **Adults:** Sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic, including the high salinity zones of certain bays and estuaries. Essential fish habitat for adult yellowtail flounder occurs on sand and sand with mud, shell hash, gravel, and rocks at depths between 25 and 90 meters.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Other Finfish													
Atlantic butterfish *Peprilus triacanthus*	●	●	--	●	●	--	●	●	●	●	●	●	**Eggs:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and on the continental shelf and slope, primarily from Georges Bank to Cape Hatteras, North Carolina. EFH for Atlantic butterfish eggs is generally found over bottom depths of 1,500 meters or less where average temperatures in the upper 200 meters of the water column are 6.5-21.5°C. **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments in Boston harbor, from the south shore of Cape Cod to the Hudson River, and in Delaware and Chesapeake bays, and on the continental shelf from the Great South Channel (western Georges Bank) to Cape Hatteras, North Carolina. EFH for Atlantic butterfish larvae is generally found over bottom depths between 41 and 350 meters where average temperatures in the upper 200 meters of the water column are 8.5-21.5°C. **Juveniles:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, in inshore waters of the Gulf of Maine and the South Atlantic Bight, and on the inner and outer continental shelf from southern New England to South Carolina. EFH for juvenile Atlantic butterfish is generally found over bottom depths between 10 and 280 meters where bottom water temperatures are between 6.5 and 27°C and salinities are above 5 ppt. Juvenile butterfish feed mainly on planktonic prey. **Adults:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, inshore waters of the Gulf of Maine and the South Atlantic Bight, on Georges Bank, on the inner continental shelf south of Delaware Bay, and on the outer continental shelf from southern New England to South Carolina. EFH for adult Atlantic butterfish is generally found over bottom depths between 10 and 250 meters where bottom water temperatures are between 4.5 and 27.5°C and salinities are above 5 ppt. Spawning probably does not occur at temperatures below 15°C. Adult butterfish feed mainly on planktonic prey, including squids and fishes.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Atlantic mackerel *Scomber scombrus*	●	●	●	●	●	●	●	●	●	●	●	●	**Eggs:** EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel eggs is generally found over bottom depths of 100 meters or less with average water temperatures of 6.5-12.5°C in the upper 15 meters of the water column. **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel larvae is generally found over bottom depths between 21 and 100 meters with average water temperatures of 5.5-11.5°C in the upper 200 meters of the water column. **Juveniles:** EFH is pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay and Penobscot Bay, Maine to the Hudson River, in the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for juvenile Atlantic mackerel is generally found over bottom depths between 10 and 110 meters and in water temperatures of 5 to 20°C. Juvenile Atlantic mackerel feed primarily on small crustaceans, larval fish, and other pelagic organisms. **Adults:** EFH is pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay, Maine to the Hudson River, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for adult Atlantic mackerel is generally found over bottom depths less than 170 meters and in water temperatures of 5 to 20°C. Spawning occurs at temperatures above 7°C, with a peak between 9 and 14°C. Adult Atlantic mackerel are opportunistic predators feeding primarily on a wider range and larger individuals of pelagic crustaceans than juveniles, but also on fish and squid.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Atlantic sea herring *Clupea harengus*	--	--	--	●	●	--	●	●	●	●	●	●	**Larvae:** Inshore and offshore pelagic habitats in the Gulf of Maine, on Georges Bank, and in the upper Mid-Atlantic Bight, and in certain bays and estuaries. Atlantic herring have a very long larval stage, lasting 4-8 months, and are transported long distances to inshore and estuarine waters where they metamorphose into early-stage juveniles ("brit") in the spring. **Juveniles:** Intertidal and sub-tidal pelagic habitats to 300 meters throughout the region, including certain bays and estuaries. One and two-year old juveniles form large schools and make limited seasonal inshore-offshore migrations. Older juveniles are usually found in water temperatures of 3 to 15°C in the northern part of their range and as high as 22°C in the Mid-Atlantic. Young-of-the-year juveniles can tolerate low salinities, but older juveniles avoid brackish water. **Adults:** Sub-tidal pelagic habitats with maximum depths of 300 meters throughout the region, including certain bays and estuaries. Adults make extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region. They seldom migrate beyond a depth of about 100 meters and – unless they are preparing to spawn – usually remain near the surface. They generally avoid water temperatures above 10°C and low salinities. Spawning takes place on the bottom, generally in depths of 5 – 90 meters on a variety of substrates (see eggs).

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Black sea bass *Centropristis striata*	--	--	●	●	●	●	●	●	●	●	●	●	**Eggs:** EFH is the estuaries where black sea bass eggs were identified in the ELMR database as common, abundant, or highly abundant for the “mixing” and “seawater” salinity zones. Generally, black sea bass eggs are found from May through October on the continental shelf, from southern New England to North Carolina. **Larvae:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH also is estuaries where black sea bass were identified as common, abundant, or highly abundant in the ELMR database for the “mixing” and “seawater salinity zones. Generally, the habitats for larvae are near coastal areas and marine parts of estuaries between Virginia and New York. When larvae become demersal, they occur on structured inshore habitat such as sponge beds. **Juveniles:** Offshore, EFH is the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. Inshore, EFH is the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the ELMR database for the mixing” and “seawater” salinity zones. Juveniles occur in estuaries in summer and spring. Generally, juveniles occur in waters warmer than 43°F with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts. Juveniles are usually found in association with rough bottom, shellfish and eelgrass beds, man-made structures in sandy shelly areas; offshore clam beds and shell patches may also be used during the wintering. **Adults:** Offshore, EFH is the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. Inshore, EFH is the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the “mixing” and seawater” salinity zones. Adults occur in estuaries from May through October. Wintering adults are generally offshore, south of New York to North Carolina. Temperatures above 43°F seem to be the minimum requirements. Structured habitats (natural and man-made), sand and shell are usually the substrate preference.

	Designated EFH for Species and Life Stages by Project Component												
	Eggs			Larvae			Juvenile			Adult			
EFH Species	**WEA**	**OEC**	**O&M**	**WEA**	**OEC**	**O&M**	**WEA**	**OEC**	**O&M**	**WEA**	**OEC**	**O&M**	**EFH Description**
Bluefish *Pomatomus saltatrix*	●	●	--	●	●	--	●	●	--	●	●	●	**Eggs:** North of Cape Hatteras, pelagic waters over the continental shelf at mid-shelf depths, from Montauk Point south to Cape Hatteras. Bluefish eggs are generally not collected in estuarine waters and thus there is no EFH designation inshore. Generally, bluefish eggs are collected between April through August in temperatures greater than 64°F (18°C) and normal shelf salinities (> 31 ppt). **Larvae:** North of Cape Hatteras, pelagic waters over the continental shelf, most commonly above 49 ft (15 m), from Montauk Point south to Cape Hatteras. Bluefish larvae are not generally collected inshore, so there is no EFH designation inshore for larvae. Generally, bluefish larvae are collected April through September in temperatures greater than 64 °F (18°C) in normal shelf salinities (> 30 ppt). **Juveniles:** 1) North of Cape Hatteras, pelagic waters found over the continental shelf from Nantucket Island south to Cape Hatteras and 2) all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally, juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the “mixing” and “seawater” zones. Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed. **Adults:** 1) North of Cape Hatteras, over the continental shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay south to Cape Hatteras and 2) all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the “mixing” and “seawater” zones. Bluefish adults are highly migratory and distribution varies seasonally according to the size of the individuals comprising the schools. Bluefish are generally found in normal shelf salinities (> 25 ppt).

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Monkfish *Lophius americanus*	●	●	--	●	●	--	●	●	--	●	●	--	**Eggs and Larvae:** Pelagic habitats in inshore areas, and on the continental shelf and slope throughout the Northeast region. Monkfish eggs are shed in very large buoyant mucoidal egg "veils." Monkfish larvae are more abundant in the Mid-Atlantic region and occur over a wide depth range, from the surf zone to depths of 1000 to 1500 meters on the continental slope. **Juveniles:** Sub-tidal benthic habitats in depths of 50 to 400 meters in the Mid-Atlantic, between 20 and 400 meters in the Gulf of Maine, and to a maximum depth of 1000 meters on the continental slope. A variety of habitats are essential for juvenile monkfish, including hard sand, pebbles, gravel, broken shells, and soft mud; they also seek shelter among rocks with attached algae. Juveniles collected on mud bottom next to rock-ledge and boulder fields in the western Gulf of Maine were in better condition than juveniles collected on isolated mud bottom, indicating that feeding conditions in these edge habitats are better. Young-of-the-year juveniles have been collected primarily on the central portion of the shelf in the Mid-Atlantic, but also in shallow nearshore waters off eastern Long Island, up the Hudson Canyon shelf valley, and around the perimeter of Georges Bank. They have also been collected as deep as 900 meters on the continental slope. **Adults:** Sub-tidal benthic habitats in depths of 50 to 400 meters in southern New England and Georges Bank, between 20 and 400 meters in the Gulf of Maine, and to a maximum depth of 1000 meters on the continental slope. Essential fish habitat for adult monkfish is composed of hard sand, pebbles, gravel, broken shells, and soft mud. They seem to prefer soft sediments (fine sand and mud) over sand and gravel, and, like juveniles, utilize the edges of rocky areas for feeding.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Ocean pout *Macrozoarces americanus*	●	●	--	--	--	--	●	●	--	●	●	--	**Eggs**: Hard-bottom habitats in the Gulf of Maine, Georges Bank, and in the Mid-Atlantic Bight, as well as the high-salinity zones in certain estuaries. Eggs are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices. Essential fish habitat for ocean pout eggs occurs in depths less than 100 meters on rocky bottom habitats. **Juveniles:** Intertidal and sub-tidal benthic habitats in the Gulf of Maine and on the continental shelf north of Cape May, New Jersey, on the southern portion of Georges Bank, and in the high salinity zones of bays and estuaries north of Cape Cod, extending to a maximum depth of 120 meters. Essential fish habitat for juvenile ocean pout occurs on a wide variety of substrates, including shells, rocks, algae, soft sediments, sand, and Gravel. **Adults**: Sub-tidal benthic habitats between 20 and 140 meters in the Gulf of Maine, on Georges Bank, in coastal and continental shelf waters north of Cape May, New Jersey, and in the high salinity zones of bays and estuaries north of Cape Cod. Essential fish habitat for adult ocean pout includes mud and sand, particularly in association with structure forming habitat types (i.e., shells, gravel, or boulders). In softer sediments, they burrow tail first and leave a depression on the sediment surface. Ocean pout congregate in rocky areas prior to spawning and frequently occupy nesting holes under rocks or in crevices in depths less than 100 meters.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Scup *Stenotomus chrysops*	--	●	●	--	●	●	●	●	●	●	●	●	**Eggs:** EFH is estuaries where scup eggs were identified as common, abundant, or highly abundant in the ELMR database for the “mixing” and “seawater” salinity zones. In general, scup eggs are found from May through August in southern New England to coastal Virginia, in waters between 55 and 73 °F and in salinities greater than 15 ppt. **Larvae:** EFH is estuaries where scup were identified as common, abundant, or highly abundant in the ELMR database for the “mixing” and “seawater” salinity zones. In general, scup larvae are most abundant nearshore from May through September, in waters between 55 and 73 °F and in salinities greater than 15 ppt. **Juveniles:** 1) Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ, from the Gulf of Maine to Cape Hatteras, North Carolina. 2) Inshore, EFH is the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the “mixing” and “seawater” salinity zones. In general, juvenile scup are found during the summer and spring in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel and eelgrass bed type substrates and in water temperatures greater than 45 °F and salinities greater than 15 ppt. **Adults:** 1) Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. 2) Inshore, EFH is the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the “mixing and “seawater” salinity zones. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45 °F.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Highly Migratory Species													
Albacore tuna *Thunnus alalunga*	--	--	--	--	--	--	●	●	●	--	--	--	**Juveniles**: Offshore, pelagic habitats of the Atlantic Ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina. EFH also includes offshore pelagic habitats near the outer U.S. EEZ between North Carolina and Florida, and offshore pelagic habitats associated with the Blake Plateau.
Bluefin tuna *Thunnus thynnus*	--	--	--	--	--	--	●	●	--	●	●	--	**Juveniles:** Coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout, from shore (excluding Long Island Sound, Delaware Bay, Chesapeake Bay, and Pamlico Sound) to the continental shelf break. EFH in coastal areas of Cape Cod are located between the Great South Passage and shore. EFH follows the continental shelf from the outer extent of the U.S. EEZ on Georges Bank to Cape Lookout. EFH is associated with certain environmental conditions in the Gulf of Maine (16 to 19°C; 0 to 40 m deep). EFH in other locations associated with temperatures ranging from 4 to 26 °C, often in depths of less than 20 m (but can be found in waters that are 40-100 m in depth in winter). **Adults:** EFH is offshore and coastal regions of the Gulf of Maine the mid-coast of Maine to Massachusetts; on Georges Bank; offshore pelagic habitats of southern New England; from southern New England to coastal areas between the mouth of Chesapeake Bay and Onslow Bay, North Carolina; from coastal North Carolina south to the outer extent of the U.S. EEZ, inclusive of pelagic habitats of the Blake Plateau, Charleston Bump, and Blake Ridge.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Skipjack tuna *Katsuwonus pelamis*	--	--	--	--	--	--	●	●	--	●	●	●	**Juveniles:** Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts); coastal and offshore habitats between Massachusetts and South Carolina; localized in areas off Georgia and South Carolina; and from the Blake Plateau through the Florida Straits. In all areas juveniles are found if waters greater than 20 m. **Adults:** Coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina and localized areas in the Atlantic off South Carolina and Georgia, and the northern east coast of Florida. EFH in the Atlantic Ocean also located on the Blake Plateau and in the Florida Straits through the Florida Keys.
Yellowfin tuna *Thunnus albacares*	--	--	--	--	--	--	●	--	--	--	--	--	**Juveniles**: Offshore pelagic habitats are seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts, and offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau. Juveniles are locally distributed in the Florida Straits and off the southwestern edge of the West Florida Shelf. Yellowfish tuna juveniles are also found in the central Gulf of Mexico from the Florida Panhandle to southern Texas. Localized EFH is southeast of Puerto Rico.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Invertebrates													
Atlantic sea scallop *Placopecten magellanicus*	●	●	--	●	●	--	●	●	--	●	●	--	**Eggs:** Benthic habitats in inshore areas and on the continental shelf, near adult scallops. Eggs are heavier than seawater and remain on the seafloor. **Larvae:** Benthic and water column habitats in inshore and offshore areas throughout the region. Any hard surface can provide an essential habitat for settling pelagic larvae ("spat"), including shells, pebbles, and gravel. They also attach to macroalgae and other benthic organisms such as hydroids. Spat attached to sedentary branching organisms or any hard surface have greater survival rates. **Juveniles:** Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, in depths of 18 to 110 meters. Juveniles leave the original substrate on which they settle and attach themselves by byssal threads to shells, gravel, and small rocks, preferring gravel. As they grow older, they lose their byssal attachment. Juvenile scallops are relatively active and swim to escape predation. While swimming, they can be carried long distances by currents. Bottom currents stronger than 10 cm/sec retard feeding and growth. In laboratory studies, maximum survival of juvenile scallops occurred between 1.2 and 15°C and above salinities of 25 ppt. On Georges Bank, age-1 juveniles are less dispersed than older juveniles and adults and are mainly associated with gravel-pebble deposits. Essential habitats for older juvenile scallops are the same as for the adults (gravel and sand). **Adults:** Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic. Essential habitats for adult sea scallops are found on sand and gravel substrates in depths of 18 to 110 meters, but they are also found in shallower water and as deep as 180 meters in the Gulf of Maine. In the Mid-Atlantic they are found primarily between 45 and 75 meters and on Georges Bank they are more abundant between 60 and 90 meters. They often occur in aggregations called beds which may be sporadic or essentially permanent, depending on how suitable the habitat conditions are and whether oceanographic features keep larval stages near the spawning population. Bottom currents stronger than 25 cm/sec inhibit feeding. Growth of adult scallops is optimal between 10 and 15°C and they prefer full strength seawater.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Atlantic surf clam *Spisula solidissima*	--	--	--	--	--	--	●	●	--	●	●	--	**Juveniles and adults:** Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Surf clams generally occur from the beach zone to a depth of about 200 feet, but beyond about 125 feet abundance is low.
Ocean quahog *Arctica islandica*	--	--	--	--	--	--	●	●	--	●	●	--	**Juveniles and adults:** Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60 °F and occur progressively further offshore between Cape Cod and Cape Hatteras.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Eggs			Larvae			Juvenile			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Longfin inshore squid *Doryteuthis pealeii*	●	●	--	--	--	--	●	●	--	●	●	--	**Eggs:** Inshore and offshore bottom habitats from Georges Bank to Cape Hatteras, generally where bottom water temperatures are between 10°C and 23°C, salinities are between 30 and 32 ppt, and depth is less than 50 meters. Eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Egg masses are demersal and anchored to the substrates on which they are laid. Substrates include a variety of hard bottom types (e.g., shells, boulders), submerged aquatic vegetation, sand, and mud. **Pre-recruits: P**elagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in the southwestern Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, and Raritan Bay. Pre-recruits are generally found over bottom depths of 6-160 meters, bottom water temperatures of 8.5-24.5°C, and salinities of 28.5-36.5 ppt. Pre-recruits migrate offshore in the fall where they overwinter in deeper waters along the edge of the shelf. Small individuals feed on planktonic organisms while larger individuals feed on crustaceans and fish. **Recruits:** Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay. Recruits are generally found over bottom depths of 6-200 meters, bottom water temperatures of 8.5-14°C, and salinities of 24-36.5 ppt. Recruits inhabit the continental shelf and upper continental slope to depths of 400 meters. They migrate offshore in the fall and overwinter in warmer waters along the edge of the shelf. Females deposit eggs in gelatinous capsules which are attached in clusters to rocks, boulders, and aquatic vegetation and on sand or mud bottom, generally in depths less than 50 meters.

Notes:
• = present
-- = not present
EEZ = Exclusive Economic Zone
EFH = Essential Fish Habitat
m = meters
OCS = Outer Continental Shelf
ppt = parts per thousand
SAV = submerged aquatic vegetation

Table 4-2. EFH-designated elasmobranchs within the Project area

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Clearnose skate *Raja eglanteria*	--	--	--	--	--	--	--	●	--	--	●	--	**Juveniles**: Sub-tidal benthic habitats in coastal and inner continental shelf waters from New Jersey to the St. Johns River in Florida, including the high salinity zones of Chesapeake Bay, Delaware Bay, and certain other bays and estuaries. Essential fish habitat for juvenile clearnose skates occurs from the shoreline to 30 meters, primarily on mud and sand, but also on gravelly and rocky bottom. **Adults**: Sub-tidal benthic habitats in coastal and inner continental shelf waters from New Jersey to Cape Hatteras as shown on Map 96, including the high salinity zones of Chesapeake Bay, Delaware Bay, and the other bays and estuaries listed in Table 28. Essential fish habitat for adult clearnose skates occurs from the shoreline to 40 meters, primarily on mud and sand, but also on gravelly and rocky bottom.
Little skate *Leucoraja erinacea*	--	--	--	--	--	--	●	●	●	--	●	●	**Juveniles:** Intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 80 meters, and including high salinity zones in certain bays and estuaries. Essential fish habitat for juvenile little skates occurs on sand and gravel substrates, but they are also found on mud. **Adults**: Intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 100 meters, and including high salinity zones in certain bays and estuaries. Essential fish habitat for adult little skates occurs on sand and gravel substrates, but they are also found on mud.
Winter skate *Leucoraja ocellata*	--	--	--	--	--	--	●	●	●	●	●	●	**Juveniles and Adults**: Benthic habitats with mud and sand substrates on the outer continental shelf in depths of 80 – 400 meters from approximately 40˚N latitude to Cape Hatteras, North Carolina.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Sharks													
Blue shark *Prionace glauca*	●	●	--	●	●	--	●	●	--	●	●	--	**Neonate/YOY:** In the Atlantic in areas offshore of Cape Cod through New Jersey, seaward of the 30m bathymetric line (and excluding inshore waters such as Long Island Sound). EFH follows the continental shelf south of Georges Bank to the outer extent of the U.S. EEZ in the Gulf of Maine. **Juveniles and Adults**: EFH is localized areas in the Atlantic Ocean in the Gulf of Maine, from Georges Bank to North Carolina, South Carolina, Georgia, and off Florida.
Common thresher *Alopias vulpinus*	●	●	--	●	●	--	●	●	--	●	●	--	**Neonates, Juveniles, and Adults**: Insufficient data are available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH is in the Atlantic Ocean, from Georges Bank (at the offshore extent of the U.S. EEZ boundary) to Cape Lookout, North Carolina, and from Maine to locations offshore of Cape Ann, Massachusetts. EFH occurs with certain habitat associations in nearshore waters of North Carolina, especially in areas with temperatures of 18.2-20.9°C and at depths of 4.6-13.7 meters.
Dusky shark *Carcharhinus obscurus*	●	●	--	●	●	--	●	●	--	●	●	--	**Neonate/YOY:** EFH in the Atlantic Ocean includes offshore areas of southern New England to Cape Lookout, North Carolina. Specifically, EFH is associated with habitat conditions including temperatures from 18.1 to 22.2 °C, salinities of 25 to 35 ppt and depths at 4.3 to 15.5 m. Seaward extent of EFH for this life stage in the Atlantic is 60 m in depth. **Juveniles and adults:** Coastal and pelagic waters inshore of the continental shelf break (< 200 meters in depth) along the Atlantic east coast from habitats offshore of southern Cape Cod to Georgia, including the Charleston Bump and adjacent pelagic habitats. Inshore extent for these life stages is the 20-meter bathymetric line, except in habitats of southern New England, where EFH is extended seaward of Martha's Vineyard, Block Island, and Long Island. Pelagic habitats of southern Georges Bank and the adjacent continental shelf break from Nantucket Shoals and the Great South Channel to the eastern boundary of the United States EEZ. Adults are generally found deeper (to 2000 meters) than juveniles, however there is overlap in the habitats utilized by both life stages. Offshore waters of the western and north Gulf of Mexico, at and seaward of the continental shelf break (a buffer is included ~10 nautical miles north of the 200-meter bathymetric line), and in proximity to numerous banks along the continental shelf edge (e.g., Ewing and Sackett Bank). The continental shelf edge habitat from Desoto Canyon west to the Mexican border is important habitat for adult dusky sharks.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Sand tiger shark *Carcharias taurus*	●	●	--	●	●	--	●	●	--	--	--	--	**Neonates and juveniles:** Neonate EFH ranges from Massachusetts to Florida, specifically the PKD bay system, Sandy Hook, and Narragansett Bays as well as coastal sounds, lower Chesapeake Bay, Delaware Bay (and adjacent coastal areas), Raleigh Bay and habitats surrounding Cape Hatteras. Juveniles EFH includes habitats between Massachusetts and New York (notably the PKD bay system), and between mid-New Jersey and the mid-east coast of Florida. EFH can be described via known habitat associations in the lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where temperatures range from 19 to 25 °C, salinities range from 23 to 30 ppt at depths of 2.8-7.0 m in sand and mud areas, and in coastal North Carolina habitats with temperatures from 19 to 27 °C, salinities from 30 to 31 ppt, depths of 8.2-13.7 m, in rocky and mud substrate or in areas surrounding Cape Lookout that contain benthic structure. **Adults:** In the Atlantic along the mid-east coast of Florida (Cape Canaveral) through Delaware Bay. Important habitats include lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where sand tiger sharks spend 95 percent of their time in waters between 17 and 23 °C. EFH is restricted off the coast of Florida to habitats that are less than 200 meters in depth.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Sandbar shark *Carcharhinus plumbeus*	●	●	--	●	●	--	●	●	--	●	●	●	**Neonate/YOY:** Atlantic coastal areas from Long Island, New York to Cape Lookout, North Carolina, and from Charleston, South Carolina to Amelia Island, Florida. Important neonate/YOY EFH includes: Delaware Bay (Delaware and New Jersey) and Chesapeake Bay (Virginia and Maryland), where the nursery habitat is limited to the southeastern portion of the estuaries (salinity is greater than 20.5 ppt and depth is greater than 5.5 m); Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. In all nursery areas between New York and North Carolina, unless otherwise noted, EFH is associated with water temperatures that range from 15 to 30 °C; salinities that vary from 15 to 35 ppt; water depths that range from 0.8 to 23 m; and sand, mud, shell, and rocky sediments/benthic habitat. EFH in the Gulf of Mexico includes localized coastal areas on the Florida panhandle (Indian Pass and St. Andrew Sound, Florida) in water temperatures from 20 to 31°C at salinities from 19 to 39 ppt and depths of 2.1 to 5.2 m in silt/clay habitats. **Juveniles:** EFH includes coastal portions of the Atlantic Ocean between southern New England (Nantucket Sound, Massachusetts) and Georgia in water temperatures ranging from 20 to 24 °C and depths from 2.4 to 6.4 m. Important nurseries include Delaware Bay, Delaware and New Jersey; Chesapeake Bay, Virginia; Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. For all EFH, water temperatures range from 15 to 30°C, salinities range from 15 to 35 ppt, water depth ranges from 0.8 to 23 m, and substrate includes sand, mud, shell, and rocky habitats. EFH in the Gulf of Mexico includes localized areas off Apalachicola Bay, Florida. **Adults:** EFH in the Atlantic Ocean includes coastal areas from southern New England to the Florida Keys, ranging from inland waters of Delaware Bay and the mouth of Chesapeake Bay to the continental shelf break. EFH in the Gulf of Mexico includes coastal areas between the Florida Keys and Anclote Key, Florida; areas offshore of the Big Bend region; coastal areas of the Florida panhandle and Gulf coast between apalachicola and the Mississippi River; and habitats surrounding the continental shelf between Louisiana and south Texas. Adults commonly use habitats in the West Florida Shelf, off Cape San Blas, and cool, deep, clear water offshore of Texas and Louisiana.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Shortfin mako shark *Isurus oxyrinchus*	●	●	--	●	●	--	●	●	--	●	●	--	**General habitat description**: The shortfin mako shark is a pelagic, oceanic species that inhabits warm and warm-temperate waters throughout all oceans (NMFS 2017). **Neonates, Juveniles, and Adults**: Pelagic waters in the Atlantic from southern New England through Cape Lookout, and specific areas off Maine, South Carolina, and Florida (NMFS 2017).
Tiger shark *Galeocerdo cuvieri*	--	--	--	--	--	--	●	●	--	●	●	--	**Juveniles and adults:** EFH in the Atlantic Ocean extends from offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (south of Georges Bank, off Massachusetts) to the Florida Keys, inclusive of offshore portions of the Blake Plateau. EFH in the Gulf of Mexico includes pelagic and coastal habitats between Tampa Bay, Florida Bay and Florida Keys, and the edge of the West Florida Shelf; and an area extending from off eastern Louisiana, Mississippi, and Alabama to offshore pelagic habitats in the central Gulf of Mexico. Grass flats in the Gulf of Mexico are considered feeding areas, and are included as EFH. EFH also includes coastal and pelagic habitats surrounding Puerto Rico (except on the northwest side of the island) and the U.S. Virgin Islands.
White shark *Carcharadon carcharias*	●	●	--	●	●	--	--	--	--	●	●	--	**Neonate/YOY:** EFH includes inshore waters out to 105 km from Cape Cod, Massachusetts, to an area offshore of Ocean City, New Jersey. **Juveniles and adults:** Known EFH includes inshore waters to habitats 105 km from shore, in water temperatures ranging from 9 to 28 °C, but more commonly found in water temperatures from 14 to 23 °C from Cape Ann, Massachusetts, including parts of the Gulf of Maine, to Long Island, New York, and from Jacksonville to Cape Canaveral, Florida.

EFH Species	Designated EFH for Species and Life Stages by Project Component												EFH Description
	Neonate/YOY			Juvenile			Subadult			Adult			
	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	WEA	OEC	O&M	
Spiny dogfish *Squalus acanthias*	--	--	--	--	--	--	sf	sf	●	f	f/m	●	**Female Sub-Adults:** Pelagic and epibenthic habitats throughout the region. Sub-adult females occur over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7-15°C. Sub-adult females are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C. **Male Sub-Adults:** Pelagic and epibenthic habitats, primarily in the Gulf of Maine and on the outer continental shelf from Georges Bank to Cape Hatteras. Sub-adult males occur over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7-15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C. **Female Adults:** Pelagic and epibenthic habitats throughout the region. Adult females occur over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7-15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C. **Male Adults:** Pelagic and epibenthic habitats throughout the region. Adult males are found over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7 to 15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C.
Smoothhound shark complex *Mustelus spp.*	--	--	--	●	●	--	●	●	--	●	●	●	**Neonate/YOY, Juvenile, and Adult:** Available information is insufficient for the identification of EFH for this life stage, therefore, all life stages are combined in the EFH designation. EFH identified in the Atlantic is exclusively for smooth dogfish. EFH in Atlantic coastal areas ranges from Cape Cod Bay, Massachusetts to South Carolina, inclusive of inshore bays and estuaries (e.g., Pamlico Sound, Core Sound, Delaware Bay, Long Island Sound, Narragansett Bay, etc.). EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras.

Notes:

• = present
-- = not present
sf = sub-females
f = female
m = male
YOY = young-of-year

EEZ = Exclusive Economic Zone
EFH = Essential Fish Habitat
OCS = Outer Continental Shelf
ppt = parts per thousand

4.1. Vulnerable species, life stages, and habitat

Many mobile species are less susceptible to potential project impacts because they can leave or avoid areas of impacts. However, certain EFH species are more susceptible because they are immobile or have limited mobility. Certain habitats are also considered sensitive. The following list summarizes vulnerable species and habitat:

- Winter flounder eggs and larvae, which are demersal and are found in Mid-Atlantic estuaries in late winter through spring
- Sessile or slow-moving benthic/epibenthic invertebrates (bivalve juveniles and adults, squid egg mops)
- Skate egg cases
- Ocean pout eggs and larvae
- Tidal saltmarshes, especially those dominated by *Spartina alterniflora* and/or *Spartina patens*. Marshes dominated by *Phragmites australis*, while still providing important wetlands functions, are not as sensitive to disturbance.
- Submerged aquatic vegetation (SAV), especially beds dominated by *Zostera marina*

4.2. Habitat Areas of Particular Concern

Fisheries Management Councils and NMFS may also designate Habitat Areas of Particular Concern (HAPC), defined as a subset of the habitats that a species is known to occupy, to conserve fish habitat in geographical locations particularly critical to the survival of a species. According to the NMFS EFH Mapper, there is no designated HAPC in the Project Area (NMFS 2022). The nearest NMFS-identified HAPC to the Project Area is for summer flounder and consists of seagrass beds located inshore of Jones Beach on Long Island, which is 5.8 miles (9.3 km) from the EW 2 submarine export cable siting corridor (Figure 4-1). HAPC for summer flounder includes all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. If native species of SAV are eliminated then exotic species should be protected because of functional value; however, all efforts should be made to restore native species.

Although no SAV was indicated in the Project Area by the NMFS HAPC Mapper, and no SAV was evident from visual surveys and collected benthic grab samples taken during a benthic survey of the Project Area conducted in July and August 2020 (AECOM 2021a,2022), NYSDEC (2021) has stated that SAV occurs south of “Pier 7”, a dilapidated bulkheaded solid landfill pier which is located south of the Project Area and extends approximately 820 feet perpendicularly from the shoreline. The SAV bed is approximately 0.6 acres, extending from the shoreline out to a distance of approximately 325 feet, and at its nearest point to the Project Area is located a horizontal distance of approximately 700 feet from the Project Area, The proposed construction techniques and BMPs to be employed during Project activities would likely minimize TSS increases in the water column. Additionally, TSS transport will be minimal and the amount of TSS is not expected to measurably impact the SAV present at Pier 7 (AECOM 2022a).

Prey Species

Prey species are those species consumed by EFH fish and invertebrate species as prey and are thus a component of EFH. Species include forage fish such as sand lance, anchovy, and river herring, as well as invertebrates such as clams, crabs and worms. Sand lance (*Ammodytes* spp.) are recognized as prey for at least 45 species of fish in the northwest Atlantic Ocean (Staudinger et al. 2020). Bay anchovy (*Anchoa* *mitchilli*) is one of the most abundant fish species in the western north Atlantic (Houde and Zastrow 1991) and is an important trophic link between planktonic production and larger piscivores. Epibenthic and infaunal species, primarily invertebrates, similarly provide important trophic linkages to upper trophic level species. Invertebrates, including worm-like invertebrates (e.g., oligochaetes, polychaetes, flatworms, and nematodes), burrowing amphipods, mysids, copepods, crabs, sand dollars, starfish, sea urchins, bivalves, snails and burrowing anemones, provide prey for several EFH species. Impacts to prey species may indirectly cause impacts on EFH and EFH species and life stages because of lost foraging opportunities or reduced foraging efficiency.

4.3. Species Groups

Species groups, defined as groups of EFH species and/or life history stages that predominantly share the same habitat type, are used throughout this assessment. Benthic/epibenthic species groups are sorted into two habitat types (soft bottom or complex) based on the benthic habitat with which the species is typically associated, with the potential for any species occur in heterogenous complex habitat. Prey species are included as species groups because they are consumed by managed fish and invertebrate species and thus are therefore a component of EFH. A list of the species groups used in this assessment is provided below.

Sessile Benthic/Epibenthic – Soft Bottom

- Atlantic scallop (juveniles, adults)
- Atlantic surfclam (juveniles, adults)
- Flatfish (eggs and larvae of winter flounder)
- Longfin and northern shortfin squid (eggs)
- Ocean pout (eggs, larvae)
- Ocean quahog (juveniles, adults)
- Skates (eggs)

Mobile Benthic/Epibenthic – Soft Bottom

- Flatfish (juveniles, adults)
- Monkfish (juveniles, adults)
- Ocean pout (juveniles, adults)
- Red hake (juveniles, adults)
- Scup (juveniles, adults)
- Sharks (neonates, juveniles, adults)
- Skates (neonates, juveniles, adults)
- Silver hake
- White hake

Sessile Benthic/Epibenthic – Complex Habitat

- Longfin and northern shortfin squid (eggs)
- Skates (eggs)

Mobile Benthic/Epibenthic – Complex Habitat

- Atlantic cod
- Black sea bass
- Scup (juveniles, adults)
- Sharks (neonates, juveniles, adults)
- White hake

Pelagic

- Atlantic butterfish (eggs, larvae, juveniles, adults)
- Atlantic herring (eggs, larvae, juveniles, adults)
- Atlantic mackerel (eggs, larvae, juveniles, adults)
- Bluefish (eggs, larvae, juveniles, adults)
- Highly Migratory Species (eggs, larvae, juveniles, adults)
- Longfin squid (larvae, juveniles, adults)
- Northern shortfin squid (larvae, juveniles, adults)
- Pollock (juveniles, adults)
- Sharks (neonates, juveniles, adults)
- All other finfish, flatfish, and bivalves except ocean pout and winter flounder (eggs or larvae)

Prey Species – Benthic/Epibenthic

- Bivalves, including blue mussel (*Mytilus edulis*), eastern oyster (*Crassostrea virginica*), and soft-shell clam (*Mya arenaria*)
- Annelid worms
- Crustaceans (e.g., amphipods, shrimps, crabs)

Prey Species – Pelagic

- Anchovy, including bay anchovy and striped (*Anchoa hepsetus*)
- Atlantic menhaden
- River herring (alewife, blueback herring)
- Sand lance

4.4. NOAA Trust Species

NOAA Trust Resources have been identified in the Lease Area and along the OECs. NOAA Trust Resources are summarized in Table 4-3 and discussed in detail in Section 7.

Table 4-3. NOAA Trust Resources within the Project area

Species	Egg	Larvae	Juvenile	Adult
American eel		X	X	X
American lobster	X	X	X	X
Atlantic croaker	X	X	X	X
Atlantic menhaden	X	X	X	X
Bivalves (blue mussel, eastern oyster, soft-shell clam)	X	X	X	X
Blue crab	X	X	X	X
Forage species (Atlantic menhaden, northern sand lance)	X	X	X	X

Gulf stream flounder	X	X	X	X
Horseshoe crab	X	X	X	X
Jonah crab	X	X	X	X
Northern kingfish	X	X	X	X
Northern sea robin	X	X	X	X
River herring (alewife, blueback herring)			X	X
Smallmouth flounder	X	X	X	X
Spot	X	X	X	X
Spotted hake	X	X	X	X
Striped bass			X	X
Tautog	X	X	X	X
Weakfish	X	X	X	X
American shad			X	X

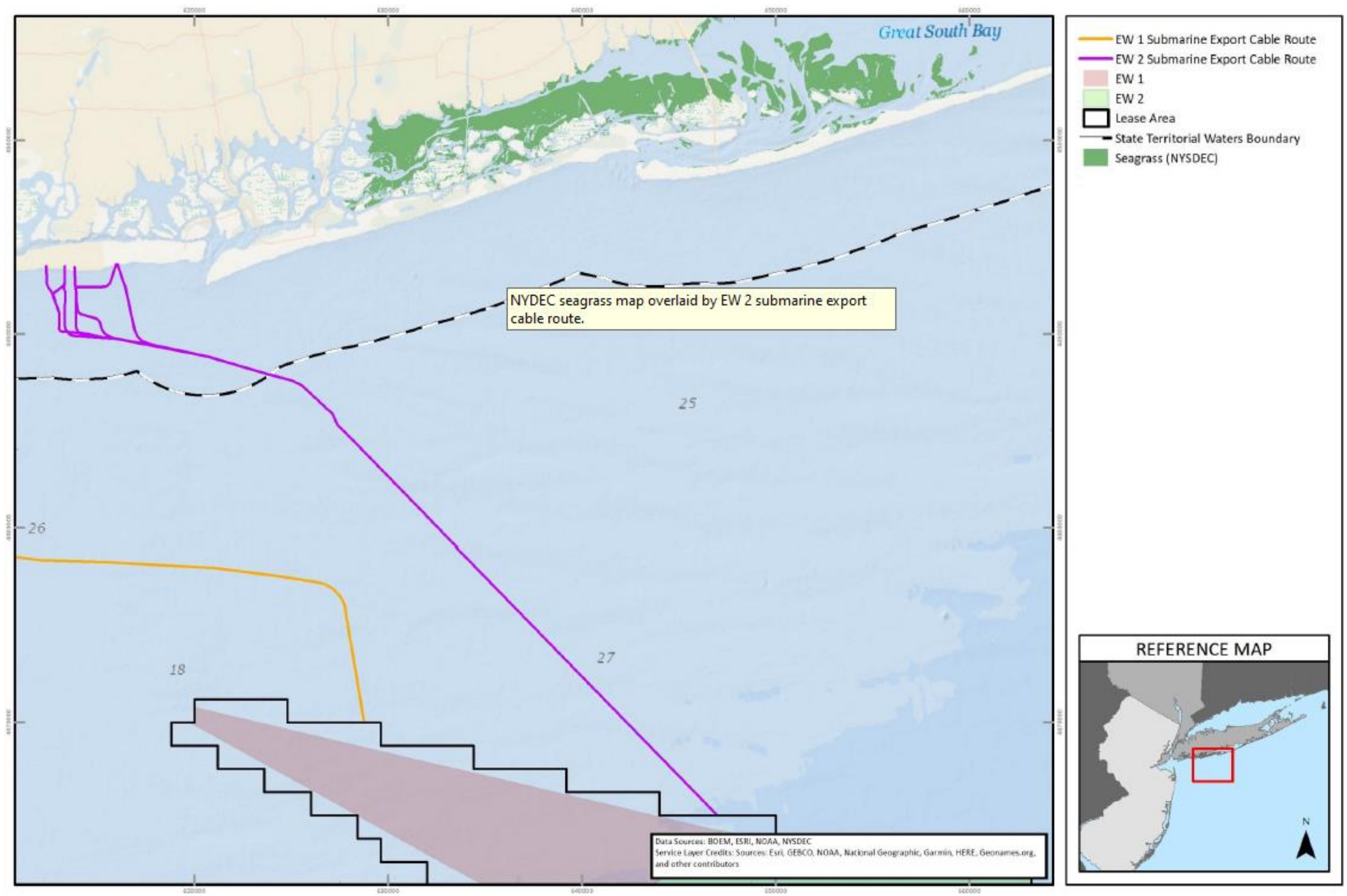

Figure 4-1. NYSDEC statewide seagrass map (2018) and EW 2 offshore export cable corridor

5. Adverse Effects

This section provides an analysis of the effects of the Proposed Action on designated EFH for managed species and life stages in the Project area defined in Section 2.1. As stated, the Project area is composed of the maximum impact footprints resulting from the EW 1, EW 1, OSSs, and OECs. These footprints are defined by the geographic extent of measurable effects from project construction and operation. Potential effects on EFH are evaluated in this section by 1) determining if designated EFH occurs in one or more project footprints, and 2) determining if impact mechanisms are likely to impair the suitability of the affected habitat for the species and life stage in question. Adverse effects on EFH may include direct or indirect physical, chemical, or biological alterations of waters or substrates used by EFH species during their life cycle, impacts to pelagic and benthic prey organisms and their habitats, and other ecosystem components. Adverse effects may be short-term (less than 2 years), long-term (2 years to less than life of Project), or permanent (life of Project), site-specific, or habitat-wide, and can result from the individual, cumulative, or synergistic consequences of actions (50 CFR § 600.910). If a project component is likely to result in a short-term, long-term, or permanent impairment of designated EFH for a managed species and life stage, this would constitute an adverse effect on EFH.

5.1. Construction & Operation Activities

Project construction would generate short-term, long-term, and permanent direct and indirect effects on EFH through vessel activity, pile driving, seabed preparation, and installation of scour protection. Effects would include noise; crushing and burial; entrainment; and elevated suspended sediments and sediment deposition. These effects would occur intermittently and at varying locations in the Project area over the construction period. Therefore, the suitability of EFH for managed species may be reduced depending on the nature, duration, and magnitude of each effect. Impacts of Project activities on EFH and EFH species are discussed below.

5.1.1. Installation of WTG/OSS structures and foundations

5.1.1.1. Vessel activity

During installation of up to 147 WTG and 2 OSS structures and associated foundations, it is anticipated that 18 construction vessels would be necessary for the construction of each of EW 1 and EW 2 (Empire 2021). Vessel activity would occur intermittently during the construction period beginning with the start of the EW 1 foundation installation in April 2024 and continuing through the completion of the EW 2 WTG installation in August 2027 (see Figure 2-2, above).

Habitat Disturbance

Certain construction vessels such as jack-up vessels or hotel vessels would require the use of stabilization spuds and anchors during WTG and OSS installation, which would disturb benthic EFH and EFH species that rely on that habitat. These activities would take place within the 79,350-acre Lease area. Vessels that use anchors (rather than spud cans) to hold position generally have a greater potential to disturb the seabed and result in crushing or burial impacts and habitat loss or conversion. However, seabed depressions known as “footprints” can remain after the removal of spud cans. The form and duration of these footprints are influenced by the shape of the spud can; the type, strength, and stratification of sediments; the degree of sediment infill during spud can removal; the local hydrodynamic regime; the method of spud can removal; and the penetration depth of the footing (Dier et al. 2004; Hossain and Stainforth 2016). Vessels within the WFA, including vessels involved in the installation of the monopile and piled jacket foundations, would primarily use dynamic positioning systems to hold position and would not result in such impacts (Table 6-1). Empire Wind has estimated that a total of 18 acres of habitat would be disturbed by anchoring of vessels during construction of the Proposed Action, including the installation of the WTGs and OSSs (Empire Wind 2022, Appendix F), though the breakdown by specific habitat type for that number is not known.

Anchor placement and retrieval, anchor chain sweep, and spud placement could cause habitat loss or conversion by disturbing or crushing habitat in the immediate area where anchors, chains, and spuds meet the seafloor, resulting in short-term to long-term direct impacts to EFH for sessile benthic/epibenthic species. EFH in soft bottom habitats would likely recover in the short-term, but impacts to complex, hard-bottom habitats (e.g., cobble and boulders) could include disturbance of epifaunal communities, which could take much longer to recover. To minimize anchoring impacts and reduce impacts to EFH and EFH species, Empire Wind has committed to an Applicant Proposed Mitigation (APM) to avoid anchoring on sensitive habitat during construction activities (Table 6-1).

Anchoring activities could also result in the crushing and burial of sessile or slow-moving benthic/epibenthic EFH species and/or life stages, resulting in direct, permanent (lethal), localized impacts to these species. Benthic/epibenthic communities in soft bottom habitat would be recoverable in the short-term, while benthic/epibenthic communities in complex habitat would be recoverable in the short-term to long-term. Anchor placement and retrieval, anchor chain sweep, and spud placement could cause mobile benthic and pelagic EFH species, as well as benthic and pelagic prey species, to avoid the area of impact, resulting in direct, short-term, localized impacts on these species. Sessile or slow-moving prey species could be crushed or buried during anchoring activities, resulting in indirect short-term effects on pelagic and mobile benthic EFH species and/or life stages that feed on those species.

Direct Effects on EFH and EFH species

- Short-term loss/conversion of EFH (APM for avoidance of sensitive habitat when anchoring):
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic
- Long-term loss/conversion of EFH:
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic
- Permanent, localized crushing and burial of EFH species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic
- Short-term avoidance of anchoring activities by EFH species:
  - Mobile Epibenthic/Benthic – Soft Bottom
  - Mobile Epibenthic/Benthic – Complex
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH species

- Short-term loss of benthic prey items:

- Mobile Benthic/Epibenthic – Soft Bottom
- Long-term loss of benthic prey items:
  - Mobile Benthic/Epibenthic – Complex

Sediment Suspension/Redeposition

Some Project vessel activities, such as those associated with anchoring (e.g., anchor placement and retrieval, chain sweep, and/or spud placement), would result in sediment suspension, a concomitant increase in turbidity in the water column, and sedimentation. Sessile benthic/epibenthic EFH species have a range of susceptibility to sediment suspension, turbidity, and sedimentation based on life stage, mobility, and feeding mechanisms. Increases in sediment suspension and deposition may cause short-term adverse impacts to EFH resulting from a decrease in habitat quality for benthic species and life stages, with small sessile or slow-moving benthic EFH species and life stages experiencing greater impacts from deposition than larger, mobile species or life stages.

Egg and larval life stages are sensitive to suspended sediment and can experience sublethal or lethal effects from as little as 0.4 inch (10 mm) of sediment deposition (Kjelland et al. 2015; Michel et al. 2013; Wilber and Clarke 2001). Certain species (e.g., winter flounder) are particularly sensitive to sediment deposition and can experience mortality at burial depths less than 0.1 inch (3 mm) (Michel et al. 2013). Modeling of sediment deposition associated with the Proposed Action has been limited to cable emplacement activities, which estimated that the sediment deposition thickness from cable emplacement would generally fall below 0.1 inch within 82 ft (25 m) of the trench centerline (Empire Wind 2021, Appendix J). This indicates that anchoring, which would disturb sediment over a shorter distance than cable emplacement, would generate sediment deposition levels of 0.1 inch only in immediate proximity to the anchoring footprint. Benthic habitats exposed to measurable burial depths from anchoring would be rendered temporarily unsuitable for EFH species with benthic or epibenthic eggs and larvae in the Lease Area.

Adult and juvenile fishes exposed to elevated suspended sediment levels may temporarily cease feeding, abandon cover, and/or experience short-term physiological stress. Modeling of suspended sediments associated with the Proposed Action has been limited to cable emplacement activities, which estimated that maximum plume distances were typically between 328 and 1,640 feet (100 and 500 meters) from the trench centerline and dissipated to background levels within 1 hour of the disturbance. This indicates that anchoring, which would disturb sediment over a shorter distance than cable emplacement, would generate elevated turbidity levels only in immediate proximity to the anchoring footprint and only for a short duration. However, short-term exposure to elevated suspended sediment levels like those anticipated from anchoring are not expected to have adverse effects on filter-feeding bivalves (Wilber and Clarke 2001; Yang et al. 2017).

Direct Effects on EFH and EFH species

- Short-term decrease in quality of EFH resulting from suspended sediments and increased turbidity:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, local impacts resulting from sedimentation:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic

Indirect Effects on EFH and EFH species

- Short-term loss of foraging opportunities:
  - Mobile Epibenthic/Benthic – Soft Bottom
  - Pelagic
- Short-term decrease in quality of EFH in areas adjacent to Project activities:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic

Vessel Noise

Vessel noise may have several effects on fish and invertebrates, including interfering with feeding and breeding, altering schooling behaviors and migration patterns (Buerkle 1973; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002; Mitson and Knudsen 2003; Ona et al. 2007), masking important environmental auditory cues (Codarin et al. 2009; Radford et al. 2014), and inducing endocrine stress response (Wysocki et al. 2006). Fish communication is mainly in the low-frequency (<1000 hertz [Hz]) range (Ladich and Myrberg 2006; Myrberg and Lugli 2006), so masking is a particular concern because many fish species have unique vocalizations that allow for inter- and intra-species identification and because fish vocalizations are generally not loud, usually ~120 decibels (dB) SPL with the loudest sounds reaching 160 dB SPL (Normandeau Associates 2012). Behavioral responses in fishes differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable to vessel noise impacts (Popper and Hastings 2009; Gedamke et al. 2016).

Underwater sound generated by vessels has been observed to cause avoidance behavior in hearing specialist fish species (e.g., Atlantic herring [*Clupea harengus*] and Atlantic cod [*Gadus morhua*]) and is likely to cause similar behavior in other hearing specialist species (Vabø et al. 2002; Handegard et al. 2003). For example, analysis of vessel noise related to the Cape Wind Energy Project observed that underwater noise generated by construction vessels at 10 feet (3 meters) was loud enough to cause an avoidance response in fish, but not loud enough to do physical harm (MMS 2008). Pelagic species and life stages and prey species that inhabit the upper water column (e.g., Atlantic butterfish, Atlantic herring, Atlantic mackerel, bluefish, and some highly migratory pelagic species) are the most likely to be impacted by vessel noise, although the behavioral avoidance impacts would be short-term. However, benthic species and life stages inhabiting inshore, shallow waters could also be impacted. Demersal and benthic invertebrates are generally less sensitive to underwater noise compared to fish and are not expected to be impacted by vessel-related noise. Project-related vessel noise would be intermittent and short-term. Vessel and pile driving noise effects on specific hearing categories for EFH-designated species are combined and detailed further in Section 5.1.1.2.

Direct Effects on EFH and EFH species

- Short-term, local avoidance responses to vessel noise:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic

  - Prey Species – Pelagic

Potential Introduction of Exotic/Invasive Species

Non-native (i.e., exotic) species can be accidentally released in the discharge of ballast water and bilge water during vessel activities. Although not all non-native species may survive introduction into a new ecosystem or cause adverse ecological effects, increasing vessel traffic throughout the construction duration of the project would increase the risk of accidental releases of species that may become invasive. Vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including U.S. Coast Guard ballast discharge regulations (33 CFR 151.2025) and U.S. Environmental Protection Agency National Pollutant Discharge Elimination System Vessel General Permit standards, both of which aim at least in part to prevent the release and movement of invasive species. Adherence to these regulations would reduce the likelihood of discharge of ballast or bilge water contaminated with invasive species (Table 6-1). Although the likelihood of invasive species becoming established due to project-related activities is low, the impacts of invasive species could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna. Indirect impacts could result from competition with invasive species for food or habitat, and/or loss of foraging opportunities if preferred prey is no longer available due to competition with invasive species.

Direct Effects on EFH and EFH species

- Extremely low likelihood, but potentially permanent and wide-spread impacts to any or all EFH and EFH species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Extremely low likelihood of competition with invasive species, loss of foraging opportunities:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

5.1.1.2. Pile driving

Impact pile driving would be required during the installation of up to 147 WTGs and 2 OSS foundations. The installation of one monopile would require approximately 2 days with approximately 5 hours of pile driving, such that impact pile driving noise impacts would occur over a maximum of 352 days (2 days per foundation). A standard installation scenario assumes that one pile is driven every four days such that up to 147 monopiles would be installed over a period of approximately 2 years. As summarized in Figure 2-

2, above, installation of the EW 1 and EW 2 WTG foundations would occur from April through August 2025 (EW 1), September through November 2025 (EW 2), and April through December 2026 (EW 2). Installation of the EW 1 and EW 2 OSSs would occur in June 2025 (EW 1), July 2025 (EW 2), and May 2026 (EW 2).

Underwater Sound

Pile driving would generate noise exceeding established thresholds for mortality, permanent or temporary injury, and behavioral effects in fish and invertebrates. Underwater noise would temporarily render the affected habitats unsuitable for EFH species and could temporarily impact prey availability for EFH species. The extent of these stressors would be limited to ensonified areas within the Lease Area and would depend on the noise sensitivity of EFH species, as described below. The assessment of acoustic impacts provided in the following section emphasizes direct acoustic effects on EFH-designated species and their life stages.

Underwater sounds are composed of both pressure and particle motion components and are perceived by fish in different ways. An underwater sound originates from a vibrating source, which causes the particles of the surrounding medium (water) to oscillate, which causes adjacent particles to move and transmit the sound wave. Sound pressure is the variation in hydrostatic pressure caused by the compression and rarefaction of particles and is measured in terms of dB relative to 1 micro Pascal (μPa).

All fish perceive the particle motion component of sound and have sensory structures in the inner ear that function to detect particle motion (Popper and Hawkins 2018; Nedelec et al. 2016). Detectable particle motion is limited to a range of a few hundred hertz), at high intensities and limits the distance over which sounds are detectable. (Ladich and Schulz-Mirbach, 2016). The sensitivity of receptor systems that perceive particle motion in fish appears to be 10^5 times higher than in crustaceans (Fay and Simmons 1998, as cited in Roberts and Elliot 2017). Limited studies have been conducted on particle motion detection in fish. One of the few studies observed that the European plaice (*Pleuroectes platessa)* is sensitive to water particle velocities of as little as 0.3 μm/s at around 20 Hz (Chapman and Sand 1974, as cited in Hawkins et al. 2021), which is considerably less than the particle velocities of 2,500 μm/s recorded 68 meters from test piles (Hazelwood and Macey 2016, as cited in Hawkins et al. 2021).

Particle motion is an important part of a fish's ability to orient itself in its environment and perceive biologically relevant sounds of prey, predators, and other environmental cues (Popper and Hawkins 2018). Fish with a swim bladder or other air-containing organ can detect the pressure component of sound as the pressure wave causes the compression and vibration of the air-filled swim bladder. The extent to which the pressure component contributes to a fish's ability to hear varies from species to species and is related to the structures in the fish's auditory system, ability to process the signal from the swim bladder, the size of the swim bladder, and its location relative to the inner ear.

Impacts from sound vary based on the intensity of the noise and the method of sound detection used by the animal. Severe impacts could include physiological reactions, such as ruptured capillaries in fins, hemorrhaging of major organs, or burst swim bladders (Popper et al. 2014), which could cause mortality. Anthropogenic noise may influence fish behavior by causing auditory masking and alteration of foraging patterns, disruption of communication, and disruption of shoaling or schooling (Herbert-Read et al. 2017; Purser and Radford 2011; Radford et al. 2014; Voelmy et al. 2014). The extent of impacts from pile-driving noise depends on the pile size, hammer energy, and local acoustic conditions, as well as the time of year during which it occurs. The impact of noise could be greater if pile driving occurs in spawning habitat during a spawning period, particularly for species that spawn in aggregations, use sound to communicate (e.g., Atlantic cod), or spawn only once during their lifetime (e.g., longfin squid).

Assessment of the potential for underwater noise to injure or disturb a fish or invertebrate requires acoustic thresholds against which received sound levels can be compared. The most conservative available injury thresholds for fish were developed by the Fisheries Hydroacoustic Working Group (2008) and Popper et al. (2014) and are provided in Table 5-1. The current underwater noise thresholds consider effects on fish mainly through sound pressure without taking into consideration the effect of particle motion. Popper et al. (2014) and Popper and Hawkins (2018) suggest that extreme levels of particle motion induced by various impulsive sources may also have the potential to affect fish tissues and that proper attention needs to be paid to particle motion as a stimulus when evaluating the effects of sound on aquatic life. However, thresholds for particle motion exposure are not currently available because of the difficulty of measuring fish sensitivity to this component of sound (Popper et al. 2014; Popper and Hawkins 2018).

Table 5-1. Acoustic thresholds for various effects of impact pile driving

Group	Metric[¤]	Threshold
Injury (PTS)[†]		
Fish equal to or greater than 2 g	$L_{E,\,24}$	187
	L_{pk}	206
Fish less than 2 g	L_E	183
	L_{pk}	206
Recoverable Injury*		
Fish without swim bladder	L_E	>216
	L_{pk}	>213
Fish with swim bladder not involved in hearing	L_E	203
	L_{pk}	>207
Fish with swim bladder involved in hearing	L_E	203
	L_{pk}	>207
Behavior[§]		
All fish	L_{rms}	150

¤ L_{pk}: zero-to-peak sound pressure level with units dB re 1 μPa; L_{rms}: root-mean-square sound pressure level with units dB re 1 μPa; $L_{E,24}$: sound exposure level calculated over a 24-hour period in units dB re 1 μPa^{2}s,

*Popper 2014

†Fisheries Hydroacoustic Working Group 2008

§Andersson et al. 2007, Wysocki et al. 2007, Mueller-Blenkle et al. 2010, Purser and Radford 2011

Noise thresholds for adult invertebrates have not been developed because of a lack of available data. In general, mollusks and crustaceans are less sensitive to noise-related injury than many fish because their lack of internal air spaces makes them less vulnerable to over-expansion or rupturing of internal organs, the typical cause of lethal noise related injury in vertebrates (Popper et al. 2001). Current research suggests that some invertebrate species groups, such as cephalopods (e.g., octopus, squid), crustaceans (e.g., crabs, shrimp), and some bivalves (e.g., scallops, ocean quahog) are capable of sensing sound through particle motion (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014). Particle motion effects dissipate rapidly and are highly localized around the noise source. Studies of the effects of intense noise sources on invertebrates, similar in magnitude to those expected from Project construction, found little or no measurable effects even in test subjects within 3.3 feet (1 meter) of the source (Edmonds et al. 2016; Payne et al. 2007). Jones et al. (2020, 2021) evaluated squid sensitivity to high-intensity impulsive sound comparable to monopile installation. They observed that squid displayed behavioral responses to particle motion effects within 6.6 feet (2 meters) of high-intensity impulsive noise. They further theorized that squid in proximity to the seabed might be able to detect particle motion from impact pile driving imparted through sediments "several hundred meters" from the source, eliciting short-term behavioral responses lasting for several minutes. Other researchers have found evidence of cephalopod sensitivity to continuous low frequency sound exposure comparable to sound sources like vibratory pile driving (Andre et al. 2011). However, Roberts et al. (2015) observed that the blue mussel (*Mytulis edulis*) exhibited behavioral changes in the form of valve closure in response to vibration stimulus at 5 to 410 Hz. Thresholds for behavioral changes were within the range of vibrations measured near anthropogenic activities (e.g., pile driving, blasting). The authors concluded that disruption of valve periodicity in response to vibration is likely to impact the overall fitness of both individuals and mussel beds.

Acoustic impacts on fish and invertebrates due to pile driving would vary depending on the ability of the organism to detect sound pressure and whether the air bladder and auditory system are linked, making the species more sensitive to sound impacts (Popper et al. 2014). Fish hearing categories from least sensitive to most sensitive are (1) organisms without swim bladders; (2) fish with swim bladders not involved in hearing; and (3) fish with swim bladders involved in hearing. These categories are shown in Table 5-2.

Table 5-2. Fish and invertebrates categorized by hearing and susceptibility to sound pressure

Category	Description	Examples	Hearing and susceptibility to sound pressure
1	Fish without swim bladder or hearing associated gas chamber, invertebrates, fish eggs and larvae	Flatfish, monkfish, sharks, rays, some tunas, cephalopods	Species are less susceptible to barotrauma. Detect particle motion but not sound pressure, but some barotrauma may result from exposure to sound pressure.
2	Fish with swim bladder that does not affect hearing	Bluefish, butterfish, scup, some tunas	Species have a swim bladder, but hearing is not connected to it or other associated gas chamber. Species detect only particle motion but are susceptible to barotrauma.
3	Fish with swim bladder or gas chamber associated with hearing (hearing generalist)	Atlantic herring, black sea bass, gadids.	Hearing connected to swim bladder or other associated gas chamber. Species detect sound pressure as well as particle motion and are most susceptible to barotrauma.

Source: Popper et al. 2014

Acoustic propagation modeling of the impact pile-driving activities for the Proposed Action was undertaken by JASCO Applied Sciences to determine distances to the established injury and disturbance thresholds for fish (Empire Wind 2021, Appendix M2). Sound fields from 2.5-meter pin piles, 9.6-meter and 11-meter monopiles were modeled at representative locations in the Lease Area during summer and winter using an IHC S-4400 impact hammer for the pin piles and an IHC S-5500 impact hammer. The modeling also used a 10-dB-per-hammer-strike noise attenuation, which is considered achievable with currently available technologies. The resulting values represent a radius extending around each pile where potential injurious-level or behavioral effects could occur and are presented in Table 5-3 for the winter modeling period, when acoustic propagation would be the greatest.

Table 5-3. Summary of acoustic radial distances (R_{max} in kilometers) for fish during typical pin pile and monopile impact pile installation with 10 dB of noise attenuation

Group	Metric	Threshold	Acoustic Radial Distance (R_{max} in km) for three 2.5-meter pin piles	Acoustic Radial Distance (R_{max} in km) for one 9.6-meter pile	Acoustic Radial Distance (R_{max} in km) for one 11-meter pile
Injury (PTS)[†]					
Fish Equal or greater than 2 g	L_E	187	1.74	3.46	3.14
	L_{pk}	206	--	0.06	0.07
Fish less than 2 g	L_E	183	2.73	4.74	4.35
	L_{pk}	206	--	0.06	0.07
Recoverable Injury*					
Fish without swim bladder	L_E	>216	0.02	0.08	0.07
	L_{pk}	>213	--	--	--
Fish with swim bladder not involved in hearing	L_E	203	0.18	0.57	0.51
	L_{pk}	>207	--	0.05	0.06
Fish with swim bladder involved in hearing	L_E	203	0.18	0.57	0.51
	L_{pk}	>207	--	0.05	0.06
Behavior[§]					
All fish	L_{rms}	150	2.60	7.66	7.51

dB re 1 μPa SPLpeak = decibel re 1 micropascal peak sound pressure level; dB re 1 μPa SPL_{RMS} = decibels re 1 micropascal root-mean-square sound pressure level; dB re 1 μPa2s SELcum = decibel re 1 micropascal squared second cumulative sound exposure level; km = kilometers; Rmax = maximum range

Notes:
A typical pile driving scenario would generate hammer energy levels of up to 3,200 kJ for three pin piles up to 2,300 kJ for a 9.6-meter pile and up to 2,500 kJ for a 11-meter pile.

Results were taken from Table 49 and Table 57 in Appendix M-2 of Empire 2021

The likelihood of injury from monopile installation depends on proximity to the noise source, intensity of the source, effectiveness of noise-attenuation measures, and duration of noise exposure. Results from the modeling show that injury from a single strike could occur up to 60 meters from a 9.6-meter monopile and up to 70 meters from an 11-meter monopile, whereas injury from a single strike would only occur in the immediate area of a 2.5-meter pin pile. The distance over which injury from prolonged cumulative exposure (over 24 hours) would occur would range from 2.73 kilometers for a 2.5-meter pin pile to 4.74 meters for a 9.6-meter monopile. The distance over which behavioral effects would occur would range from 2.60 kilometers for a 2.5-meter pin pile to 7.66 meters for a 9.6-meter monopile. Within this area, it is likely that some level of behavioral reaction is expected and could include startle responses or migration out of areas exposed to underwater noise (Hastings and Popper 2005). Behavioral disturbance to fish from pile driving noise is therefore considered short-term for the duration of the activity. The ensonified areas over which injurious effects and behavioral effects would occur would overlap between adjacent WTG foundations, but only one foundation would be installed at a given time, such that EFH species would not be subjected to noise from multiple foundations at the same time.

As described in Section 3.1.4, above, the radial distance for injurious and behavioral effects from pile driving noise would extend to several areas that fish are known to aggregate at and which are adjacent to the Project area, including Hempstead Town Reef and three New Jersey Prime Fishing Areas (i.e., Angler's Bank, Cholera Bank, and the HA Buoy). Exposure to noise during pile driving may cause injury to fish and invertebrates inhabiting these areas or may cause reef-dwelling fish and invertebrates to migrate away from the reefs, potentially to less suitable habitat.

Injurious and behavioral effects of noise from impact pile driving for the installation of WTGs and OSS foundations would occur intermittently from May 1 through November 30, depending on protected species time-of-year restrictions, weather, and other potential delays. Pile driving may also occur from December 1 through December 31 if unanticipated delays from weather or technical issues arise that necessitate extending pile driving into December, in which case Empire would notify NMFS and BOEM in writing by September 1 that circumstances are expected to necessitate pile driving in December. A total of 147 WTGs and 2 OSSs are anticipated for the Proposed Action. Each WTG requires one monopile, with each monopile requiring 3 hours of pile driving to install, whereas each OSS jacket foundation requires 24 pin piles, with each pin pile requiring 4.2 hours of pile driving to install. Installation of the WTG foundations would require up to 522 hours of pile driving, which would occur over a two-year period. Installation of the OSS foundations would require up to 100 hours of pile driving, which would occur over a one-year period. To mitigate impacts to the extent practicable, the Project will use a noise attenuation system that achieves an at least 10 dB reduction in sound levels during all impact pile driving, such that measured ranges to isopleth distances are consistent with those modeled based on 10 dB attenuation, determined via sound field verification. Further, the Project will employ soft starts during impact piling, allowing a gradual increase of hammer blow energy, thus allowing mobile marine life to leave the area (Table 6-1).

Impact pile driving would produce acoustic impacts that would adversely affect EFH for fish and invertebrates across all hearing categories, but the extent of the impacts would vary depending on hearing sensitivity (see Table 5-2) and distance from the pile. EFH species could exhibit physiological and behavioral impacts depending on intensity and duration of the acoustic impact, distance from the sound source, and hearing sensitivity. The noise levels would temporarily make the habitat less suitable and cause individuals to vacate the area of Project activities. Pile driving is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact will be short-term and EFH is expected to return to pre-pile driving conditions.

Direct Effects on EFH and EFH species

- Short-term effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
- Short-term effects on EFH of all Species Groups:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Mobile Benthic/Epibenthic – Soft Bottom
    - Sessile Benthic/Epibenthic – Complex
    - Mobile Benthic/Epibenthic – Complex
    - Pelagic
    - Prey Species – Benthic-Epibenthic
    - Prey Species – Pelagic

Habitat Conversion

Based on the WTG and OSS layout depicted in Figure 3-3, which includes 138 WTGs and 2 OSSs, I installation of 31.5-foot (9.6-m) to 36-foot (11-meter) diameter monopile foundations for the WTGs and 8.2-foot (2.5-meter) piled jacket foundations for the OSSs would render approximately 4.4 to 5.2 acres of benthic habitat unavailable to EFH species for the entire 30-year life of the project through decommissioning when the foundations are removed; this habitat would include 4.1 to 4.8 acres of soft-bottom habitat, 0.3 to 0.4 acres of complex habitat, and less than 0.1 acres of heterogeneous complex habitat. The installation of these structures in the Lease Area, where the average water depth is approximately 100 feet (30 meters) (Empire Wind 2021), would introduce approximately 38 acres of new hard surfaces to the water column extending from the seabed to the water surface. These vertical structures would alter the character of pelagic habitats used by many EFH species and their prey and foraging resources. Over time these new hard surfaces will become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reef.

The artificial reef effect created by offshore structures like WTGs is well documented and can have an attractive effect on many marine species (Langhamer 2012; Peterson and Malm 2006; Reubens et al 2013; Wilhelmsson et al. 2006). This can lead to localized increases in fish abundance and changes in community structure. In a meta-analysis of studies on windfarm reef effects, Methratta and Dardick (2019) observed that, overall, abundance of demersal finfish was greater inside of wind farms compared to nearby reference sites; however, an increase in abundance was only observed for a relatively small number of studies. Studies of finfish distributions before and after installation of OWFs demonstrate that some demersal finfish species, including Atlantic cod and black sea bass, spend at least part of their life cycle closely associated with offshore wind structures (Bergström et al. 2013; Reubens et al. 2014; Wilber et al. 2020). Several offshore wind facilities have been observed to attract demersal fish species that are associated with hard substrate and are therefore rare on the surrounding sandy seabed (Van Hal et al. 2017). Effects on pelagic fish species are less clear, however (Floeter et al. 2017; Methratta and Dardick 2019). Increases in fish abundance around offshore structures may be caused by an attraction of individuals without an increase in the local population. Alternatively, the local population may be increased by the addition of suitable habitat that enhances settlement, survival, and/or growth (Schwartzbach et al., 2020).

Beneficial effects of increased habitat suitability for some species could be offset if the colonizable habitats provided by the monopiles aggregate predators and prey, increasing predation risk, or provide steppingstones for non-native species invasions (Adams et al. 2014; De Mesel et al. 2015; Langlois et al. 2005). The potential for introduction of non-native species is particularly concerning, given that fouling communities can be dominated by non-native species, especially in areas where human-mediated colonization is frequent (Lambert and Lambert 1998). Non-native invertebrates have been observed to tolerate significantly higher temperatures than native species, raising the concern that, as climate change causes ocean temperatures to warm, non-native species may increase in abundance (Sorte et al. 2010; Stachowicz et al. 2002). Given the duration over which the monopiles will remain in the water column (~30 years), the presence of these structures may interact synergistically with warming ocean temperatures to promote the establishment of invasive species.

Over time, the attractive effects of the structures and complex habitats formed by the maturing reef effect are also expected to alter food web dynamics in ways that are difficult to predict. Colonization of the new hard-surface habitat typically begins with suspension feeders and progresses through intermediate and climax stages (6+ years) characterized by the codominance of plumose anemones and blue mussels (Degraer et al. 2020, Kerckhof et al. 2019). Suspension feeders can act as biofilters, removing particles from the water column that would have otherwise passed by and resulting in reduced turbidity and deeper light penetration. This biofilter effect been observed at the local scale (Reichart et al. 2017) and in the laboratory (Mavraki 2020) but may also manifest at a large scale through the cumulative influence of multiple offshore wind facilities. Soft sediment around turbines may be enriched through the deposition of fecal pellets produced by filter feeders (Maar et al. 2009), thereby facilitating the transfer of pelagic food sources to the benthic community (Slavik et al. 2019). The trophic resources used by suspension feeders could include pelagic eggs or larvae of EFH species, as well as prey resources for ichthyoplankton. This could result in a local decrease of eggs and larvae but is unlikely to impact the reproductive success of the affected species as a whole or have more than a localized effect on prey availability for EFH species. As noted above, the colonization of the WTG and OSS foundations could also attract fish due to the increase in resource availability and shelter. This aggregation and change in resource availability could lead to shifts in food web dynamics. While localized effects are possible, ecosystem modeling studies of a European windfarm did not detect a significant difference in key food web indicators before and after construction (Raoux et al. 2017). Even though the biomass of certain taxa increased in proximity to the wind farm, trophic group structure was functionally similar between the before and after scenarios. Thus, large-scale food web shifts are not expected due to the installation of WTGs and conversion of pelagic habitat to hard surface.

Direct Effects on EFH and EFH species

- Permanent, adverse effects on EFH and EFH species resulting from decrease in preferred habitat:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic
- Long-term, beneficial effects on EFH and EFH species resulting from increase in preferred habitat:
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Long-term, adverse effects to EFH and EFH species due to increased predation risk associated with aggregation effect and increased risk of establishment of invasive species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

5.1.1.3. Seabed preparation

Habitat Loss/Conversion

Seabed preparation may be required prior to the installation of WTG and OSS foundations in certain areas depending on the seabed and the foundation type. Non-complex soft-bottom habitat, including small sand waves and depressions in the seabed, is present in the Lease Area and provides EFH for some species in the area (e.g., hakes, flounders). Seabed preparation would remove these habitat features. Seabed preparation activities may include levelling and removal of surface or subsurface debris such as boulder and sand waves, or MEC/UXO removal. Based on the WTG and OSS layout depicted in Figure 3-3, which includes 138 WTGs and 2 OSSs, installation of the WTG and OSS foundations would temporarily disturb an estimated 73 acres of benthic habitat beyond the footprint of the foundations and scour protection; this habitat would include 66 acres of soft-bottom habitat, less than 1 acre of heterogeneous complex habitat, and 7 acres of complex habitat. . Seabed preparation would occur over several months prior to the start of installation of EW 1 and EW 2 foundations in April 2024 and April 2025, respectively (see Figure 2-2, above).

Habitat may be impacted by boulder relocation during seabed preparation for installation of the WTGs and OSSs. Some boulders may be relocated to non-complex benthic habitat.. Areal extent of impacts from boulder relocation are unavailable but the amount of impacted habitat is expected to be small based on the benthic surveys of the Lease Area, which did not observe any boulders. The relocation process is likely to injure or kill encrusting organisms and damage biogenic structures that contribute to habitat. Over time, the relocated boulders would be recolonized, contributing to the habitat function provided by existing complex benthic habitat and the artificial reef effect provided by the WTG and OSS foundations and scour protection.

The area affected by seabed preparation would be rendered unavailable as long as the foundations remain in place for EFH species associated with complex, heterogenous complex, and soft bottom benthic habitats during one or more life stages. Seabed preparation would therefore result in a permanent, localized, adverse effect on EFH lasting through the 30-year life span of the Proposed Action.

Direct Effects on EFH and EFH species

- Permanent, localized, adverse effects to EFH and EFH species/life stages resulting from decreased in preferred habitat for:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic

Sediment Suspension/Redeposition

Seabed preparation activities (e.g., removal of debris or seabed leveling) will result in short-term, localized resuspension and sedimentation of finer grain sediments. Medium to course-grained sediments within the Lease Area are likely to settle to the bottom of the water column quickly, with sand redeposition being short-term and localized. These effects would occur intermittently at varying locations in the project area over the duration of project construction but are not expected to cause permanent effects on EFH quality. Depending on the nature, extent, and severity of each effect, this may temporarily reduce the suitability of EFH for managed species, which would result in short-term, adverse effects on EFH for those species. Indirect impacts to EFH could occur from sediment suspension, temporarily decreasing foraging success due to increased turbidity. It would be expected that normal foraging behavior would resume following completion of installation and settlement of suspended sediments.

Changes to the Project design and additional impacts that were not considered in the EFH assessment could occur in the unlikely event that MEC or UXO are discovered in the project footprint. These changes could include additional micrositing of monopile foundations and cable routes to avoid MEC or UXO hazards. The relocation of project features would result in the same type of short-term construction related and permanent operational impacts as those described in the EFH assessment, but the location, extent, and distribution of those impacts by habitat type may vary. These changes could, in theory, limit the ability to avoid impacts to complex benthic habitat in specific circumstances. As described in Section 2.2.2.2, above, avoidance is proposed as the preferred approach for mitigation of any confirmed MEC/UXO. If avoidance is not possible, MEC/UXO may be relocated to a safe location on the seafloor or to a designated disposal area using a “Lift and Shift” operation. Relocation of MEC/UXO would cause disturbances to the seafloor (sediment suspension and deposition) as well as noise. Impacts are expected to be short term and direct, with the potential to cause injury or mortality to benthic species within the direct vicinity of the disposal activities.

Regardless of mitigation strategy, any change in impact area resulting from potential MEC/UXO risk avoidance is unknown but is likely to be small relative to the effects of project construction. Those effects would be similar in nature to the short-term effects considered in the EFH assessment and would not alter the effect determination in the EFH assessment for any EFH species. Further coordination with the appropriate federal agencies (e.g., NMFS) will occur as appropriate if MEC/UXO mitigation requires action that was not considered in this consultation.

Direct Effects on EFH and EFH species

- Short-term, localized, adverse effects to EFH and EFH species/life stages resulting from sediment suspension and deposition would affect the following groups:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Mobile Benthic/Epibenthic – Soft Bottom
    - Prey Species – Benthic/Epibenthic

Underwater Sound (Vessels)

The impacts and direct and indirect effects to EFH and EFH species due to underwater sound from vessels associated with seabed preparation would be similar to those impacts analyzed in Section 5.1.1.1 Vessel Activity.

5.1.1.4. Installation of scour protection

Habitat Loss/Conversion

Based on the WTG and OSS layout depicted in Figure 3-3, which includes 138 WTGs and 2 OSSs, the placement of scour protection for 31.5-foot (9.6-m) to 36-foot (11-meter) diameter monopile foundations for the WTGs and 8.2-foot (2.5-meter) piled jacket foundations for the OSSs would permanently impact an estimated 127 to 131 acres of benthic habitat, including 114 to 118 acres of soft-bottom habitat, 1 acre of heterogeneous complex habitat, and 12 acres of complex habitat. Approximately 115 to 119 acres of soft-bottom and heterogeneous complex habitat would be converted to complex, hard-bottom habitat. The soft-bottom benthic habitats that existed previously in the footprint of the scour protection would no longer be available to EFH species for the entire 30-year life of the project through decommissioning when the foundations and scour protection are removed. Over time, these concrete and natural rock surfaces would become colonized by sessile organisms and would gradually evolve into functional habitat for EFH species. However, the concrete mattresses may take 3 to 12 months to fully cure following placement, during which time the hard substrate would be toxic to eggs, larvae, and invertebrates (Lukens and Selberg 2004). The increase in abundance of hard-bottom habitat and expected artificial reef effect suggests an expansion of available EFH for species associated with complex benthic habitat like Atlantic cod, black sea bass, and scup. However, it could take a decade or more for the reef effect to develop before fully functional habitat status is achieved (Auster and Langton 1999; Collie et al. 2005; Tamsett et al. 2010). Further, it is uncertain whether the new hard-bottom habitat would enable population growth of structured-oriented species or would merely attract these species from other locations. Therefore, the addition of complex benthic habitat is expected to provide a neutral to beneficial increase in available EFH lasting for approximately 20 years of Project life, depending on the species-specific responses to this habitat. These features may or may not be removed when the Project is decommissioned, depending on the habitat value they provide.

Beneficial effects of increased habitat suitability for some species could be offset if the colonizable habitats provided by the scour protection aggregate predators and prey, increasing predation risk, or provide steppingstones for non-native species invasions. As described in Section 5.1.1.2, above, the potential for the introduction of non-native species is particularly concerning because non-native species may increase in abundance as ocean temperatures warm. Given the duration over which the scour protection will remain in the water column (~30 years), the presence of these structures may interact synergistically with warming ocean temperatures to promote the establishment of invasive species.

It is anticipated that mobile life stages would move out of the construction area during installation of scour protection to avoid potential impacts. Demersal non-mobile life stages would be impacted by the placement of scour protection in the immediate area of installation. Most juvenile and adult finfish would actively avoid all construction activities. However, immobile finfish life stages such as demersal eggs and larvae, and sessile organisms could experience mortality from being crushed or buried by the scour protection. EFH-designated species that would likely be impacted by crushing and burial effects of installation of scour protection are like those listed in Section 5.1.1.1.

Direct Effects on EFH and EFH species

- Permanent, adverse effects on EFH and EFH species resulting from decrease in preferred habitat:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic
- Long-term, neutral to beneficial effects on EFH and EFH species resulting from increase in preferred habitat:
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Permanent, adverse effects to EFH and EFH species due to increased predation risk associated with aggregation effect and increased risk of establishment of invasive species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

Sediment Suspension/Redeposition

Installation of the scour protection for the WTGs and OSSs would disrupt approximately 131 acres of primarily soft-bottom benthic habitat. Methods of installation may include side stone dumping, fall pipe, or crane placement. Placement of scour protection may temporarily increase suspended sediments due to resuspension of bottom sediments. These benthic disturbances would increase turbidity and suspend sediment in the water column. Impacts to benthic habitat would occur locally and temporarily at each of the proposed WTG and OSS locations because of the predominately sandy composition of the upper sediments in the Project area. EFH-designated species that would likely be impacted sediment suspension associated with the installation of scour protection are similar to those listed in Section 5.1.1.1.

Direct Effects on EFH and EFH species

- Short-term, localized decrease in quality of EFH resulting from suspended sediments and increased turbidity:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, localized impacts from sedimentation:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH species

- Short-term, localized loss of foraging opportunities:
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, localized decrease in quality of EFH in areas adjacent to Project activities:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

5.1.2. Interarray and offshore/onshore cable installation

5.1.2.1. Vessel activity

During installation of the interarray cables and OECs, it is anticipated that up to 18 construction vessels would be necessary for the installation of the interarray cables and offshore export cable. Vessels involved in cable installation include main laying vessels, burial vessels, and support vessels. Vessel activity would occur intermittently during the construction period beginning with the start of the EW 1 interarray cable installation in April 2024 and continuing through the completion of the EW 2 OEC installation in January 2025 and again during the EW2 interarray cable installation from April through September 2026 (see Figure 2-2, above).

Habitat Disturbance

The cable laying vessel will use dynamic positioning and will not require the use of anchors. Some of the support vessels may require anchoring and/or spudding during the installation of the cables, which may disturb benthic EFH and EFH species associated with that habitat. Vessel anchoring associated with cable emplacement will occur along the up to 207-mile (333-kilometer) long interarray cable route, the 47-mile (75-kilometer) EW 1 OEC route, and the 30- to 33--mile (49- to 52-kilometer) EW 2 OEC route. Empire Wind has estimated that a total of 18 acres of benthic habitat would be disturbed by anchoring of vessels during construction of the Proposed Action, including the installation of the interarray cables and OECs (Empire Wind 2022, Appendix F). Impacts of habitat disturbance on EFH from anchoring during array cable installation are expected to be similar to impacts that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

Sediment Suspension/Redeposition

In general, vessel activities (i.e., anchoring and/or spudding) associated with cable installation would cause short-term impacts to water quality intermittently throughout Project construction. These benthic disturbances would increase turbidity and suspend sediment in the water column. The potential impacts to water quality, and by extension, EFH and EFH-designated species, such as resuspension of sediments, would be short-term and localized. Impacts of sediment suspension on EFH from anchoring during array cable installation are expected to be similar to impacts that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

Underwater Noise (Vessels)

Impacts of vessel noise on EFH from anchoring during array cable installation are expected to be similar to impacts of vessel noise that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

5.1.2.2. Seabed preparation

Seabed preparation may be required prior to installation of interarray and offshore export cables and may include seabed levelling and removal of surface or subsurface debris such as boulders, lost fishing gear, or lost anchors. Excavation may be required where debris is buried or partially buried. Seabed preparation would occur intermittently during the construction period beginning with the start of the EW 1 interarray cable installation in April 2024 and continuing through the completion of the EW 2 OEC installation in January 2025 and again during the EW2 interarray cable installation from April through September 2026 (see Figure 2-2, above).

Habitat Alteration

Empire Wind has estimated that seabed preparation prior to cable installation would result in short-term to long-term disturbances to benthic habitat over an estimated area of up to 1,167 acres within the Lease Area and up to 718 acres within the OEC corridor. Seabed preparation in this area is expected to disturb both soft-bottom and complex benthic habitat. Non-complex soft-bottom habitat, including small sand waves and depressions in the seabed, is present in the Lease Area and along the ECCs and provides EFH for some species in the area (e.g., hakes, flounders). Sand bedforms that are dredged would likely be redeposited in areas of similar sediment composition, and tidal and wind-forced bottom currents are expected to reform most ripple areas within days to weeks following disturbance. Although some sand ripples may not recover to the same height and width as pre-disturbance, the habitat function is expected to fully recover post-disturbance. Therefore, impacts of sand bedform clearing on EFH and EFH species are expected to be localized and short term, dissipating over time as mobile sand waves fill in the altered seabed profile. Short-term disturbances are expected for soft-bottom habitat and long-term disturbances are expected for complex habitat, which may require several years to recover.

Boulder relocation would potentially alter the composition of both the original and relocated habitat. Over time, the relocated boulders would be recolonized, contributing to the habitat function provided by existing complex benthic habitat of relocated boulders. Areal extent of impacts from boulder relocation are unavailable but the amount of impacted habitat is expected to be small based on the benthic surveys of the export cable corridors. For instance, during the 2019 survey of the export cable corridors, boulders were only observed at 2 out of 157 sampling sites (Empire 2021, Appendix T). Long-term to permanent impacts of artificial structures associated with the Project, as well as affected species are discussed in Section 5.1.3.1.

Direct Effects on EFH and EFH species

- Short-term loss/conversion of EFH:

- Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic
- Long-term loss/conversion of EFH:
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH species

- Short-term loss of benthic prey items:
  - Mobile Benthic/Epibenthic – Soft Bottom
- Long-term loss of benthic prey items:
  - Mobile Benthic/Epibenthic – Complex

Sediment Suspension/Redeposition

Sediment suspension and redeposition will occur as a result of seabed preparation activities. Impacts to EFH species similar to those resulting from seabed preparation for WTG and OSS foundation installation are expected to occur. Sediment in the Lease Area consists primarily of sand with slightly gravelly sand in the eastern half of the Lease Area (Empire 2021), which are likely to settle to the bottom of the water column quickly. Sand re-deposition would be minimal and close in vicinity to the trench centerline, minimizing impacts to demersal fish eggs. Direct impacts to foraging habitat are expected to be localized to the width of the trench and short-term as benthic organisms would recolonize the area.

Direct Effects on EFH and EFH species

- Short-term decrease in quality of EFH resulting from suspended sediments and increased turbidity:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Pelagic
- Short-term, local impacts resulting from sedimentation:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic

Indirect Effects on EFH and EFH species

- Short-term loss of foraging opportunities:
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term decrease in quality of EFH in areas adjacent to Project activities:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

Entrainment

Some types of seabed preparation equipment (e.g., hydraulic dredges) use water withdrawals, which can entrain planktonic larvae of benthic fauna (e.g., larval polychaetes, mollusks, crustaceans) with assumed 100-percent mortality of entrained individuals. Because of the surface-oriented intake, water withdrawal could entrain pelagic eggs and larvae, but would not affect resources on the seafloor. Because of the limited volume of water withdrawn, BOEM does not expect population-level impacts on any given species. This is because the rate of egg and larval survival to adulthood for many species is naturally very low (MMS 2009).

Direct Effects on EFH and EFH species

- Loss of EFH and EFH species due to water intake for eggs, larvae, and small juveniles:
  - Pelagic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Loss of food sources for planktivorous species, including filter-feeding invertebrates:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

Underwater Noise (Vessels)

The impacts on EFH and EFH species resulting from underwater sound generated by vessels associated with seabed preparation would be similar to those impacts analyzed in Section 5.1.1.1 Vessel Activity.

5.1.2.3. Trenching/cable installation

Habitat Loss/Conversion

Array cable installation is expected to be completed via post-lay and vertical injector jetting along the EW 1 and EW 2 export cable routes. Alternative plowing and trenching methods were considered early in the design process but are not likely to be used. Direct impacts to EFH due to habitat disturbance are expected along the entire length of the interarray cable within the 50-foot and 100-foot-wide construction corridors of EW 1 and EW 2, respectively (Empire Wind 2021, Appendix E). Based on the inter-array cable layout depicted in Figure 3-3, which includes 207 miles (333 km) of cables, installation of the inter-array cables would result in short-term disturbance of an estimated 831 acres of benthic habitat, including 741 acres of soft-bottom habitat, 21 acres of heterogeneous complex habitat, and 69 acres of complex habitat. It is anticipated that pelagic species and motile life stages will avoid construction activities based on typical installation speeds, and direct impacts are not anticipated. Direct impacts to foraging habitat are expected to be localized to the width of the trench and short-term as benthic organisms would recolonize the area. Indirect impacts to EFH could occur from sediment suspension, temporarily decreasing foraging success due to increased turbidity. It would be expected that normal foraging behavior would resume following completion of installation and settlement of suspended sediments. Sediment suspension impacts are discussed further below.

The EW 1 and EW 2 OECs will be placed by the same methods described above for array cables, depending on site conditions. The total installed cable length is 94 miles (150 km) for the two EW 1 OECs and 90 to 99 miles (147 to 156 km) for the three EW 2 OECs. Direct impacts to EFH due to habitat disturbance are expected along the entire length of each corridor within the designated 150-foot-wide

OEC construction corridor (Empire Wind 2021, Appendix E). Depending on the cable route, installation of the EW 1 OEC would result in short-term disturbance of an estimated 382 to 385 acres of benthic habitat, including 257 to 265 acres of soft-bottom habitat, 24 to 29 acres of heterogeneous complex habitat, and 96 to 97 acres of complex habitat. Depending on the landfall location, installation of the EW 1 OEC would result in short-term disturbance of an estimated 357 to 393 acres of benthic habitat, including 215 to 234 acres of soft-bottom habitat and 138 to 160 acres of complex habitat. The impacts of OEC installation are expected to be similar to those of the interarray cables.

Installation of the interarray cable and OECs could result in direct impacts such as crushing and burial, of slow-moving or sessile organisms and life stages. The sea-to-shore transition will occur where the onshore and offshore segments of the export cable meet. Cofferdam installation, dredging and side cast, and vessel anchoring at the sea-to-shore transition could result in crushing and burial effects. Direct mortality of benthic life stages and sessile organisms could also result from fluidizing the sediments along the cable corridors during cable burial. The effects of crushing and burial impacts on EFH resulting from cable installation will vary depending on how benthic and demersal habitats exposed to these impacts are used by EFH-designated species. Benthic and epibenthic life stages will be the primary groups affected, with secondary effects on EFH-designated species and life stages that prey upon benthic and epibenthic organisms. Mobile organisms such as juvenile and adult finfish may be temporarily displaced by cable installation but will be able to avoid direct impacts related to these activities.

Direct Effects on EFH and EFH Species

- Short-term loss/conversion of EFH:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic
- Permanent, localized crushing and burial of EFH species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Prey –Benthic/Epibenthic

Indirect Effects on EFH and EFH Species

- Short-term loss of benthic prey items:
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Complex

Sediment Suspension and Redeposition

Cable installation activities would generate localized plumes of suspended sediments within the immediate proximity of the trench excavation and reburial. Modeling of sediment suspension and deposition associated with cable emplacement for the Proposed Action was conducted by Tetra Tech (Empire Wind 2021, Appendix J). The models assumed that cable emplacement would occur with a jet plow because this is the method that would be used along the majority of interarray and OEC routes. Jet plow installation would result in greater disturbance of marine sediments than mechanical plow or mechanical cutter installation, such that the results provide an upper bound of impacts. As Project-specific sediment density data and grain size distribution data were not available when the model was developed, Tetra Tech used publicly available Poseidon Project sediment data to inform the analytical sediment model. The Poseidon Project data included percent gravel, sand, and fines; specific gravity; and D50 data for 47 locations along a submarine electric cable route in Raritan Bay and the New York Bight. The Poseidon Project cable route covered approximately 70 percent of the export cable corridor, all within 3 nautical miles (5.56 km) of Long Island, New York. Based on the sediment characteristics of the stations in the Poseidon Project, the Project area was divided into two zones:

- Riverine: For stations close to the river mouth, sediment characteristics were calculated by averaging all stations that were close to the river. These stations typically had high fine sediment content.

- Non-Riverine: For stations not close to the river mouth, sediment characteristics were calculated by averaging all other stations. These stations typically had high sand content.

The sediment data only provided percentages of gravel, sand, and fine sediments. The percentage of sand was equally divided into coarse sand and fine sand, and the percentage of fine sand was then equally divided into fine sand and very fine sand. The percentage of fine sediments was equally divided into silt and clay. The assignment of sediments to these classes enabled a finer scale modeling effort reflecting a broad range of size classes consistent with the particle size distribution of marine sediments in the region. Settling velocities were assigned to these classes. Table 5-4 shows the fine sediment particle percentages for the Riverine and Non-Riverine areas.

Table 5-4. Project area sediment particle size distribution

Sample	Gravel (%)	Fine Sand (%)	Very Fine Sand (%)	Silt (%)	Clay (%)
Riverine	19.50	9.38	9.38	30.87	30.87
Non-Riverine	46.56	21.93	21.93	4.79	4.79

As described in Section 5.1.1.1, above, egg and larval life stages are highly sensitive to sediment deposition, with certain species (e.g., winter flounder) experiencing mortality at burial depths of less than 0.1 inch (3 mm). Modeling of sediment deposition associated with cable emplacement for the Proposed Action estimated that cable emplacement could result in sediment deposition of greater than 0.1 inch (3 mm) within 82 ft (25 m) of the trench in non-riverine areas and within 328 ft (100 m) of the trench in riverine areas (Empire Wind 2021, Appendix J). This indicates that emplacement of the interarray cables and OECs would expose the most sensitive eggs and larvae to sediment deposition effects over an area of up to 6,580 acres, including 5,387 acres in marine waters and 1,193 acres in New York Harbor.

Juvenile fish are expected to be able to avoid burial effects from sediment deposition and would primarily respond to elevated total suspended sediment (TSS) concentrations in the water column. Modeling of suspended sediments associated with the Proposed Action, estimated that maximum TSS concentrations could exceed 100 mg/L within 1,640 feet (500 meters) of the trench in non-riverine waters and within 3,281 feet (1,000 meters) of the trench in riverine waters and would dissipate to background levels in less than 1 hour. Concentrations of this magnitude and duration are typically associated with behavioral avoidance and sublethal physiological effects on juvenile marine and estuarine fishes (Michel et al. 2013; Wilber and Clarke 2001). This indicates that emplacement of the interarray cables and OECs would temporarily expose juvenile fish to sediment suspension effects over an area of 119,673 acres, including 107,743 acres in marine waters and 11,931 acres in New York Harbor.

Adult fish are expected to be able to avoid burial effects from sediment deposition and would primarily respond to elevated TSS concentrations in the water column. Short-term exposure to TSS concentrations exceeding 1,000 mg/L has been associated with sublethal and behavioral avoidance effects on adult marine and estuarine fishes, while concentrations of less than 500 mg/L are more commonly associated with behavioral avoidance (Michel et al. 2013; Wilber and Clarke 2001). Modeling of suspended sediments associated with the Proposed Action estimated that maximum TSS concentrations from cable emplacement could exceed 500 mg/L within 800 feet (250 meters) of the trench in non-riverine waters and within 2,625 feet (800 meters) of the trench in riverine waters and would dissipate to background levels in less than 1 hour. This indicates that emplacement of the interarray cables and OECs would temporarily expose adult fish to sediment suspension effects over an area of 63,417 acres, including 53,871 acres in marine waters and 9,545 acres in New York Harbor.

Cable installation would expose adult bivalves to sublethal effects of suspended sediments at TSS concentrations of 1,000 mg/L or higher (Wilber and Clarke 2001). Further, sediment deposition depths between 0.4 and 1.2 inches (10 and 30 mm) could result in sublethal to lethal effects on benthic life stages of bivalves. Atlantic sea scallop may be particularly vulnerable to sediment deposition effects because each life stage of this species is partially or entirely benthic and each life stage has EFH in the Project area. Sea scallop eggs are benthic and may be present in the Project area following spawning, which usually occurs late summer or early fall. The typical scallop spawning period overlaps the installation periods for the offshore export cables and inter-array cables (see Figure 2-2, above), such that scallop eggs are likely to be exposed to lethal effects of sediment deposition during cable emplacement. Modeling of suspended sediments associated with the Proposed Action estimated that maximum TSS concentrations from cable emplacement of 1,000 mg/L would occur as far out 492 feet (150 meters) from the trench in non-riverine waters and as far out as 3,281 feet (1,000 meters) from the trench in riverine waters and would dissipate to background levels in less than 1 hour. Further, modeling estimated that suspended sediment from the Proposed Action would generate sediment depths of 0.4 in (10 mm) within 82 feet (25 meters) of the trench in non-riverine areas and within 164 feet (50 meters) of the trench in riverine areas (Empire Wind 2021, Appendix J). These results indicate that emplacement of the interarray cables and OECs could temporarily expose bivalves to sediment suspension effects over an area of 44,254 acres, including 32,323 acres in marine waters and 11,931 acres in New York Harbor, and sediment deposition effects over an area of 5,983 acres, including 5,387 acres in marine waters and 596 acres in New York Harbor.

As described in Section 3.1.4, above, the maximum distance that would be impacted by suspended sediment from cable laying activities would extend to several areas that are known to support aggregations of fish, including Hempstead Town Reef and two New Jersey Prime Fishing Areas (i.e., Ambrose Channel and Cholera Bank). Exposure to sediment deposition during cable installation may cause mortality in sessile fish and invertebrates (e.g., eggs and larvae) inhabiting these areas, and suspended sediment may cause mobile fish and invertebrates (e.g., juveniles and adults) to migrate away from these areas, potentially to less suitable habitat.

Subsurface sediment disturbed by cable installation in the EW 1 submarine export cable siting corridor, particularly in the Lower and Upper Bays, is likely to contain elevated concentrations of contaminants of concern. Sediment suspension may cause hydrophobic organic contaminants and heavy metals to desorb from sediments and become readily available for bioaccumulation. Exposure to these contaminants may impact reproduction, development, osmoregulation, and hormones in various species and life stages of fish and invertebrates (Wenger et al. 2017). While the impact of a single exposure may have little or no effect, repeated exposures to multiple contaminants can cause contaminant accumulation to levels that are toxic (Maceda-Veiga et al. 2010). Resuspended contaminants may be taken up by filter feeding organisms, such as bivalves. For instance, Voie et al. (2002) demonstrated that PCB concentrations in mussels increased during remediation dredging and remained elevated up to 6 months after dredging activities had ceased.

Direct Effects on EFH and EFH Species

- Short-term decrease in quality of EFH resulting from suspended sediments and increased turbidity:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, local impacts resulting from sedimentation:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH Species

- Short-term loss of foraging opportunities:
  - Mobile Epibenthic/Benthic – Soft Bottom
  - Pelagic
- Short-term decrease in quality of EFH in areas adjacent to Project activities for:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic

Entrainment

In areas where a jet plow is used for cable installation, the surface-oriented intake of the jet plow would potentially entrain pelagic eggs and larvae but would not affect organisms on the seafloor. Because of the limited volume of water withdrawn, BOEM does not expect population-level impacts on any given species.

Direct Effects on EFH and EFH species

- Loss of EFH and EFH species due to water intake for eggs, larvae, and small juveniles:
  - Pelagic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Loss of food sources for planktivorous species, including filter-feeding invertebrates:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Pelagic

Horizontal Directional Drilling

During installation of the estuarine portion of the OECs, impacts to EFH will be minimized, where practicable, by the use of trenchless installation methods which install the cable beneath overlying sediments without direct physical disturbance. During HDD, a sediment mix including drilling mud (i.e., bentonite) is used. During drilling, reaming, or pulling events, some drilling mud may be released from the end of the bore hole. Therefore, each HDD will have an exit pit to receive the drilling mud. Bentonite is heavier than water, so it will remain in the exit pit and then be removed through a vacuum or suction dredge. HDD conduits will be drilled for landfall. An HDD entry pit would be required for each cable duct. Trenchless installation (e.g., HDD) has the potential for impact in the event of inadvertent return of drilling fluids, thus causing adverse impacts to water quality through increases in turbidity, as well as hazardous chemical impacts to EFH and EFH-designated species. Best management practices, such as monitoring of the drilling mud volumes, pressures, and pump rates and returns, would be followed to determine if drill mud loss occurs in amounts that signal a possible inadvertent return. Sensitive habitat will be avoided wherever possible, and impacts minimized should the cable need to traverse a unique habitat (e.g., complying with seasonal work windows and other best management practices) (Table 6-1). Following construction, the areas of cable burial would be restored to previous elevations and natural succession would proceed.

Open-cut alternatives are being considered for the installation of the onshore export cable at the EW 1 OEC landfall and at inland waterway crossings for the EW 2 onshore export cable because of potential limitations of an HDD alternative. The proposed location of the EW 1 OEC landfall is at SBMT, a paved commercial shipping terminal in the Upper Bay. The portion of the Upper Bay surrounding SBMT is classified by NWI as an excavated subtidal estuarine system with an unconsolidated bottom and by the NYSDEC tidal wetland database as a littoral zone. The EW 2 onshore cable route would intersect Wreck Lead Channel, which is classified by NWI as a subtidal estuarine feature with an unconsolidated bottom and by the NYSDEC tidal wetland database as a littoral zone. The southern bank of Wreck Lead Channel is highly modified, comprising of a mix of riprap and natural shoreline that quickly transitions to industrial properties. Open-cut alternatives may require open-cut trenching/dredging or jetting to facilitate installation at target burial for approach to landside in these waterbodies. These methods would disturb sediment, exposing fish and invertebrates to behavioral effects associated with suspended sediment and lethal effects associated with sediment deposition. As described above, egg and larval life stages are highly sensitive to sediment deposition, with certain species (e.g., winter flounder) experiencing mortality at burial depths of less than 0.1 inch (3 mm). Further, bivalves may experience mortality at sediment deposition depths between 0.4 and 1.2 inches (10 and 30 mm). Based on modeling of cable installation using a jet plow in riverine areas (Empire Wind 2021, Appendix J), sediment deposition levels sufficient to cause mortality in sensitive species and life stages of fish would extend out to 328 ft (100 m) from the trench centerline, and sediment deposition levels sufficient to cause mortality in bivalves would extend out to 164 ft (50 m).

Underwater Sound

Underwater noise would be generated during the installation of the interarray cables and OECs, but the types of sound would be characterized as continuous, as opposed to percussive (i.e., such as that produced during impact pile driving) and would therefore not cause the same types of impacts as impact pile driving. Any noise impacts would be short-term and would extend only a short distance beyond the emplacement corridor. Noise generated by the cable installation equipment is not likely to result in injury or mortality for finfish in the immediate vicinity of the activity but may cause short-term behavioral changes in a broader area. Following the completion of cable installation, finfish would be expected to return to the impacted areas.

Direct Effects on EFH and EFH Species

- Short-term, direct effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
- Short-term, direct effects on EFH of all Species Groups

- Sessile Benthic/Epibenthic – Soft Bottom
- Mobile Benthic/Epibenthic – Soft Bottom
- Sessile Benthic/Epibenthic – Complex
- Mobile Benthic/Epibenthic – Complex
- Pelagic
- Prey Species – Benthic/Epibenthic
- Prey Species – Pelagic

5.1.2.4. Cable protection (concrete mattresses, etc.)

Cable protection may be required where burial cannot occur, sufficient depth cannot be achieved, or protection is required due to crossing other cables or pipelines. Placement of rocks, rock bags, concrete mattresses and/or geotextile mattresses may be used to protect the cable (see Section 2.2.2.4). Approximately 10% of the cable route may require cable protection (Empire Wind 2021). Installation of cable protection would cause permanent and localized habitat conversion and short-term and localized sediment suspension and subsequent redeposition that would adversely affect EFH and EFH-designated species.

Habitat Loss/Conversion

Empire Wind conservatively assumes that cable protection (e.g., concrete mattresses) would be required along 10 percent of installed transmission cables, including up to 21 miles (33 km) of inter-array cables and up to 19 miles (31 km) of export cables . Based on the inter-array layout depicted in Figure 3-3, which includes approximately 207 miles (333 km) of cable, the installation of the inter-array cable protection would permanently disturb an estimated 42 acres of benthic habitat, including 37 acres of soft-bottom habitat, 1 acre of heterogeneous complex habitat, and 4 acres of complex habitat. The 38 acres of soft-bottom habitat and heterogeneous complex habitat would be converted to complex, hard-bottom habitat. The installation of cable protection along the EW 1 OEC would permanently disturb an estimated 42 acres of benthic habitat, including 28 to 29 acres of soft-bottom habitat, 3 acres of heterogeneous complex habitat, and 11 acres of complex habitat. Depending on the landfall location, the installation of cable protection along the EW 2 OEC would permanently disturb an estimated 39 to 43 acres of benthic habitat, including 24 to 26 acres of soft-bottom habitat and 15 to 17 acres of complex habitat. Approximately 55 to 58 acres of soft-bottom and heterogeneous complex habitat would be converted to complex, hard-bottom habitat along the export cable corridors. These soft-bottom benthic habitats would no longer be available to EFH species for the entire 30-year life of the project through decommissioning when the foundations and scour protection are removed. Non-complex benthic habitat, including small sand waves and depressions in the seabed, may be present in the Lease Area and along the OEC corridor and may provide EFH for some species in the area (e.g., hakes, flounders). Conversion or loss of non-complex benthic habitat could influence the local food web by introducing habitat for colonizing organisms. Conversion of soft-bottom habitat to complex, rocky habitat would support a different suite of species and could even aid in dispersal pathways (Adams et al. 2014). While the local food web may shift with the conversion of habitat, large-scale effects to ecosystem trophic structure are not expected (Raoux et al. 2017). Impacts to the suitability of EFH for managed species due to food web effects are not anticipated.

As described for the WTG and OSS foundation scour protection Section 5.1.1.4, the natural rock surfaces provided by the cable protection would become colonized by sessile organisms and would gradually develop into functional habitat for EFH species. The projected increase in abundance of epibenthic and demersal fish species resulting from the reef effect suggests an expansion of available EFH for species associated with complex benthic habitat. However, it could take a decade or more for the reef effect to develop before fully functional habitat status is achieved. Further, it is uncertain whether the new hard-bottom habitat would enable population growth of structured-oriented species or would merely attract these species from other locations. Therefore, the addition of complex benthic habitat is expected to provide a neutral to beneficial increase in available EFH lasting for approximately 20 years of Project life, depending on the species-specific responses to this habitat. These features may or may not be removed when the Project is decommissioned, depending on the habitat value they provide.

Beneficial effects of increased habitat suitability for some species could be offset if the colonizable habitats provided by the cable protection aggregate predators and prey, increasing predation risk, or provide steppingstones for non-native species invasions. As described in Section 5.1.1.2, above, the potential for the introduction of non-native species is particularly concerning because non-native species may increase in abundance as climate changes causes ocean temperatures to warm. Given the duration over which the cable protection will remain in the water column (~30 years), the presence of these structures may interact synergistically with warming ocean temperatures to promote the establishment of invasive species.

Direct Effects on EFH and EFH species

- Permanent, adverse effects on EFH and EFH species resulting from decrease in preferred benthic habitat:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic
- Long-term, neutral to beneficial effects on EFH and EFH species resulting from increase in preferred benthic habitat:
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex

Indirect Effects on EFH and EFH species

- Permanent, adverse effects to EFH and EFH species due to potential increased predation risk associated with aggregation effect and potential increased risk of establishment of invasive species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Prey Species – Benthic/Epibenthic

Sediment Suspension/Redeposition

Installation of cable protection may temporarily increase suspended sediments due to resuspension of bottom sediments. These benthic disturbances would increase turbidity and suspend sediment in the water column. Impacts to benthic habitat would occur locally and temporarily within each previously discussed cable corridor. These seabed disturbances could result in short-term suspended sediment and direct mortality of sessile or slow-moving organisms due to burial upon sediment deposition. However, the spatial extent of suspended sediment and redeposition levels that would result in impacts on EFH is expected to be smaller than that described for cable emplacement in Section 5.1.2.3. The EFH-designated species that would likely be impacted by suspended sediment from installation of cable protection are similar to those listed in Section 5.1.2.3.

5.1.3. Port facilities

5.1.3.1. Vessel Traffic

The Connected Action would result in a small increase in vessel traffic. During construction, less than 1 vessel per day is expected to be used. All construction vessels would have a large below-water envelope and would operate at a slow speed. During operation, up to 9 vessels may transit to and from SBMT per week. Seven (7) of these vessel visits during operation would be CCV or barges, which typically operate at slow speeds nearshore.

Habitat Disturbance

The O&M vessels will use dynamic positioning to the greatest extent possible, which will limit the use of anchors (Table 6-1). Some of the O&M vessels may require anchoring and/or spudding, which may disturb benthic EFH and EFH species associated with that habitat. Impacts on seafloor habitats could be long-term if they occur on hard-bottom habitat; however, sediments in the area of the Connected Action consist primarily of sandy silts with an organic content typically between 3 and 4 percent, and no reefs or other fish-aggregating structures are present (AECOM 2021). Impacts of habitat disturbance on EFH from anchoring during O&M activities are expected to be similar in nature but at a smaller scale compared to impacts that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

Sediment Suspension/Redeposition

In general, vessel activities (i.e., anchoring and/or spudding) associated with cable installation would cause short-term impacts to water quality intermittently throughout Project construction. These benthic disturbances would increase turbidity and suspend sediment in the water column. The potential impacts to water quality, and by extension, EFH and EFH-designated species, such as resuspension of sediments, would be short-term and localized. Impacts of sediment suspension on EFH from anchoring during O&M activities are expected to be similar in nature but at a smaller scale compared to impacts that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

Underwater Noise (Vessels)

Impacts of vessel noise on EFH from anchoring during O&M activities are expected to be similar in nature but at a smaller scale compared to impacts of vessel noise that would occur during installation of the WTG and OSS foundations, as described in Section 5.1.1.1.

5.1.3.2. Pile driving

Underwater Sound

The Connected Action would require the installation of 203, 30- to 48-inch (0.8- to 1.2-meter) steel pipe piles and 770, 27.6-inch (0.7-meter) diameter AZ sheet piles and in marine habitat. Steel pipe piles in marine areas would be installed from a crane barge using a vibro-hammer for the majority of the length and then an impact hammer over the last 10 to 15 feet to ensure the piles are fully seated in the load bearing soil / stratum. Sheet piles would be installed from a crane barge using a vibro-hammer for the entirety of the length. During impact hammer use on the crane barge, slow starts would be used to minimize potential noise impacts.

As provided in the description of pile driving of the WTG and OSS foundations in Section 5.1.1.2, impact pile driving may result in permanent injury and temporary behavioral changes for EFH fish and invertebrate species within the ensonified area. The NMFS Greater Atlantic Regional Fisheries Office (GARFO) Acoustic Tool[1] for ESA-listed species was used to quantify the distance at which impact pile driving of steel pipe piles would exceed thresholds for behavioral and injurious impacts on sturgeon, which are identical to thresholds for fish greater than 2 g summarized in Table 5-1. The results of this analysis indicated that impact pile driving of 30- to 48-inch (0.8- to 1.2-meter) steel pipe piles across water depths ranging from 0 to 32 feet would result in behavioral impacts on fish at distances of 295 to 607 feet (90 to 185 meters), injurious impacts from exposure to peak sound levels at distances of 26 to 59 feet (8 to 18 meters), and injurious impacts from cumulative sound exposure at distances of 144 to 443 feet (44 to 135 meters) (Table 5-5).

Vibratory pile driving generates non-impulsive underwater noise with lower source levels than impact pile driving. Noise impacts from non-impulsive noise sources are generally smaller compared to noise impacts from impulsive noise sources, but physiological effects may still occur near the noise source if source levels are sufficiently high and/or if animals are exposed to those levels for a sufficient duration. The GARFO Acoustic Tool was used to quantify the distance at which vibratory pile driving of steel pipe piles and steel sheet piles would exceed thresholds for behavioral and injurious impacts on sturgeon, which provide a proxy for other fish species. The results of this analysis indicated that vibratory pile driving of 30- to 36-inch[2] (0.8- to 0.9-meter) steel pipe piles at water depths ranging from 9 to 32 feet would result in behavioral impacts on fish and invertebrates at distances of 164 to 230 feet (50 to 70 meters) and injurious impacts from cumulative sound exposure at distances of 144 to 197 feet (44 to 60 meters) (Table 5-5). Vibratory pile driving of steel sheet piles at a water depth of 49 feet would result in behavioral impacts on fish and invertebrates at distances of 98 to 131 feet (30 to 40 meters) and injurious impacts from cumulative sound exposure at distances of 98 to 131 feet (30 to 40 meters) (Table 5-5).

Table 5-5. Summary of acoustic radial distances for fish during impact and vibratory pile driving of steel pipe piles and sheet piles

Type of Pile	Water Depth (feet)	Hammer Type	Acoustic Radial Distance (meters/feet)		
			Peak Injury, L_{pk} = 206 dB	Cumulative Injury, L_E = 187 dB	Behavioral, L_{rms} = 150 dB
48” steel pipe	0	Impact	--	135.0 / 442.9	185.0 / 607.0
36” steel pipe	< 16	Impact	14.0 / 45.9	70.0 / 229.7	90.0 / 295.3
36” steel pipe	32	Impact	18.0 / 59.0	76.0 / 229.7	96.0 / 315.0
36” steel pipe	< 16	Vibratory	--	60.0 / 196.9	60.0 / 196.9
36” steel pipe	32	Vibratory	--	50.0 / 164.0	50.0 / 164.0
30” steel pipe	9	Impact	18.0 / 59.1	64.0 / 210.0	90.0 / 295.3
30” steel pipe	12-16	Impact	8.0 / 26.2	70.0 / 229.7	90.0 / 295.3
30” steel pipe	9	Vibratory	--	44.0 / 144.4	70.0 / 230.0
30” steel pipe	12-16	Vibratory	--	50.0 / 164.0	70.0 / 230.0
24” steel pipe	16	Impact	0	103.3 / 338.9	140.0 / 459.3
24” steel pipe	49	Impact	12.0 / 39.4	66.0 / 216.5	98.0 / 321.5
24” steel pipe	16	Vibratory	--	70.0 / 229.7	106.7 / 350.1

[1] Available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultation-technical-guidance-greater-atlantic
[2] Data for 48-inch (1.2-meter) piles are not available.

AZ steel sheet	49	Vibratory	--	30.0 / 98.4	30.0 / 98.4
AZ steel sheet	49	Vibratory	--	40.0 / 131.2	40.0 / 131.2

As described above, steel pipe pile installation would be divided between vibratory and impact pile driving, whereas sheet pile installation would only include vibratory pile driving. The expected total duration of in-water vibratory and impact pile driving causing underwater noise at the thresholds given above is summarized for each relevant structure in Table 5-6. Vibratory and impact pile driving are expected to have total durations of 147 hours and 378 hours, respectively.

Table 5-6. Expected periods of vibratory and impact pile driving

Structure	Number / Type of Piles In-water	Period of Vibratory Pile Driving (hours)	Period of Impact Pile Driving (hours)
39S Bulkhead	468 / 27.6” sheet pile	58.5	0
39W Bulkhead	302 / 27.6” sheet pile	37.0	0
32-33 Bulkhead	39 / 20” pipe pile	9.7	3.4
35W Wharf	104 / 48” pipe pile	17.4	182.0
35N Wharf	46 / 36” pipe pile	21.3	86.6
32-33 CTB Wharf	14 / 36” pipe pile	3.5	10.5
	Total	**147.4**	**377.8**

[1] Includes vibratory pile driving, impact pile driving, and setup times

Impact and vibratory pile driving would produce acoustic impacts that would adversely affect EFH for fish and invertebrates across all hearing categories, but the extent of the impacts would vary depending on hearing sensitivity (see Table 5-2) and distance from the pile. EFH species could exhibit physiological and behavioral impacts depending on intensity and duration of the acoustic impact, distance from the sound source, and hearing sensitivity. The noise levels would temporarily make the habitat less suitable and cause individuals to vacate the area of Project activities. Pile driving is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact will be short-term and EFH is expected to return to pre-pile driving conditions.

Direct Effects on EFH and EFH species

- Short-term effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
- Short-term effects on EFH of all Species Groups:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Mobile Benthic/Epibenthic – Soft Bottom
    - Sessile Benthic/Epibenthic – Complex
    - Mobile Benthic/Epibenthic – Complex
    - Pelagic
    - Prey Species – Benthic-Epibenthic
    - Prey Species – Pelagic

5.1.3.3. Dredging and In-water Construction

Habitat Disturbance

The Connected Action includes the installation of new wharf piles and bulkheads, the removal of an existing cofferdam, regrading of a portion of unvegetated riprap slope, and dredging of current basin areas at the SBMT and navigation channels leading to the SBMT. Removal of existing cofferdam and fill structures will reduce the overall impact. In-water work is proposed to begin in summer 2024 with bulkhead replacement/reinforcement and wharf installation. Dredging and capping of sediments are expected to occur in the summer and fall of 2024 and in the fall of 2025. Although this construction timeframe avoids time-of-year restrictions, peak abundance and species diversity of benthic invertebrate fauna in this region generally occur in the fall months (Maurer et al. 1979; Szedlmayer and Able 1996). Although this may result in a greater amount of injury to and mortality of benthic organisms, no population-level impacts are expected.

Construction of the Connected Action would result in a permanent loss of 1.69 acres of marine habitat, including 0.14 acres from filling, 0.05 acres from armoring, 1.42 acres from riprap, and 0.08 from piles for overwater structures (Table 5-7). Habitat losses would be partially mitigated by removing fill from the 32-33 bulkhead and 35W cofferdam, as described in Section 2.2.3.2, above. Factoring in these mitigating activities, construction of the Connected Action would result in a net loss of 0.05 acres of marine habitat and a net reduction of fill volume in the water column (-2.124 CY below MHW). Installation of overwater structures would result in permanent shading of 0.53 acres of marine habitat, all of which is appropriate for winter flounder egg EFH (i.e., depths of –16.4 ft MLW or less). Shading from above-water structures would not affect any SAV resources, the nearest of which is located approximately 700 feet away from the Connected Action footprint (see Section 4.2, above). The regrading of a 46,310 square-foot area in support of the construction of a new wharf on the north side of the 35th Street Pier would result in the excavation of 10,532 cubic yards of existing riprap and fill below mean high water, which would be replaced with similar materials. This action would temporarily disturb 0.75 acres of marine habitat and 0.31 acres of tidal wetland habitat.

Table 5-7. Summary of habitat disturbance associated with the connected action at SBMT

Material	Total Area (acres)	Net Marine Habitat Lost (acres)	Net Winter Flounder Egg EFH Lost (acres)
Fill	0.14	0.14	0.00
Armoring	0.05	0.05	0.00
Riprap	1.42	0.57	0.00
Piles for Overwater Structures	0.08	-0.71	0.03
Total	**1.69**	**0.05**	**0.03**

The sediments in the area of the connected action, which consist primarily of unconsolidated sandy silts, would be dredged to depths of up to 20 feet below the existing mudline to a final water depth of -38.1 feet MLLW (-43 feet mean high water) to accommodate the drafts of vessels required to install offshore WTGs. A total of approximately 189,000 cubic yards of sediments would be dredged from a 14.2-acre dredge footprint as part of the Connected Action. The dredge footprint contains approximately 7.1 acres of habitat with depths suitable for winter flounder egg EFH (i.e., depths of –16.4 ft MLW or less), all of which would be rendered unsuitable for this species and life stage. Within the dredge footprint, all benthic organisms would be removed and the post-dredging surface substrates would consist of unconsolidated sediments. In addition to dredging, an existing cofferdam at the western end of the 35th Street Pier and 5,000 cubic yards of associated fill would be removed and the exposed surface would be graded and covered with bedding and armor stone. This action would result in new water column and unvegetated tidal habitat. It is anticipated that sediments within the dredge footprint and new soft-bottom benthic habitat created by the cofferdam removal, if any, would quickly be recolonized by benthic organisms from surrounding, undisturbed sediments.

It is anticipated that pelagic species and mobile life stages will avoid areas where dredging is occurring activities based on typical installation speeds. Direct impacts to foraging habitat are expected to be localized to the immediate area of dredging and short-term, as benthic organisms would recolonize the area. Dredging could result in crushing and burial effects of benthic finfish and invertebrates with limited mobility. The effects of crushing and burial impacts on EFH resulting from dredging will vary depending on how benthic and demersal habitats exposed to these impacts are used by EFH-designated species. Benthic and epibenthic life stages will be the primary groups affected, with secondary effects on EFH-designated species and life stages that prey upon benthic and epibenthic organisms. Mobile organisms such as juvenile and adult finfish may be temporarily displaced by dredging activities but will be able to avoid direct impacts related to these activities.

To reduce the impacts of construction activities on benthic resources, dredging activities would utilize a clamshell dredger with an environmental bucket that would be operated at slow withdrawal speeds. Dredged sediments would be deposited into scows, allowed to settle for 24 hours prior to onsite dewatering (decanting), adhering to regulations and permit requirements, and then transported to an appropriately permitted upland disposal site.

Direct Effects on EFH and EFH Species

- Short-term loss/conversion of EFH:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic
- Permanent, localized crushing and burial of EFH species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Prey –Benthic/Epibenthic

Indirect Effects on EFH and EFH Species

- Short-term loss of benthic prey items:
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Complex

Sediment Suspension/Redeposition

Dredging, pile-driving, cofferdam replacement, and shoreline regrading activities conducted during construction as part of the Connected Action would result in increased total suspended sediment concentrations and sediment deposition in the area. Mechanical dredging activities could result in total suspended sediment concentrations of up to 445 milligrams per liter (mg/L) above ambient conditions (NMFS 2021). Pile driving could result in total suspended sediment concentrations of approximately 5 to 10 mg/L above ambient conditions within approximately 300 feet of the point of origin (FHWA 2012). However, these elevated total suspended sediment concentrations are below the short-term (1 to 2 days) concentrations shown to have adverse effects on fish, which range from 580 mg/L for the most sensitive species to 1,000 mg/L for more tolerant species (Burton, 1993; Wilber and Clark, 2001), and benthic communities (390 mg/L) (USEPA 1986). In inshore areas, such as the Upper Bay, sediments are comprised of fine to medium grains, such that disturbed sediments may take longer to settle to the seabed than in areas of sand or coarser-grained sediments. However, across many different USACE dredging projects in New York Harbor, even in area with a high percentage of fine grain particles, sediment plumes dissipated rapidly over distance (within 650 feet [200 meters] in the upper water column and 2,000 feet [600 meters] in the lower water column) to levels not detectable against background conditions. Active swimmers would be able to easily avoid plumes, and passive drifters would only be exposed over short distances (USACE 2015). However, the deposition of these sediments could smother benthic organisms, possibly resulting in mortality of benthic organisms and benthic and demersal life stages (e.g., winter flounder eggs). Sandy or silty habitats, which are abundant in the vicinity of the Connected Action, are expected to recover fairly quickly from disturbance, although recovery time varies by region, species, and type of disturbance.

As described in Section 4.2, above, there is a SAV bed approximately 700 feet south of SBMT, on the southside of Pier 7. Based on the location of the location of this SAV bed, the solid nature of Pier 7, and the strong currents present in New York Harbor, it is anticipated that any dredging- or construction-related suspended sediments present during an ebb tide would likely flow towards the navigation channel and then out to sea, rather than accumulate on the south side of Pier 7 where the SAV bed is located. Any suspended sediments that may end up in the area of the SAV bed are anticipated to be a low level that would not smother the SAV nor measurably reduce light penetration in the water column in that area (AECOM 2021b).

Sediments in Gowanus Bay have been negatively affected by centuries of industrial, sewage, and transportation discharge, and flow from the Gowanus Canal Superfund Site (USEPA 2021). AECOM (2021a) performed sediment sampling in 2021 to assess grain size and chemical contamination of sediments in the dredge area. Sediment concentrations were compared to threshold values identified in Technical & Operational Guidance Series 5.1.9 (NYSDEC 2004) and classified based on threshold exceedances. Class A sediments are defined as containing no appreciable contamination and being non-toxic to aquatic life; Class B sediments are moderately contaminated and are considered to have chronic toxicity to aquatic life; and Class C sediments have high levels of contamination and are considered acutely toxic to aquatic life (NYSDEC 2004). Approximately 60 percent of the targeted dredged material and 85 percent of post-dredging surface samples exceeded at least one Class C sediment quality threshold; however, samples did not show levels of contaminants that would classify the sediments as "hazardous" under NYSDEC regulations at 6 New York Codes, Rules and Regulations Part 371. Metals, including mercury, were most often detected at more elevated concentrations that exceeded the Class C criteria. Of the organic constituents evaluated, Class C thresholds were occasionally exceeded in the targeted dredged material and post-dredging surface for total polycyclic aromatic hydrocarbons, total PCB, and dichlorodiphenyltrichloroethane/dichlorodiphenyldichloroethane/ dichlorodiphenyldichloroethylene. Dioxins exceed the Class C threshold (50 nanograms per kilogram) in

approximately 20 percent of the targeted dredged material samples and 55 percent of the post-dredging surface samples (AECOM 2021a).

Benthic and demersal species in the area would be potentially exposed to increased contaminant levels directly from exposure to incidental suspended solids due to sediment resuspension and deposition and through bioaccumulation in prey species. As discussed in Section 5.1.2.3, above, sediment suspension may cause hydrophobic organic contaminants and heavy metals to desorb from sediments and become readily available for bioaccumulation, which may impact reproduction, development, osmoregulation, and hormones in various species and life stages. Further, resuspended contaminants may be taken up by filter feeding organisms and may remain elevated in these organisms for several months after dredging activities have been completed. Sediment grab samples indicated the presence of both pollution-tolerant species and cosmopolitan, pollution-intolerant species in the SBMT area. Species more tolerant to pollution would likely experience fewer negative effects as a result of the increased exposure to contaminants than less-tolerant species. Because dredging activities associated with the connected action are anticipated to expose a post-dredging surface with higher contamination levels than those in current surface sediments, a 1-foot cap of clean sand (9,033 cubic yards) would be placed over 5.6 acres in Areas 2.1A and 23, where 2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalence concentrations in the post-dredging surface would significantly exceed their NYSDEC Technical and Operational Guidance Series 5.1.9 Class C thresholds. This clean sand cap would achieve a sediment quality across the Project area that is similar to or better than current conditions when considered on an average Project-wide basis.

Impacts of sediment suspension and redeposition would be limited by following BMPs, including avoiding barge overflow, avoiding draining of the bucket into the water column, careful placement of the dredge material onto the scows, and use of turbidity curtains for a large proportion of the dredge area; by using a clamshell dredge with a closed environmental bucket to minimize movement of turbidity beyond the dredge footprint; and by conducting dredging in accordance with time-of-year restrictions to avoid periods of anadromous fish migrations.

Direct Effects on EFH and EFH Species

- Short-term decrease in quality of EFH resulting from suspended sediments and increased turbidity:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, local impacts resulting from sedimentation:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH Species

- Short-term loss of foraging opportunities:
  - Mobile Epibenthic/Benthic – Soft Bottom
  - Pelagic
- Short-term decrease in quality of EFH in areas adjacent to Project activities for:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic

5.1.4. Operation/presence of structures

5.1.4.1. Artificial substrate (WTG/OSS/scour protection)

Habitat Loss/Conversion

Habitat loss and conversion resulting from the presence of WTG and OSS foundations and associated scour protection are discussed in detail in Sections 5.1.1.2 and 5.1.1.4.

5.1.4.2. Underwater sound

The operation of the EW 1 and EW 2 WTGs would produce non-impulsive, low-frequency underwater noise and particle motion effects. Operational noise would occur continuously in the waters immediately surrounding the WTGs over the approximate 30-year lifespan of the Proposed Action from the completion of construction until decommissioning.

Offshore WTGs produce continuous, non-impulsive underwater noise during operation, mostly in lower-frequency bands below 8 kilohertz. Available measurements of operational noise for WTG sizes ranging from 0.2 to 6.15 MW recorded at distances ranging from 14 to 1,000 meters were evaluated in a study by Tougaard et al. (2020). The authors estimated that operational noise from a 6.15-MW WTG, normalized to a distance of 100 meters and a wind speed of 10 m/s, would result in sound pressure levels ranging from 110 to 125 dB re 1 µPa. Applying the practical spreading loss model to a source noise level of 125 dB RMS at 100 meters, noise levels exceeding the behavioral effects threshold of 150 dB RMS for fish (see Table 5-1**)** would be limited to within 5 feet (1.5 meters) of the monopile surface, and a fish belonging to the hearing specialist group would have to remain within 1 foot (0.32 meter) of the pile surface for 24 hours to experience a temporary threshold shift. However, it is important to note that the noise levels generated by the 10-MW WTGs that would be installed under the Proposed Action are expected to be higher than those generated by the 6.2-MW WTGs evaluated in Tougaard et al. (2020). Stöber and Thomsen (2021) attempted to estimate operational noise from larger current-generation, direct-drive WTGs and observed that these designs could generate higher operational noise levels than those reported in earlier research. Overall, operating WTGs would generate noise exceeding injury and behavioral effects thresholds only in the immediate area of the pile surface, such that potentially significant underwater noise effects from the Proposed Action on habitat suitability would be restricted to a small area around each monopile.

Cod and other hearing specialist species are also potentially sensitive to particle motion effects. Elliot et al. (2019) compared available research on particle motion sensitivity in fish to observed detectable particle motion effects 164 feet (50 meters) from the foundations of the Block Island Windfarm during turbine operation. Their observations suggest that particle motion effects in the 1- to 6-kHz range could occasionally exceed the lower limit of observed behavioral responses in hearing specialists within these limits. Although behavioral avoidance impacts of operational noise are expected to be limited to the immediate area of the WTGs, operational noise may cause masking of communication and orientation signals in fish over a much larger distance, potentially up to 25 km (Wahlberg and Westerberg 2005).

Some degree of habituation to these operational noise and particle motion effects is to be anticipated. Bedjer et al. (2009) argue that habituation of organisms to ongoing low-level disturbance is not necessarily a neutral or benign process. For example, habituation to particle motion effects could make individual fish or invertebrates less aware of approaching predators, or could cause masking effects that interfere with communication, mating or other important behaviors.

Collectively, these observations indicate that EW 1 and EW 2 WTG operations could have limited adverse effects on habitat suitability for EFH species within a certain distance of each monopile foundation. The extent of these effects is difficult to quantify as they are likely to vary depending on wind speed, water temperature, ambient noise conditions, and other factors. Potential adverse effects on habitat suitability for fish belonging to the hearing specialist group are estimated to extend up to 164 feet (50 meters) from each foundation. This equates to potential adverse effects over approximately 340 acres of habitat during the operation of 147 31.5-foot (9-meter) monopiles and approximately 348 acres of habitat during the operation of 147 36-foot (11-meter) monopiles.

Direct Effects on EFH and EFH species

- Permanent, local avoidance responses to operational noise in hearing specialist species:
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

5.1.4.3. Hydrodynamic effects

The presence of the WTG and OSS foundations during the operation of EW 1 and EW 2 would cause hydrodynamic effects, potentially including changes in water flow, changes in vertical mixing and associated primary production, and changes in larval distribution patterns. Based on hydrodynamic modeling studies, the presence of offshore wind arrays would potentially disrupt water flow downstream of the foundations.. While impacts on current speed and direction decrease rapidly around monopiles, there is evidence that monopile wakes can extend out to several kilometers (Cazenave et al. 2016; Li et al. 2014; Vanhellemont and Ruddick 2014). However, other studies observed that substantial disruptions to water flow from monopiles were localized. For instance, Schultze et al. (2020) observed that 6-meter (20-foot) monopiles produced elevated turbulence levels that dissipated to background levels within 300 meters (984 feet) downstream of the monopiles, but that strong turbulence was limited to within 50 to 100 meters (164 to 328 feet) downstream of the monopiles. Miles et al. (2017) observed that water currents returned to background levels 8.3 pile diameters downstream of monopiles, suggesting that flow disruptions would occur 80 to 91 meters (262 to 299 feet) downstream of the monopiles being considered for the Proposed Action. The discrepancies in the spatial extent of flow disruptions among studies are likely related to local conditions, wind farm scale, and sensitivity of the analyses. Under the Proposed Action, the WTGs would be no less than 1.2 km (0.65 nautical miles) apart, which is greater than downstream extent of individual hydrodynamic effects observed in most studies at other offshore wind facilities. This suggests that hydrodynamic effects would be localized around each monopile and would not produce additive effects across the entire array. These localized hydrodynamic effects would last over the approximate 30-year lifespan of the Proposed Action from completion of construction through decommissioning..

Storms and upwelling in the fall result in increased mixing and deterioration of the stratified layers. The presence of monopiles in the water column can introduce small-scale mixing and turbulence that also results in some loss of stratification (Carpenter et al. 2016; Floeter et al. 2017; Schultze et al. 2020). In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing toward stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017). On the Mid-Atlantic Bight, processes that result in increased mixing may influence the strength and persistence of the Cold Pool, a band of cold, near-bottom water that exists at depth from the spring to fall. However, the turbulence introduced by individual monopiles is expected to be insufficient to disrupt the strong stratification that maintains the Cold Pool, wherein water temperature differences between the surface and the Cold Pool can reach 50°F (10°C) (Lentz 2017).

In addition to their direct effects on mixing and turbulence in the water column, the presence of the monopiles would generate areas of reduced wind speed known as wind wakes, which may drive upwelling/downwelling dipoles (Broström 2008; Nerge and Lenhart 2010). Large monopiles that will be used for future offshore wind projects may generate wind wakes that extend up to 50 km from the edge of the wind farm (Golbazi et al. 2022). Christiansen et al. (2022) developed a hydrodynamic model to simulate the seasonal cycle of the stratification in consideration of wind farm development in the North Sea and observed that wind wakes caused changes in the vertical and lateral flow that were sufficiently strong to alter the temperature and salinity distribution in areas of wind farm operation. In particular, the authors observed large-scale structural changes in stratification strength, including increased summer stratification. Ocean warming associated with climate change has caused increasing ocean stratification over the past-half century and is expected to continue to cause increased stratification (Li et al. 2020). Given that the monopiles installed under the Proposed Action would remain in the water column for approximately 30 years, wind wake effects from these structures would potentially interact synergistically with climate change effects to influence stratification in the mid-Atlantic OCS. The up to 147 WTGs are likely to create individual localized hydrodynamic effects that could have localized effects on food web productivity and pelagic eggs and larvae. Given their planktonic nature, altered circulation patterns could transport pelagic eggs and larvae out of suitable habitat, leading to reduced survival. BOEM (2021) used Agent-Based Models (ABMs) to evaluate how the introduction of commercial scale offshore wind energy facilities in the Massachusetts-Rhode Island (MA-RI) marine areas may affect local and regional oceanic responses (e.g., currents, temperature stratification) and related egg and larval advection patterns. Three representative species (i.e., sea scallop, silver hake, and summer flounder) were selected to evaluate egg and larval transport patterns. The ABMs included numerous variables that are relevant to dispersal and settlement, including mortality and growth, environmental variables (e.g., temperature, depth, salinity), larval swimming speeds, and vertical migration patterns. The ABMs demonstrated that alterations in circulation patterns related to the presence of offshore wind foundations resulted in a spatial shift in larval settlement density, with some areas experiencing higher settlement density and others experiencing reduced settlement density. Further, the authors observed that, depending on the release characteristics of eggs and larvae, altered current direction and speeds either acted independently and/or collectively to cause the observed shifts. Changes in larval distribution and settlement density can affect regional or local abundances, depending on the species and the spatial scale of its population network. However, effects on egg and larval survival from altered circulation patterns could be offset by increased primary productivity in the wake of the monopiles. Turbulence downstream of the monopiles could introduce nutrients to the surface mixed layer that promote primary production, increasing the forage base for pelagic larvae (Floeter et al. 2017). These offsetting effects are expected to be highly localized and small relative to the size of the Project area and the natural mortality rate of ichthyoplankton.

Pelagic juvenile and adult fish may experience hydrodynamic effects down-current of the WTG and OSS foundations. These effects may include decreased current speeds and minor changes to seasonal stratification regimes, which could cause reduced habitat suitability for some EFH species in localized areas. Pelagic juveniles and adults would likely avoid habitat with decreased suitability. Hydrodynamic effects are expected to vary depending on seasonal and tidal hydrodynamic cycles.

5.1.5. Operation/presence of interarray and offshore/onshore cables

5.1.5.1. Power transmission (EMF, heat)

The interarray cables and OECs would generate intermittent induced magnetic and electrical field effects and substrate heating effects whenever they are under power through the life of the Project. These effects would be present whenever winds speeds are sufficient to turn WTGs. As such, these effects are anticipated to be continuous, with intermittent interruptions during periods of no wind. EFH is divided into the following components for the purpose of this assessment:

- Benthic habitats used by EFH fish and invertebrate species having benthic or epibenthic eggs and larvae. Minimum physiological effect thresholds are defined as follows (Brouard et al. 1996):
    - Magnetic field: 1,000 mG (observed developmental delay)
    - Electrical field: > 500 millivolts per meter (mV/m)
- Bottom habitats used by benthic or epibenthic life stages of EFH finfish species. Minimum physiological effect thresholds are defined as follows (Armstrong et al. 2015; Basov 1999; Bevelhimer et al. 2013; Orpwood et al. 2015):
    - Magnetic field: > 1,000 mG
    - Electrical field: 20mV/m
- Demersal habitats (from 3.3 to 26.2 feet [1 to 8 meters] off the seabed) used by pelagic life stages of EFH finfish and invertebrates:
    - Same thresholds as above
    - Magnetic field - squid: > 800 mG (Love et al. 2015)
- Bottom habitats used by benthic and epibenthic life stages of EFH shark and skate species. Minimum effect thresholds are defined as follows (Bedore and Kajiura 2013; Hutchison et al. 2020; Kempster et al. 2013):
    - Magnetic field: Detection, unknown; behavioral, 250-1,000 mG (species-specific)
    - Electrical field: Detection, 20-50 µV/cm (2-5 mV/m) for fields < 20 Hz, no response to electrical fields above 20 Hz
- Benthic and infaunal habitats used by EFH shellfish species, and benthic invertebrate prey organisms for EFH species

EMF Effects on Habitats Used by Benthic or Epibenthic Eggs and Larvae

Benthic eggs and larvae of fish and invertebrates could settle in areas along the interarray cable and OEC corridors, including both buried and exposed cable segments. The maximum induced magnetic field and electrical field generated by the interarray cable would be 65.1 mG and 4.3 mV/m at the bed surface immediately adjacent to exposed cable segments, respectively. The maximum induced magnetic field and electrical field generated by the OECs would be 76.6 mG and 5.4 mV/m, respectively. Induced electrical field effects in aquatic species are a function of body size, with smaller-bodied organisms experiencing a smaller induced field effect than larger organisms. Induced electrical field effects on eggs and larvae would be insignificant based on their small body size.

Species-specific data on egg and larval sensitivity to EMF effects are lacking. The limited research on fish sensitivity to magnetic and electrical fields did not observe significant effects of EMF on eggs and larvae . For example, Cameron et al. (1985) determined that magnetic fields on the order of 1,000 mG were required to produce observable developmental delay on the eggs of euryhaline Japanese rice fish. Brouard et al. (1996) exposed rainbow trout embryos to electrical fields ranging as high as 5,000 mV/m and observed no evident effects on development or subsequent survival. These test exposures are orders of magnitude higher than the largest potential EMF levels likely to result from interarray cable and OEC operation. Additional studies conducted across a broader range of finfish species are need to determine whether EMF generated by transmission cables would have an effect on egg and larval stages.

EMF Effects on Habitats Used by Benthic or Epibenthic Juveniles and Adults

Several EFH species and their fish prey species use benthic or epibenthic habitats within 3.3 feet (1 meter) of the seabed during their life cycle that overlap with the interarray cable and OEC paths, including both buried and exposed cable segments. This indicates that EFH species and their prey could be exposed to EMF effects, as summarized in Table 5-8.

Table 5-8. Potential EMF effects on benthic or epibenthic eggs, larvae, juveniles and adults resulting from operation of the interarray cables and OECs

Component	Effect	Feature	Measurement
Interarray cable	Induced magnetic field	Buried cable	21 mG
		Exposed cable	65.1 mG
	Electrical field	Buried cable	1.4 mV/m
		Exposed cable	4.3 mV/m
	Induced electrical field	Juvenile/subadult	< 0.4 mV/m
		Adult	< 0.74 mV/v
OEC	Induced magnetic field	Buried cable	30 mG
		Exposed cable	76.6 mG
	Electrical field	Buried cable	2.1 mV/m
		Exposed cable	5.4 mV/m
	Induced electrical field	Juvenile/subadult	< 0.59 mV/m
		Adult	< 1.05 mV/m

While there are limited species-specific data on the magnetic and electrical field sensitivity for juvenile and adult fish, the available data generally indicate that the minimum magnetic field exposure threshold for behavioral effects exceeds 1,000 mG for most fish species (e.g., Armstrong et al. 2015; Bevelhimer et al. 2013; Orpwood et al. 2015). The minimum threshold for observable detection of electrical fields in electrosensitive fish species is on the order of 20 mV/m (Basov 1999). The magnetic and electrical field exposure thresholds are greater than the maximum potential EMF levels likely to result from interarray cable and OEC operations, indicating that EMF effects of this project component on benthic EFH for the juveniles and adults would be insignificant. Consistent with this, in a review of EMF effects produced by offshore wind energy, Copping et al. (2016) concluded that induced electrical fields generated in fish in close proximity to the interarray cables and OECs would have no observable effects on physiology or behavior.

EMF Effects on Habitats Used by Pelagic Fish

Pelagic fish and invertebrates may periodically use demersal habitats at or near 3.3 feet (1 meter) of the seabed during their life cycle. This may include habitats overlapping buried and exposed segments of the interarray cable. Prey organisms for pelagic fish species may also occur within this EMF exposure zone. This indicates that these species could be exposed to EMF effects, as summarized in Table 5-9.

Table 5-9. Potential EMF effects on pelagic fish resulting from operation of the interarray cables and OECs

Component	Effect	Feature	Measurement
Interarray cable	Induced magnetic field	Buried cable (3 ft above seabed)	9 mG
		Exposed cable (3 ft above seabed)	27.9 mG
	Electrical field	Buried cable (3 ft above seabed)	0.9 mV/m
		Exposed cable (3 ft above seabed)	2.8 mV/m
	Induced electrical field	Juvenile/subadult	< 0.19 mV/m
		Adults 3.3-6 ft long	< 0.31 mV/m

		Adult 6-8.2 ft long	< 0.43 mV/m
OEC	Induced magnetic field	Buried cable (3 ft above seabed)	21 mG
		Exposed cable (3 ft above seabed)	53.6 mG
	Electrical field	Buried cable (3 ft above seabed)	1.4 mV/m
		Exposed cable (3 ft above seabed)	3.6 mV/m
	Induced electrical field	Juvenile/subadult	< 0.25 mV/m
		Adults 3.3-6 ft long	< 0.47 mV/m
		Adult 6-8.2 ft long	< 0.62 mV/m

Applying the effect thresholds and rationale presented in the previous section, the EMF effects of interarray cable and OEC operations on demersal habitats used by pelagic fish and invertebrates and their prey would be insignificant.

EMF Effects on Habitats Used by Pelagic Invertebrates

Two pelagic EFH invertebrate species, longfin squid and shortfin squid, may periodically use demersal habitats at or near 3.3 feet (1 meter) of the seabed during their life cycle. This may include habitats overlapping buried and exposed segments of the interarray cable. Prey organisms within this zone would also experience EMF exposure. This indicates that these species could be exposed to EMF effects, as summarized in Table 5-10.

Table 5-10. Potential EMF effects on pelagic invertebrates resulting from operation of the interarray cables and OECs

Component	Effect	Feature	Measurement
Interarray cable	Induced magnetic field	Buried cable (3 ft above seabed)	9 mG
		Exposed cable (3 ft above seabed)	27.9 mG
	Electrical field	Buried cable (3 ft above seabed)	0.9 mV/m
		Exposed cable (3 ft above seabed)	2.8 mV/m
	Induced electrical field	Juvenile/adult	< 0.25 mV/m
OEC	Induced magnetic field	Buried cable (3 ft above seabed)	21 mG
		Exposed cable (3 ft above seabed)	53.6 mG
	Electrical field	Buried cable (3 ft above seabed)	1.4 mV/m
		Exposed cable (3 ft above seabed)	3.6 mV/m
	Induced electrical field	Juvenile/adult	< 0.25 mV/m

While directed studies are lacking, there is little evidence that cephalopods like squid are electromagnetically sensitive (Normandeau 2011; Williamson 1995). Anecdotal observations suggest that EMF from submarine power cables has no effect on cephalopod behavior. Love et al. (2015) observed no differences in octopus predation on caged crabs placed immediately adjacent to a powered HVAC electrical cable producing induced magnetic fields ranging from 450 to 800 mG, and at a control site adjacent to an unpowered cable. The lack of effects on predation behavior suggests that cephalopods are insensitive to EMF effects of this magnitude. Given that the largest projected magnetic field effects from the interarray cable are 1 to 2 orders of magnitude lower than these values, it is reasonable to conclude that the EMF effects of this project feature on EFH used by longfin squid would be insignificant.

EMF Effects on Habitats Used by Sharks and Skates

Several shark and skate species have one or more life stages that use demersal or epibenthic habitats overlapping the proposed interarray cable and OEC corridors. Further, shark species and life stages that primarily use pelagic habitat may periodically use demersal habitats at or near 3.3 feet (1 meter) of the seabed during their respective life cycles. These species may be exposed to EMF effects, as summarized in Table 5-11.

Table 5-11. Potential EMF effects on sharks and skates resulting from operation of the interarray cables and OECs

Component	Effect	Feature	Measurement
Interarray cable	Induced magnetic field	Buried cable	21 mG
		Exposed cable	65.1 mG
		Buried cable (3 ft above seabed)	9 mG
		Exposed cable (3 ft m above seabed)	27.9 mG
	Electrical field	Buried cable	1.4 mV/m
		Exposed cable	4.3 mV/m
		Buried cable (3 ft above seabed)	0.9 mV/m
		Exposed cable (3 ft above seabed)	2.8 mV/m
	Induced electrical field	Juvenile/subadult	< 0.4 mV/m
		Adults 3.3-6 ft long	< 0.74 mV/m
		Adult 6-8.2 ft long	< 1.02 mV/m
		Juvenile/subadult (3 ft above seabed)	< 0.19 mV/m
		Adults 3.3-6 ft long (3 ft above seabed)	< 0.31 mV/m
		Adults 6-8.2 ft long (3 ft above seabed)	< 0.43 mV/m
OEC	Induced magnetic field	Buried cable	30 mG
		Exposed cable	76.6 mG
		Buried cable (3 ft above seabed)	21 mG
		Exposed cable (3 ft above seabed)	53.6 mG
	Electrical field	Buried cable	2.1 mV/m
		Exposed cable	5.4 mV/m
		Buried cable (3 ft above seabed)	1.4 mV/m
		Exposed cable (3 ft above seabed)	3.6 mV/m
	Induced electrical field	Juvenile/subadult	< 0.4 mV/m
		Adults 3.3-6 ft long	< 0.74 mV/m
		Adult 6-8.2 ft long	< 1.02 mV/m
		Juvenile/subadult (3 ft above seabed)	< 0.19 mV/m
		Adults 3.3-6 ft long (3 ft above seabed)	< 0.31 mV/m
		Adults 6-8.2 ft long (3 ft above seabed)	< 0.43 mV/m

While sharks and rays demonstrate sensitivity to bioelectrical fields of less than 1 mV/m (Adair et al. 1998; Ball et al. 2016; Bedore and Kajiura 2013; Kempster et al. 2013), fields with frequencies greater than 20 Hz are beyond the detection range of most electrosensitive organisms (Bedore and Kajiura 2013). Therefore, the 60-Hz electrical fields that would be generated by the interarray cables and OECs are not expected to be detectable by elasmobranchs. The minimum sensitivity of sharks and rays to magnetic fields is unknown, but some species have exhibited behavioral responses to field strengths ranging from 250 to 1,000 mG (Hutchison et al. 2018, 2020; Normandeau 2011), which are an order of magnitude above the maximum induced magnetic fields that would be generated by the cables. The induced electrical fields that would be generated in even the largest fish are less than those generated by muscular and nervous activity in living animals (~10 mV/m) and are therefore expected to be undetectable (Adair et al. 1998). Based on the above evidence, the EMF effects of the interarray cables and OECs on EFH used by epibenthic or demersal sharks and skates are expected to be insignificant, but additional research is needed to confirm that the magnetic fields generated by offshore transmission cables would be below the minimum thresholds for detection by sharks and skates..

EMF and Heat Effects on Habitats Used by Benthic Invertebrates

Several benthic invertebrate species have one or more life stages that use benthic habitats overlapping the proposed interarray cable and OEC corridors. The potential for EMF and heat effects of cable operation on benthic invertebrates is of particular concern because they are sessile and would be exposed to stressors over prolonged periods. The available evidence on invertebrate sensitivity to EMF suggest that the interarray cables and OECs could produce sufficient EMF to cause adverse effects on benthic invertebrates, but the specific sensitivity of EFH species likely to occur in the cable path remains unclear. Studies have demonstrated that marine invertebrates may not be able to detect or respond to magnetic fields produced by AC cables that have a frequency of 60 Hz or less, especially at intensities below 50 mG (Normandeau et al. 2011). These results suggest that the maximum magnetic field along buried sections of the export cables (i.e., 30 mG) would be below the threshold for detection, and the maximum magnetic field along exposed sections of cable (i.e., 76.6 mG) would be above the threshold. Further, marine invertebrates that burrow into the seafloor (i.e., Atlantic surf clam, ocean quahog) would potentially be exposed to magnetic fields exceeding detection thresholds along both buried and exposed segments of the cable. Additionally, bivalves inhabiting inlands waters (e.g., hard clams) that would be traversed by the EW 1 and EW 2 export cables, including portions of New York Harbor and Wreck Lead Channel, would be exposed to EMF during Project operations.

In addition to EMF effects, buried segments of the interarray cables and OECs would generate sufficient heat to raise the temperature of the surrounding sediments by as much as 10 to 20 °C above ambient within 1.3 to 2 feet (0.4 to 0.6 meter) of the cable. Substrate temperature changes of this magnitude could adversely affect habitat suitability for juvenile and adult life stages of Atlantic surf clam and ocean quahog (Acquafredda et al. 2019; Harding et al. 2008) inhabiting the offshore export cable corridor, as well as bivalves inhabiting inlands waters (e.g., hard clams) that would be traversed by the EW 1 and EW 2 export cables, including portions of New York Harbor and Wreck Lead Channel. However, because the interarray cables and OECs would be buried to a minimum depth of 6 feet (1.8 meters) along the majority of their length (Table 6-1), heat effects from buried cable segments on benthic infauna are expected to occur over only a small area.

5.1.5.2. Cable protection

Community structure changes resulting from installation of cable protection are discussed in detail in Section 5.1.2.4.

5.2. Project Monitoring Activities

5.2.1. Passive Acoustic Monitoring

Passive Acoustic Monitoring (PAM) would be conducted during pile driving to determine whether protected species are present in the area. PAM would be conducted in accordance with NOAA and BOEM minimum recommendations for use of passive acoustic listening systems in offshore wind energy development monitoring and mitigation programs (Parijs et al. 2021). PAM systems that may be used for monitoring would either be stationary (e.g., moored) or mobile (e.g., towed autonomous surface vehicle, or autonomous underwater vehicles). Stationary PAM systems include PAM buoys that would be anchored to the seabed using various types of anchors typically employed in a variety of marine research activities. Typical anchor types include small concrete blocks, steel rings, sandbags, or truck tires filled with cement. PAM systems are typically rigged with a surface float to allow for full retrieval of the buoy, rigging, and anchor system. These mooring systems would temporarily introduce new hard structures to the environment that could become colonized by benthic organisms, including invasive species.

Encrusting organisms would be removed from the ecosystem upon removal of the PAM anchoring systems. Placement of the anchors would result in sediment disturbance and a short-term increase in suspended sediment near the anchors and would crush any organisms and habitat underneath the anchors. The effects of the anchors on EFH species and habitats would result in short-term and long-term impacts to EFH and managed species. The movement of autonomous PAM systems and the minimal sound they produce could disturb pelagic EFH and could affect pelagic and benthic managed species through collisions or by impacting behavior (e.g., inducing startle responses), but these impacts are very unlikely. Therefore, it is understood that PAM would not change the effects determination for EFH for any species in the EFH assessment.

5.2.2. Fisheries Surveys

INSPIRE Environmental is developing a fisheries monitoring plan for the Proposed Action. The fisheries monitoring plan will detail survey designs for the lease area and, potentially, the offshore cable route. Development of inshore monitoring surveys in the vicinity of the cable landing will be incorporated into the plan once finalized during the New York state Article VII process. Appropriate survey types will be determined through the review of existing fisheries data for both the commercial and recreational sectors, incorporation of stakeholder outreach data collected by Equinor's Fisheries Liaisons, and review of fisheries monitoring plans for other offshore wind projects. The plan will incorporate non-extractive survey techniques, if possible, to limit interactions with protected species as well as reduce mortality of species of interest. If deemed appropriate, Before-After Control-Impact (BACI) or Before-After Gradient (BAG) designs will be used to compare pre-construction conditions to the construction and post-construction time periods in an effort to identify potential impacts from the project. Traditional fisheries monitoring techniques (i.e., otter trawl, pots) may be use in some survey designs, though current permitting timelines and the higher potential for protected species interactions may preclude pre-construction data collection using these gear types. Power analyses will be conducted and presented for all proposed survey designs to refine the amount of sampling needed to determine the degree of changes that may be detected over the proposed survey duration.

5.2.3. Benthic Habitat Monitoring

INSPIRE Environmental is developing two complimentary benthic monitoring plans for the Proposed Action – one focused on federal waters and the other within NY state waters. The plan developed for federal waters (i.e., the Lease Area and part of the OEC corridor) will focus monitoring on the novel hard surfaces introduced during construction (e.g., turbine foundations, scour protection layer, cable mattresses) and surrounding benthic habitats. Video and/or still imagery may be obtained using standard techniques (e.g., ROV, SPI). Image and video analysis will be conducted to identify key and/or dominant species as well functional changes in community composition both spatially and temporally on the novel hard surfaces. Random stratified and BAG survey designs will be incorporated where applicable. The plan developed for New York State waters will focus on the area of the potential cable landing. SPI and/or grab sampling may be used to examine the soft bottom habitats present along the export cable route in state waters and allow for accurate comparisons to be made before and after cable installation activities.

5.3. Decommissioning

A separate EFH consultation would be conducted for the decommissioning phase of the project. As described in Section 2.4, above, Empire Wind will be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions when these facilities reach the end of their 35-year designed service life. Decommissioning activities will involve removing WTG and OSS foundations 15 ft (4.6 m) below the mudline. Interarray cables, OECs, and associated scour protection will either be removed or retired in place, depending on the habitat value they provide. All Project components that are removed will be transported to an appropriate disposal and/or recycling facility.

Vessels involved in decommissioning would generate underwater noise, which may cause short-term behavioral effects on pelagic EFH species similar to those described in Section 5.1.1.1, above. Vessel noise may result in brief periods of exposure near the surface of the water column but is not expected to cause injury, hearing impairment or long-term masking of biologically relevant cues in fish and invertebrates.

If the cable protection is left in place, hard-bottom habitat would remain along parts of the cable corridors and would continue to support an assemblage of EFH species associated with complex benthic habitat. Removal of the cables would disturb soft-bottom habitat and would cause short-term impacts on EFH species with benthic or epibenthic life stages (e.g., crushing or burial, sediment suspension and deposition) similar to those described for cable emplacement in Section 5.1.2.3, above. Removal of the scour protection would convert hard-bottom habitat to soft-bottom habitat and would likely result in a recolonization by EFH species preferring soft-bottom sand and fine-sediment habitat and the loss of any EFH species associated with complex benthic habitat.

5.4. Cumulative and Synergistic Effects to EFH

In addition to the two existing offshore wind facilities in U.S. waters, there are over 30 offshore wind projects that are planned for construction in the Mid-Atlantic and New England from 2023 through 2030, including the Proposed Action. Collectively, the construction and operation of these facilities would impact EFH and EFH species primarily through seafloor disturbance during cable emplacement, pile driving noise, habitat conversion, hydrodynamic changes, and EMF. The cumulative and synergistic effects of each of these IPFs are discussed in the following paragraphs.

Planned offshore wind development, including the Proposed Action, would place thousands of miles of buried or armored cable along transmission corridors and interarray connections, disturbing more than 184,000 acres of seafloor. Cable emplacement and would disturb, displace, and injure or kill finfish and invertebrates, release sediment into the water column, and cause habitat alterations. As described in Section 5.1.2, above, mobile finfish and invertebrates are likely to move away from cable-laying equipment, but immobile or slow-moving demersal species and life stages (e.g., eggs, larvae) may be injured or killed by the equipment. Some types of equipment that are used to prepare the seabed prior to cable emplacement (e.g., hydraulic dredges) use water withdrawals, which can entrain planktonic eggs and larvae with assumed 100-percent mortality of entrained individuals. Suspended sediment and sediment deposition associated with cable emplacement may cause impacts on EFH and EFH species out to several hundred meters, including behavioral changes in fish and invertebrates and burial of sessile species and life stages. Seabed preparation prior to cable emplacement would cause short-term disturbances of soft-bottom habitat and long-term disturbances of complex habitat, which may require several years to recover.

Planned offshore wind projects, including the Proposed Action, would generate pile driving noise during the installation of up to 2,941 WTG and 66 foundations, which would cause instantaneous behavioral effects and cumulative injurious effects over distances of up to several kilometers from each foundation. The Proposed Action would install 147 WTG foundations from 2024 through 2025, which would overlap with the construction period of several other offshore wind projects, including projects that would install 637 WTGs in the MA/RI region, a project that would install 98 WTGs in the NY/NJ region, projects that would install 227 WTGs in the DE/MD region, and projects that would install 395 WTGs in the VA/NC region. Pile driving noise generated by these projects would temporarily make the surrounding habitat less suitable and cause individuals to vacate the area of project activities. Pile driving is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact will be short-term, as EFH is expected to return to pre-pile driving conditions.

The primary impacts of the Proposed Action on EFH would result from the presence of structures. Planned and existing offshore wind activities, including the Proposed Action, would install or continue to operate up to 2,948 WTG and 68 OSS foundations, 4,344 acres of foundation scour protection, and 2,662 acres of cable protection. BOEM anticipates that structures would be added intermittently over an assumed 5-year period and that they would remain until decommissioning of each facility is complete. These structures would be constructed in mostly sandy seafloor and would therefore convert soft-bottom habitat to hard-bottom habitat. The installation of these structure would result in a permanent loss of EFH for epibenthic and benthic finfish and invertebrates that associate with soft-bottom habitat (e.g., clams, flounders, skates). New structures could affect migration through the area of species that prefer complex habitat by providing unique, complex features (relative to the primarily sandy seafloor). This could lead to retention of those species and possibly impact spawning opportunities. Complex habitat and its associated faunal communities are limited in the Mid-Atlantic, and it is possible that additional habitat will facilitate the expansion of these communities. The structures would create an “artificial reef effect,” whereby more sessile and benthic organisms would likely colonize over time (e.g., sponges, algae, mussels, shellfish, sea anemones). Higher densities of invertebrate colonizers would provide a food source and habitat to other invertebrates, such as mobile crustaceans, and some finfish species. With new foundations being added from additional offshore wind farms, EFH for fishes and invertebrates adapted to complex habitat would increase, but at the expense of EFH for species that are typically associated with soft-bottom habitat. Potential benefits of added complex habitat may be offset if the colonizable habitat provides steppingstones for non-native species. Given the duration over which the monopiles from these projects will remain in the water column (~30 years) and that non-native species have been observed to tolerate higher water temperatures than native species, the presence of these structures may interact synergistically with warming ocean temperatures to promote the establishment of invasive species.

Planned and existing offshore wind activities, including the Proposed Action, would collectively operate up to 2,948 WTG foundations and 68 OSS foundations in the waters of the Mid-Atlantic and New England by 2030. As described in Section 5.1.4.3, above, the presence of these foundations would cause hydrodynamic effects, potentially including changes in water flow, changes in vertical mixing and associated primary production, and changes in larval distribution patterns. NOAA consensus on other projects in the region is that hydrodynamic effects would be limited to within a few hundred meters of the monopiles, such that hydrodynamic effects would be localized around each monopile and are not expected to produce additive effects across offshore wind facilities. These localized hydrodynamic effects would last over the lifespan of each of the projects from completion of construction through decommissioning.

Planned and existing offshore wind activities, including the Proposed Action, would collectively install over 11,000 miles of export and interarray cables in the waters of the Mid-Atlantic and New England. Operation of these cables would increase the presence of EMF in the surrounding waters. EMF strength rapidly decreases with distance from cables and would mostly be confined to within a few meters of cable corridors. As discussed in Section 5.1.5.1, above, EMF levels generated by export and interarray cables are expected to be insufficient to cause impacts on any life stages of finfish. However, because they are sessile and would be exposed to stressors over prolonged periods, benthic invertebrates may be subjected to physiological effects of EMF within 10 meters of cables. In addition to EMF effects, buried segments of the interarray cables and OECs would generate sufficient heat to raise the temperature of the surrounding sediments by as much as 10 to 20 °C above ambient within 1 to 2 feet of the cable. Substrate temperature changes of this magnitude could adversely affect habitat suitability for juvenile and adult life stages of Atlantic surf clam and ocean quahog, as well as other benthic infauna species. Because transmission cables would be buried along most of their length, heat effects from cable operations on benthic infauna are expected to occur over only a small area. EMF impacts on EFH habitat suitability would persist continuously over the operating life of each project.

6. Avoidance, Minimization, and Mitigation

6.1. Applicant-Proposed Mitigation Measures

This section outlines Applicant Proposed Mitigations (APMs) proposed by Empire Wind and additional mitigation and monitoring measures that are intended to avoid and/or minimize potential impacts to EFH-designated species and EFH. Relevant APMs and mitigation measures, contributions to avoiding and/or minimizing adverse effects on EFH, and supporting rationale are summarized by project component in Table 6-1.

6.2. Environmental Protection Measures that BOEM Could Impose

This section outlines Environmental Protection Measures (EPMs) that BOEM could impose to avoid and/or minimize potential impacts to EFH-designated species and EFH. Relevant EPMs and mitigation measures, contributions to avoiding and/or minimizing adverse effects on EFH, and supporting rationale are summarized by project component in Table 6-2.

Table 6-1. Applicant Proposed Mitigations (APMs) for construction and operation of the Proposed Action

Proposed APM	Project Component				Expected Effects
	WTGs and OSSs	Inter-array Cable	OEC	O&M Facility	
Establish seasonal work windows that avoid sensitive life stages, as feasible.	X	X	X	X	This measure would minimize construction impacts (e.g., noise, sediment suspension) on EFH and EFH species.
Consideration of the timing of construction activities; working with the fishing industry and fisheries agencies on sensitive spawning and fishing periods to actively avoid or reduce interaction with receptors, where feasible.	X	X	X	X	This measure would minimize construction impacts (e.g., noise, sediment suspension) on EFH and EFH species.
Use dynamic positioning in most construction vessels, thereby limiting the use of anchors and jack-up features.	X	X	X	X	This measure would minimize anchoring impacts on EFH and EFH species.
Using appropriate measures for vessel operation and implementing an OSRP, which includes measures to prevent, detect, and contain accidental release of oil and other hazardous materials. Project personnel would be trained in accordance with relevant laws, regulations, and Project policies, as described in the OSRP.	X	X	X	X	This measure would minimize water quality impacts on EFH and EFH species.
Use soft-start procedures during pile driving to enable fish and invertebrates to leave the construction area. Vibration of piles to maximum depth to minimize the amount of pile driving that occurs.	X			X	The reduction in sound pressure levels would reduce the areal extent of noise impacts on EFH species and the prey they feed upon.
Use of commercially available and technically feasible noise attenuation technologies to reduce pile driving noise.	X			X	This measure would minimize impacts of pile driving noise on EFH and EFH species.
A commitment to sufficiently bury electrical cables (target 6 feet [1.2 meters]) where feasible, minimizing seabed habitat loss and reducing the effects of EMF; where deep burial is not technically feasible, rock armoring will shield the cable from the overlying water.		X	X		This measure would minimize EMF impacts on EFH and EFH species.
Site structures (wind turbines, offshore substations, export and inter-array cables) in areas that would minimize overlap with sensitive benthic habitats.	X	X	X		This measure would minimize impacts to sensitive and slow to recover habitats used by EFH species.

Proposed APM	Project Component: WTGs and OSSs	Project Component: Inter-array Cable	Project Component: OEC	Project Component: O&M Facility	Expected Effects
Install silt curtains in sensitive construction areas, as warranted by results of the sediment modeling.		X	X	X	This measure would minimize sediment suspension and deposition impacts on EFH and EFH species.
Use cable installation tools (e.g., jet plow) that minimize the area and duration of sediment suspension.		X	X		This measure would minimize sediment suspension and deposition impacts on EFH and EFH species.
Use HDD at the EW 2 OEC landfall to minimize physical disturbance of coastal habitats.			X		This measure would minimize the extent of direct habitat impacts on EFH and EFH species.
Implement appropriate measures during HDD activities at export cable landfalls to minimize potential release of HDD fluid			X		This measure would minimize water quality impacts on EFH and EFH species.
Sensitive lighting schemes to minimize exposure of light.	X			X	This measure would minimize light impacts on EFH and EFH species.
Development of appropriate monitoring program(s) in close coordination with regulatory agencies and stakeholders.	X	X	X	X	This measure would minimize project impacts to EFH and EFH species.
Follow best management practices for dredge work in SBMT project area, including the use of turbidity curtains, no barge overflow, no draining of the bucket over the water column, careful placement of the dredge material onto the scows, and a closed environmental bucket.				X	This measure would minimize water quality and chemical contamination impacts on EFH and EFH species.
Placement of one foot of clean sand over contaminated sediment in the SBMT project area post-dredging.				X	This measure would minimize water quality chemical contamination impacts on EFH and EFH species.
Concurrent scheduling of in-water work at the SBMT project area to minimize the duration of in-water work. Dredging activities would be scheduled to occur 24 hrs a day and 7 days a week to reduce the construction timeline to two seasons (vs. three) if using standard time of year restrictions.				X	This measure would reduce impacts to EFH and EFH species.

Table 6-2. Environmental Protection Measures (EPMs) that BOEM Could Impose: General Avoidance/Minimization of Potential Impacts to EFH

EPMs and Mitigation Measures to Avoid and Minimize Impacts	Project Component				Expected Effects
	WTGs and OSSs	Inter-array Cable	OEC	O&M Facility	
All intakes for inshore hydraulic dredges should be covered with a mesh screen or screening device that is properly installed and maintained to minimize potential for impingement or entrainment of fish species. The screening device on the dredge intake should prevent the passage of any material greater than 1.25” in diameter, with a maximum opening of 1.25”x 6”. Water intakes should be positioned at an appropriate depth to avoid or minimize the entrainment of eggs and larvae. Intake velocity should be limited to less than 0.5 ft/sec.			X		This measure minimizes potential for impingement or entrainment of EFH species.
To the extent technically and economically feasible, Empire must ensure that all materials used for scour and cable protection consist of natural or engineered stone that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions.	X	X	X		Smaller long-term project footprint limits impacts to EFH and EFH species by minimizing the extent of direct habitat impacts.
Empire will develop and comply with an anchoring plan to reduce impacts on benthic habitats associated with the Proposed Action. This plan should specifically delineate areas of complex habitat around each turbine and cable locations, and identify areas restricted from anchoring. Anchor chains should include midline buoys to minimize impacts to benthic habitats from anchor sweep where feasible. The habitat maps and inshore maps delineating sensitive benthic habitat adjacent to the landfall and O&M facility should be provided to all cable construction and support vessels to ensure no anchoring of vessels be done within or immediately adjacent to these habitats.	X	X	X	X	This measure would minimize anchoring impacts, particularly for sensitive and slow to recover habitats used by EFH species.

EPMs and Mitigation Measures to Avoid and Minimize Impacts	Project Component				Expected Effects
	WTGs and OSSs	Inter-array Cable	OEC	O&M Facility	
Vessel operators would be provided with maps of sensitive hard-bottom habitat in the Project area, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	X	X	X	X	This measure would minimize anchoring impacts, particularly for sensitive and slow to recover habitats used by EFH species.
Empire would develop and implement a monitoring plan for live and hard bottom features that may be impacted by proposed activities. The monitoring plan would also include assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following the Coastal and Marine Ecological Classification Standards (CMECS), including live bottoms (e.g., submerged aquatic vegetation and corals and topographic features. The plan would also include a means of recording observations of any increased coverage of invasive species in the impacted hard-bottom areas.	X	X	X	X	This measure would provide an assessment of the recovery of hard-bottom habitat and the presence of invasive species.

6.3. Mitigation

Empire has not proposed any mitigation measures to offset potential Project impacts on EFH-designated species and EFH. Empire would further evaluate the need for mitigation measures as the Proposed Action progress through development and permitting and in cooperation and coordination with Federal and State jurisdictional agencies and other stakeholders.

6.4. Environmental Monitoring

6.4.1. HRG and Geotechnical Surveys

Empire would conduct high-resolution geophysical (HRG) surveys prior to, during, and after the installation of offshore infrastructure. The purpose of these HRG surveys would be to facilitate installation activities, including that of foundations, wind turbines, OSSs, interarray cables, submarine export cables, and scour protection. These surveys would be performed in the Lease Area, along the ECCs, and at the export cable landfall sites. Equipment used in HRG surveys would include Subsea Positioning / Ultra-short baseline, multi-beam echosounder, SSS, and Obstacle Avoidance Sonar Remotely Operated Vehicle. Geotechnical surveys would examine soil structure and other attributes that, combined with the HRG survey observations, would establish engineering parameters for turbine foundations, substations, cable burial trenches, and other infrastructure. The HRG and geotechnical surveys would also help identify sensitive habitats (e.g., shellfish and SAV beds) and allow these areas to be avoided to the extent practicable for siting of the WTGs, OSSs, and cable routes. Identifying and avoiding and/or minimizing to the extent practicable the disturbance to sensitive seabed habitats would help minimize impacts primarily to benthic EFH habitat and benthic or epibenthic EFH species and/or life stages, with secondary effects on EFH species and/or life stages that prey on benthic and epibenthic organisms.

6.4.2. Fisheries Surveys

Plans for fisheries monitoring are currently under development by Empire Wind.

6.4.3. Benthic Monitoring Plan

Plans for benthic habitat monitoring are currently under development by Empire Wind.

6.4.4. Protected Species Mitigation and Monitoring

As part of the protected species mitigation and monitoring plan, both visual observations and PAM would be used to monitor for marine mammals during HRG surveys and pile driving. Clearance and Shutdown zones would be established to monitor for marine mammals and, if necessary, to either delay the start of operations or shut down operations. For HRG surveys the Clearance and Shutdown zones both range from 100 – 500 meters, depending on the species observed. For vibratory pile driving, the Clearance and Shutdown zones both range from 50 – 1,600 meters, depending on the species observed. For impact pile driving, the Clearance zone ranges from 200 – 5,000 meters and the Shutdown zone ranges from 200 – 1,500 meters, depending on the species observed. These shut down protocols would temporarily reduce the area of effects on EFH-designated species and the prey they feed upon that are within the Clearance and Shutdown zones.

6.5. Adaptive Management Plans

No adaptive management plans have been proposed by the applicant.

6.6. Alternate Project Designs

This section discusses alternative turbine layouts, export cable routes, and dredging activities proposed for the Project. Although all alternatives are not specifically geared towards reducing the impacts on EFH, these alternatives would still benefit and minimize impacts to EFH.

6.6.1. Alternative B – Remove Up to Six WTG Positions from the Northwest End of EW 1

Under Alternative B, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, the EW 1 turbine layout would be modified to remove up to six WTG positions from the northwestern end of EW 1 to reduce impacts at the edge of Cholera Bank and on scenic resources and navigation safety (Figure 6-1). Alternative B would also establish a No Surface Occupancy area where WTG positions would be excluded. The area of EFH temporarily disturbed by impacts of cable emplacement and WTG construction (e.g., injury, mortality, turbidity, sedimentation) and the amount of soft-bottom habitat converted to hard-bottom habitat under Alternative B would be similar to those of the Proposed Action because this alternative would allow for installation of the maximum number of WTGs defined in Empire's PDE. Therefore, impacts on EFH and EFH species under Alternative B are expected to be similar to those of the Proposed Action.

6.6.2. Alternative C – EW 1 Submarine Export Cable Route

Under Alternative C, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, BOEM would approve only one of the two EW 1 submarine export cable route options that traverse either the Gravesend Anchorage Area or the Ambrose Navigation Channel on the approach to SBMT (Figure 6-2). Each of the below sub-alternatives may be individually selected or combined with any or all other action alternatives or sub-alternatives.

- Alternative C-1: Gravesend Anchorage Area. In the vicinity of Gravesend Bay, the EW 1 submarine export cable route would traverse a charted anchorage area identified on NOAA Chart 12402 for the Port of New York (U.S. Coast Guard Anchorage #25).
- Alternative C-2: Ambrose Navigation Channel. In the vicinity of Gravesend Bay, the EW 1 submarine export cable route would traverse the Ambrose Navigation Channel.

The export cable route under Alternative C-2 would be slightly shorter than under the Proposed Action, such that the area of EFH temporarily disturbed by impacts of cable emplacement (e.g., injury, mortality, turbidity, sedimentation) would be slightly reduced under Alternative C-2.

6.6.3. Alternative D – EW 2 Submarine Export Cable Route Options to Minimize Impacts on the Sand Borrow Area

Under Alternative D, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, BOEM would only approve submarine export cable route options for EW 2 that avoid the sand borrow area offshore Long Island (Figure 6-3). The export cable route under Alternative D would require a slightly longer export cable to avoid sand borrow areas offshore of Long Island, such that the area of EFH temporarily disturbed by impacts of cable emplacement (e.g., injury, mortality, turbidity, sedimentation) would be slightly increased under Alternative D.

6.6.4. Alternative E – Setback Between EW 1 and EW 2

Under Alternative E, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. Alternative E would remove seven WTG positions from EW 2 to create a 1-nm setback between EW 1 and EW 2 to improve access for fishing (Figure 6-4). The area of EFH temporarily disturbed by impacts of cable emplacement and WTG construction and the amount of soft-bottom habitat converted to hard-bottom habitat under Alternative E would be similar to those of the Proposed Action because this alternative would allow for installation of the maximum number of WTGs defined in Empire's PDE. Therefore, impacts on EFH and EFH species under Alternative E are expected to be similar to those of the Proposed Action.

6.6.5. Alternative F – Wind Resource Optimization with Modifications for Environmental and Technical Considerations

Under Alternative F, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, the wind turbine layout would be optimized to maximize annual energy production and minimize wake loss while addressing geotechnical considerations as shown on (Figure 6-5).

6.6.6. Alternative G – EW 2 Onshore Cable Route to Reduce Impacts on Tidal Wetlands

Under Alternative G, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and associated export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, EW 2 would use an alternate onshore export cable route option that reduces impacts on tidal wetlands on the onshore cable route segment that crosses Barnum Channel on the approach to the onshore POI. Because Alternative G would result in reduced impacts on tidal wetlands, it is expected to result in reduced impacts on EFH species that rely on tidal wetlands for shelter and foraging along that portion of the cable corridor.

6.6.7. Alternative H – Reductions of Impacts on Aquatic Ecosystems due to Project-Related Upgrades at South Brooklyn Marine Terminal

Under Alternative H, the construction, O&M, and conceptual decommissioning of the 816-MW EW 1 Project and the 1,260-MW EW 2 Project within the Lease Area and would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, construction at the SBMT would use an alternate method of dredge or fill activities requiring a permit from USACE under Section 404(b)(2) that would have the least adverse impact on the aquatic ecosystem. Dredging impacts (i.e., sediment suspension and deposition, habitat disturbance) on EFH and EFH species from dredging activities between the 35th Street and 29th Street piers would be reduced under Alternative H.

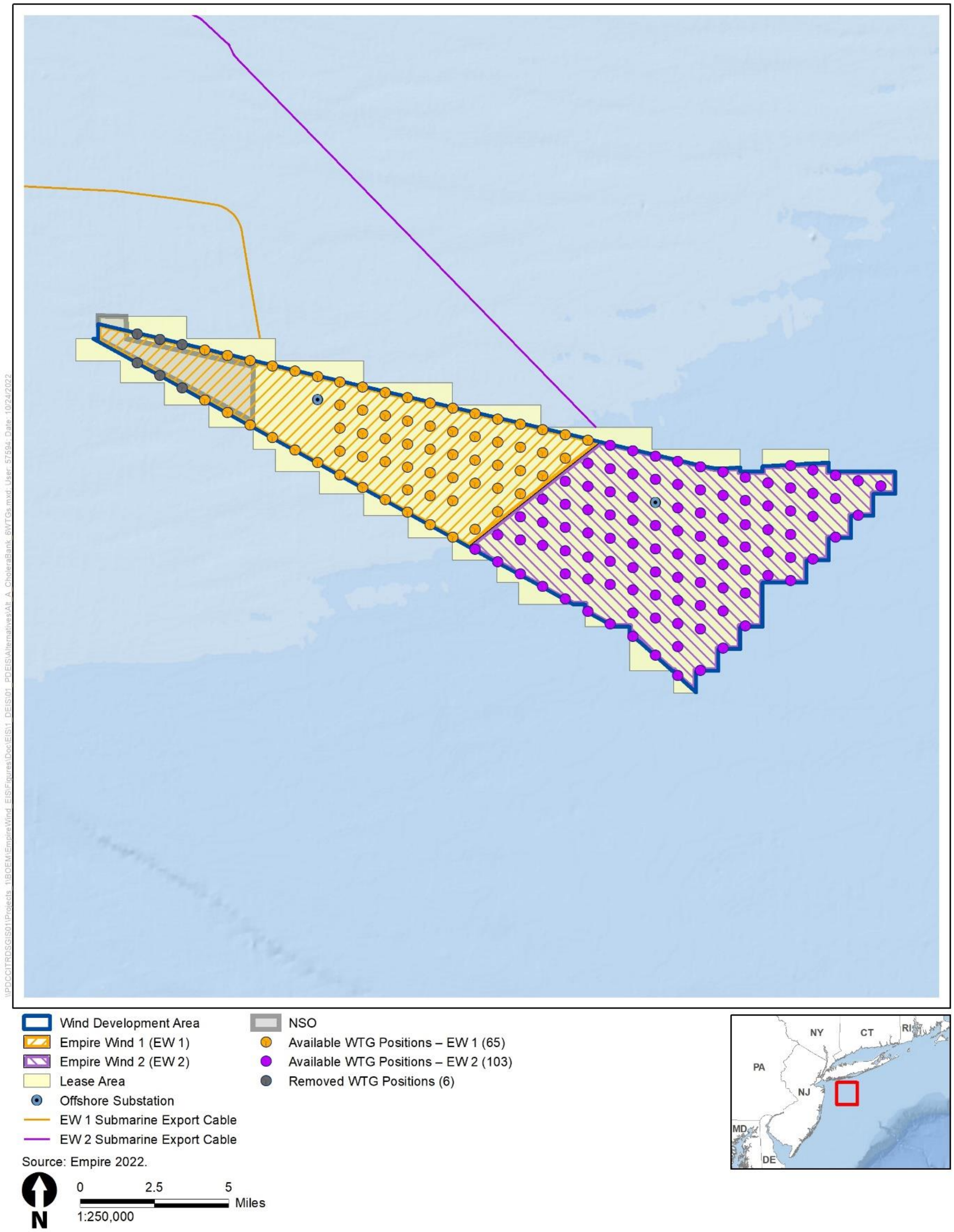

Figure 6-1. Alternative B: Remove Up To Six WTG Positions from the Northwest End of EW 1

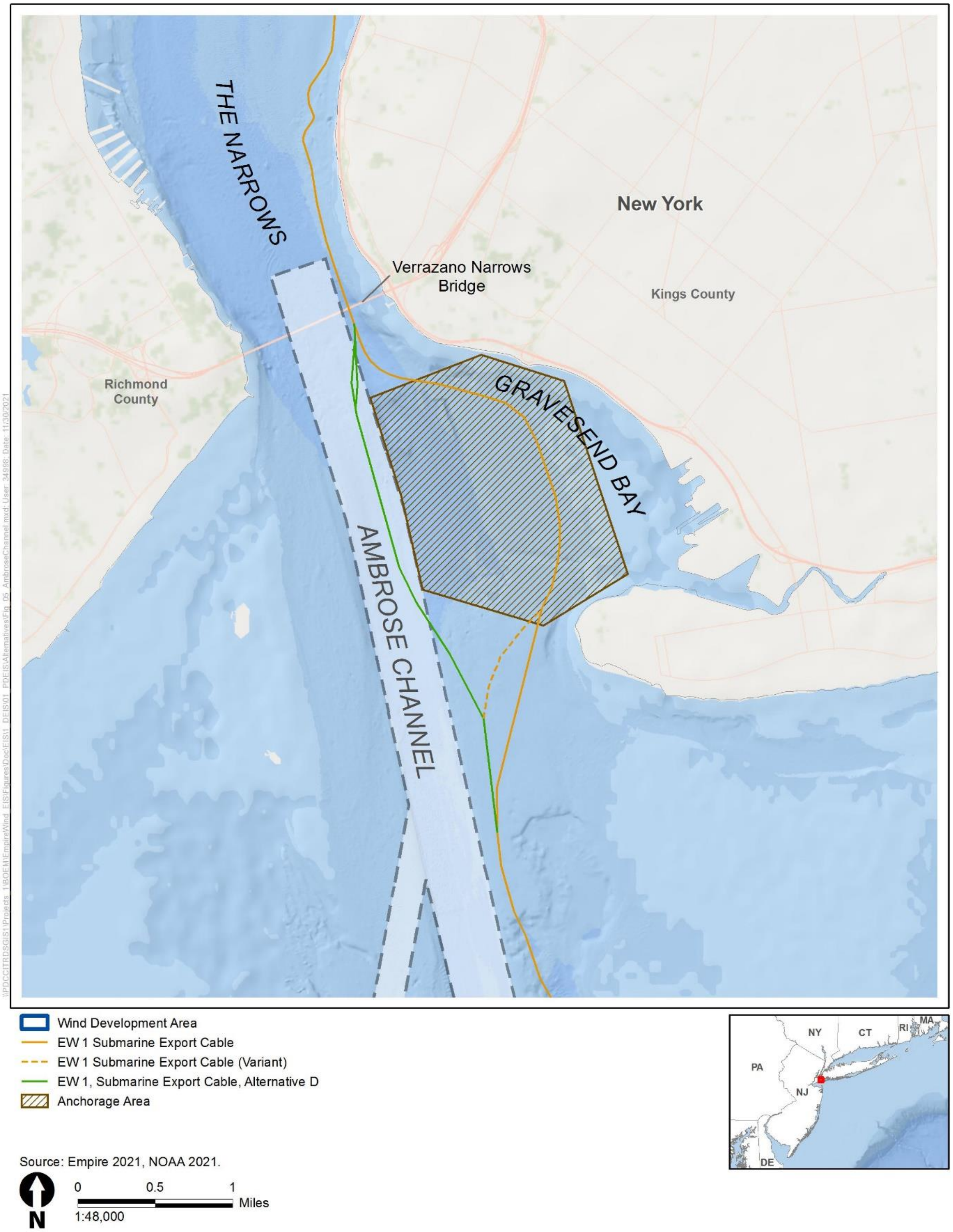

Figure 6-2. Alternative C: EW 1 Submarine Export Cable Route

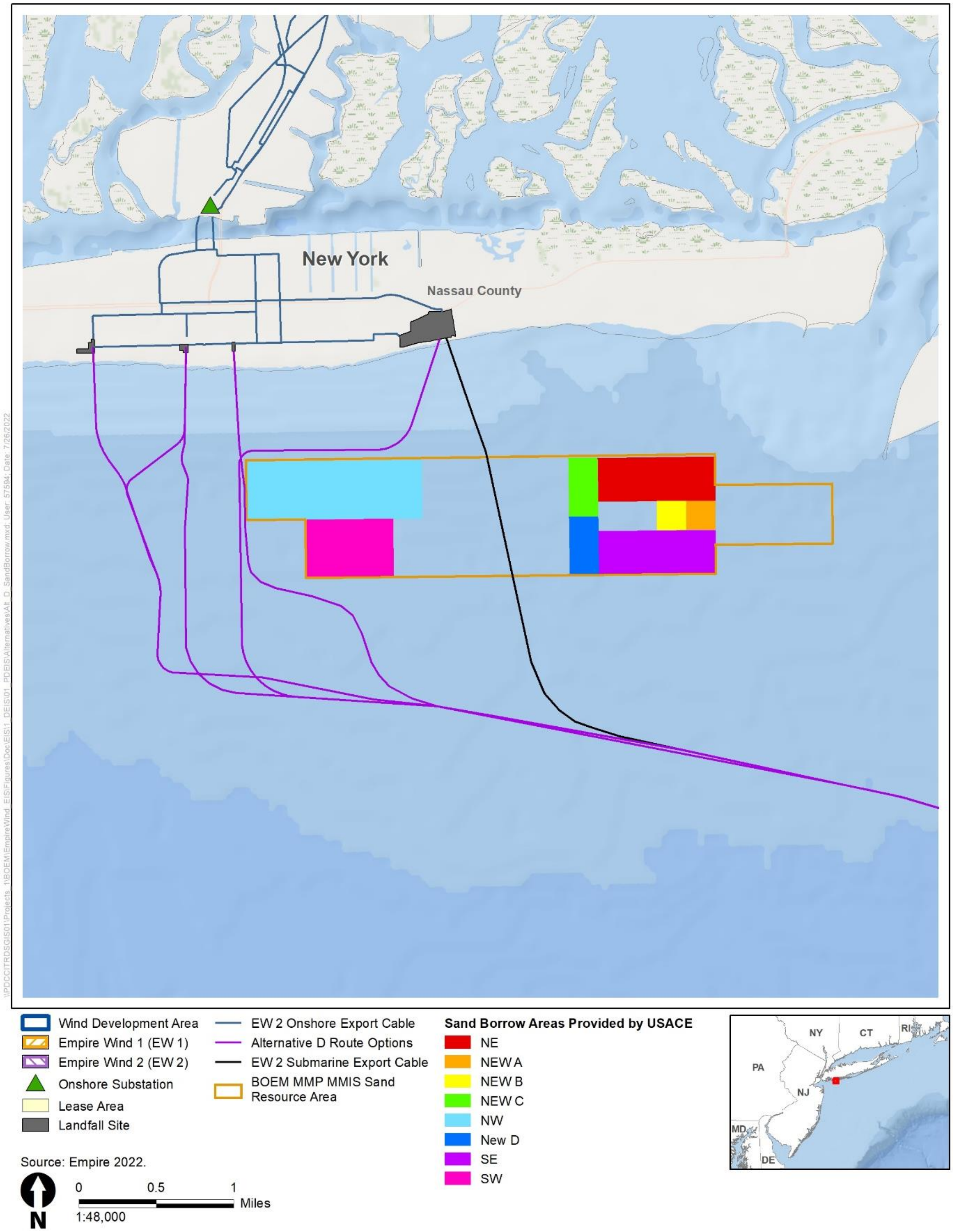

Figure 6-3. Alternative D: EW 2 Submarine Export Cable Route Options to Minimize Impacts on the Sand Borrow Area

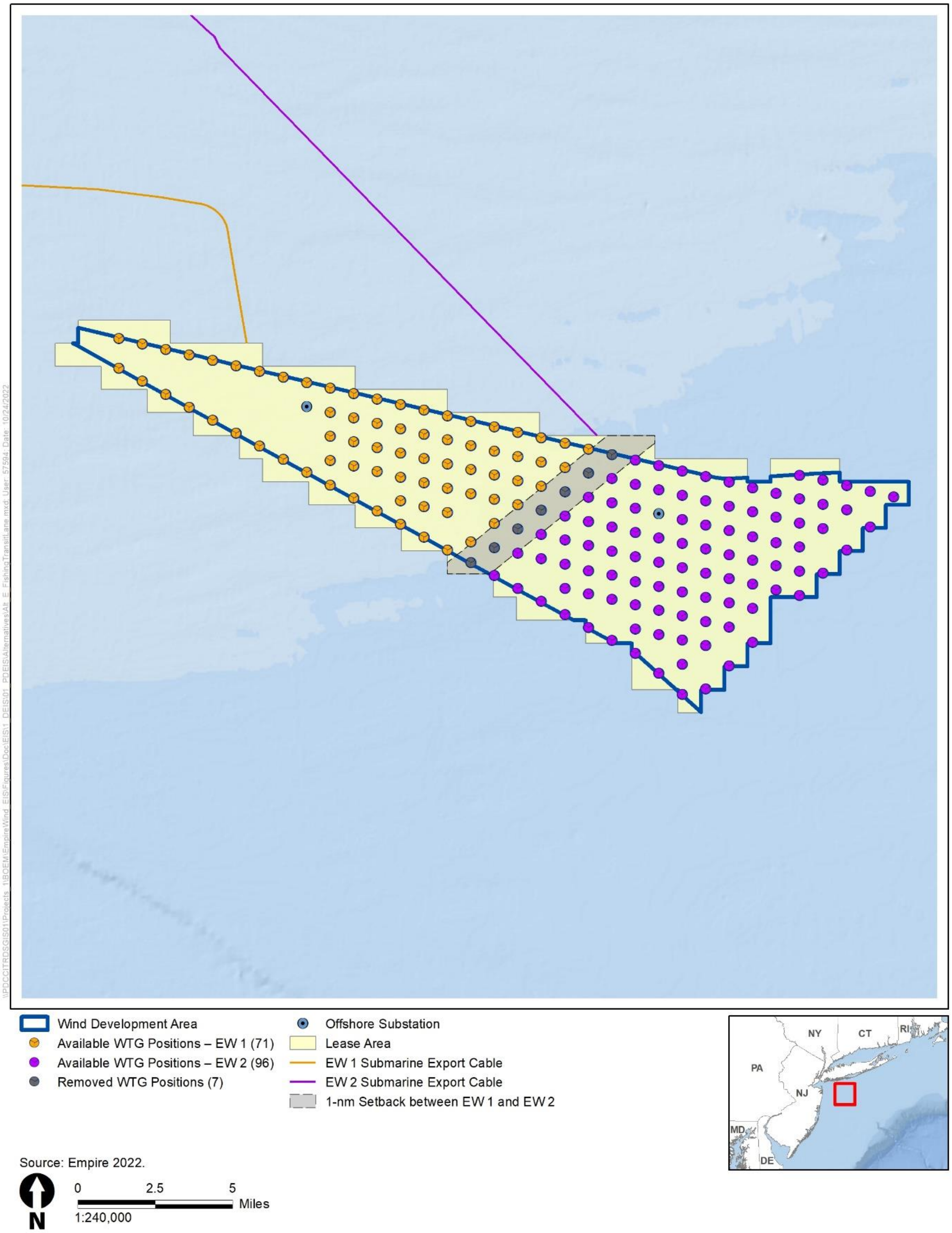

Figure 6-4. Alternative E: Setback Between EW 1 and EW 2

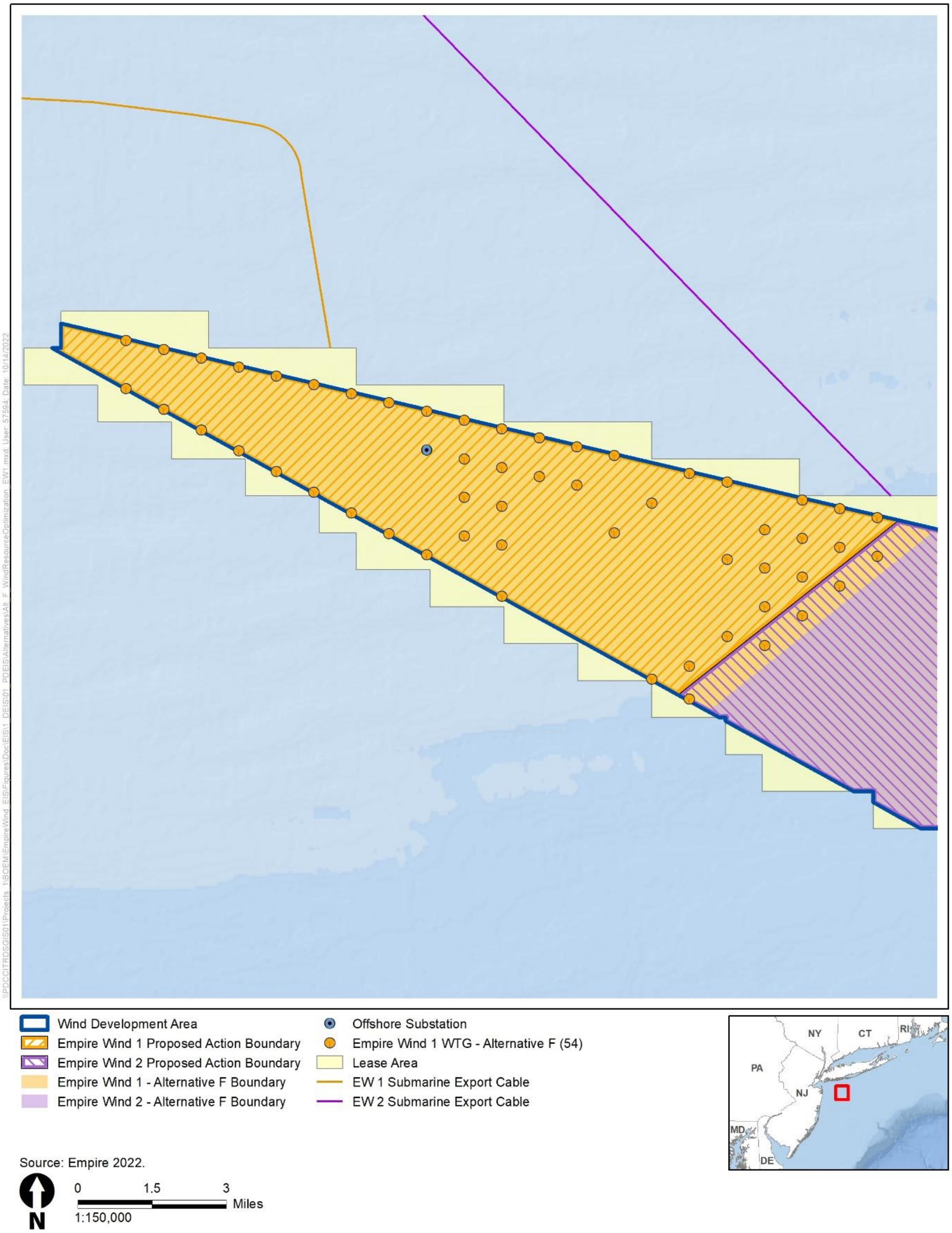

Figure 6-5. Alternative F: Wind Resource Optimization with Modifications for Environmental and Technical Considerations

7. NOAA Trust Resources

Twenty-three species of NOAA Trust Resources have been identified within the general vicinity of the Lease and OEC corridor. Table 7-1 discusses species and life stages within the Project area, as well as the impact determination for each NOAA Trust Resource species.

The following NOAA Trust Resource species or species groups may utilize habitat within the Project area:

- Alewife (*Alosa pseudoharengus*)
- American eel (*Anguilla rostrata*)
- American shad (*Alosa sapidissima*)
- Atlantic croaker (*Micropogonias undulatus*)
- Atlantic menhaden (*Brevoortia tyrannus*)
- Blueback herring (*Alosa aestivalis*)
- Blue crab (*Callinectes sapidus*)
- Blue mussel (*Mytilus edulis*)
- Eastern oyster (*Crassostrea virginica*)
- Gulf stream flounder (*Citharichthys arctifrons*)
- Horseshoe crab (*Limulus polyphemus*)
- Jonah crab (*Cancer borealis*)
- Northern kingfish (*Menticirrhus saxatilis*)
- Northern sand lance (*Ammodytes dubius*)
- Northern sea robin (*Prionotus carolinus*)
- Smallmouth flounder (*Etropus microstomus*)
- Soft-shell clams (*Mya arenaria*)
- Spot (*Leiostomus xanthurus*)
- Spotted hake (*Urophycis regia*)
- Striped bass (*Morone saxatilis*)
- Tautog (*Tautoga onitis*)
- Weakfish (Cynoscion regalis)

Table 7-1. Determination for NOAA trust resources by species or species group

Species	Life Stages within Project Area	Impact Determination	Rationale for Determination
Alewife	Juvenile, Adult	Short-term, long-term, and permanent impacts	Project construction would result in short-term effects (i.e., crushing and burial, entrainment, sediment suspension and deposition, noise, alteration of soft bottom habitat) and long-term effects (i.e., alteration of complex habitat) on EFH. Behavioral effects of suspended sediment from cable emplacement and pile-driving noise would have the greatest areal extent, respectively occurring over estimated areas of up to 119,673 acres and up to 276,786 acres of benthic and pelagic habitat; however, these impacts would occur intermittently at various locations within the Project area and not throughout the entire area for the entire duration of construction. Benthic community structure of disturbed soft-bottom habitat would recovery rapidly, within a few months of the activity, but benthic community structure of disturbed hard-bottom habitat may take several years to recover. Up to 215 acres of soft-bottom benthic habitat would be permanently displaced or altered by placement of the WTG and OSS foundations, scour protection, and cable protection. Once scour protection is colonized it would provide habitat features for species associated with hard substrates. Operational noise and EMF effects would occur throughout the operational lifespan of the Proposed Action but are below established thresholds for injury effects for fish. Collectively, construction related impacts on soft-bottom habitats would be short term, rapidly returning to baseline conditions within minutes to months after the project is completed, whereas construction related impacts on hard-bottom habitats would be long term, requiring years to recover. Permanent habitat alterations would occur in the foundation footprints and in areas where scour and cable protection are required.
American eel	Larvae, Juvenile, Adult		
American lobster	All		
Atlantic croaker	All		
Atlantic menhaden	All		
Blue crab	All		
Blueback herring	Juvenile, Adult		
Gulf stream flounder	All		
Horseshoe crab	All		
Jonah crab	All		
Northern kingfish	All		
Northern sand lance	All		
Northern sea robin	All		
Smallmouth flounder	All		
Spot	All		
Spotted hake	All		
Striped bass	Juvenile, Adult		
Tautog	All		
Weakfish	All		
American shad	Juvenile, Adult		

Species	Life Stages within Project Area	Impact Determination	Rationale for Determination
Bivalves (blue mussel, eastern oyster, soft-shell clam)	All	Short-term, long-term, and permanent impacts	Project construction would result in short-term effects (i.e., crushing and burial, entrainment, sediment suspension and deposition, noise, alteration of soft bottom habitat) and long-term effects (i.e., alteration of complex habitat) on EFH for bivalve species. Effects of suspended sediment and sediment deposition from cable emplacement would occur over estimated areas of up to 44,254 acres and up to 5,983 acres of benthic habitat, respectively. Benthic community structure of disturbed soft-bottom habitat would recovery rapidly, within a few months of the activity, but benthic community structure of disturbed hard-bottom habitat may take several years to recover. Up to 215 acres of soft-bottom benthic habitat would be permanently displaced or altered by placement of the monopile and OSS foundations, scour protection, and cable protection. The Lease Area and OEC have been sited to avoid and minimize overlap of structures with known shellfish habitats in designated EFH. The benthic community structure would adapt and recover rapidly, within a few months of the activity.

8. Conclusions/Determinations

The Proposed Action includes construction, O&M, and decommissioning of the Project components at the end of the 30-year planned lifespan of the Project. These activities may have short-term (i.e., less than 2 years), long-term (greater than 2 years but less than the Project lifespan), and permanent (i.e., the Project lifespan) adverse effects on EFH and EFH-designated species in the Project area. There are forty species of finfish, elasmobranchs, and invertebrates with designated EFH within the Lease Area and OEC corridor. EFH-designated species with one or more demersal life stage are more likely to experience adverse effects than species with only pelagic life stages, primarily resulting from the permanent conversion of benthic habitat following the installation of the turbine foundations, scour protection, and cable protection.

Project construction is expected to cause short-term, long-term, and permanent adverse effects on the environment that could affect habitat suitability for EFH and EFH-designated species. Short-term adverse effects would include those from construction-related underwater noise; crushing and burial; entrainment; increased turbidity and sedimentation; and construction-related disturbances of soft-bottom habitat, which is expected to recover in the short term. Long-term adverse effects would include those from construction-related disturbance of hard-bottom habitat, which may take several years to recover. Adverse effects from Project construction would occur intermittently at varying locations in the Project area during the construction period and may include permanent effects on individual fish and invertebrates in some cases (e.g., crushing and burial, entrainment), but Project construction is not expected to cause permanent effects on EFH.

Project operations and maintenance are expected to cause permanent adverse effects on EFH for some life stages of EFH-designated species. Permanent adverse effects would include those from operational noise; EMF and heat; hydrodynamic changes; and the loss of 215 acres of soft-bottom benthic habitat resulting from the presence of WTG foundations, scour protection, and cable protection. Conversion of benthic habitat resulting from the presence of scour and cable protection and conversion of pelagic habitat resulting from the presence of the WTG and OSS foundations may also cause long-term (i.e., greater than 2 years but less than the Project lifespan) neutral to beneficial effects on EFH-designated species that are associated with complex habitat, depending on whether species experience population growth because of the added habitat or are merely attracted to the habitat.

Table 8.1 details short-term, long-term, and permanent adverse effects on habitat suitability by impact mechanism described in Section 5 for managed species and life stage. The Proposed Action is expected to adversely affect EFH for a species and life stage if: 1) EFH for the designated species and life stage occurs in the Project area, and 2) one or more of the impact mechanisms described in Section 5 is expected to have an adverse effect on the species and life stage.

Table 8-1. Summary of adverse effects of the Proposed Action on EFH for managed species and life stages

				Short-Term Effects					Long-Term Effects	Permanent Effects			
EFH Species Group	EFH Species	Life Stage	Habitat Association	Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance (Soft Bottom)	Habitat Disturbance (Hard Bottom)	Operational Noise	EMF & Heat	Hydrodynamic	Habitat Conversion
Gadids	Atlantic cod	Eggs	Surface	X									
		Larvae	Pelagic	X		X							
		Adult	Benthic complex	X	X		X		X	X			
	Haddock	Larvae	Surface	X									
		Juvenile	Benthic complex	X	X		X		X	X			
	Pollock	Larvae	Pelagic	X		X							
		Juvenile	Benthic complex/non-complex		X		X	X	X				X
	Red hake	Eggs	Surface	X									
		Larvae	Surface	X									
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Silver hake	Eggs	Surface	X									
		Larvae	Surface	X									
		Juvenile	Benthic complex/non-complex	X	X		X	X	X	X			X
		Adult	Benthic complex/non-complex		X		X	X	X				X
	White hake	Juvenile	Pelagic/benthic non-complex		X		X	X					X
Other finfish	Atlantic butterfish	Eggs	Pelagic	X		X							
		Larvae	Pelagic	X		X							
		Juvenile	Pelagic/benthic non-complex	X	X		X	X		X			X
		Adult	Pelagic/benthic non-complex	X	X		X	X		X			X
	Atlantic sea herring	Larvae	Pelagic	X		X							
		Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Black sea bass	Larvae	Benthic complex	X	X		X		X				
		Juvenile	Benthic complex	X	X		X		X	X			
		Adult	Benthic complex	X	X		X		X	X			

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects					Long-Term Effects	Permanent Effects			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance (Soft Bottom)	Habitat Disturbance (Hard Bottom)	Operational Noise	EMF & Heat	Hydrodynamic	Habitat Conversion
Other finfish (cont.)	Bluefish	Eggs	Pelagic	X		X							
		Larvae	Pelagic	X		X							
		Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Monkfish	Eggs	Surface	X									
		Larvae	Pelagic	X		X							
		Juvenile	Benthic complex	X	X		X		X	X			
		Adult	Benthic complex	X	X		X		X	X			
	Ocean pout	Eggs	Benthic complex	X	X		X		X				
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Scup	Eggs	Pelagic			X							
		Larvae	Pelagic			X							
		Juvenile	Benthic non-complex/complex	X	X		X	X	X	X			X
		Adult	Benthic non-complex/complex	X	X		X	X	X	X			X
Flatfish	Windowpane flounder	Eggs	Surface	X									
		Larvae	Pelagic	X		X							
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Winter flounder	Eggs	Benthic non-complex		X		X	X					X
		Larvae	Pelagic/benthic non-complex	X	X	X	X	X	X				X
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Witch flounder	Eggs	Surface	X									
		Larvae	Surface	X									
		Adult	Benthic non-complex	X	X		X	X		X			X

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects					Long-Term Effects	Permanent Effects			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance (Soft Bottom)	Habitat Disturbance (Hard Bottom)	Operational Noise	EMF & Heat	Hydrodynamic	Habitat Conversion
Flatfish (cont.)	Yellowtail flounder	Eggs	Surface	X									
		Larvae	Surface	X									
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Summer flounder	Eggs	Pelagic	X		X							
		Larvae	Pelagic	X		X							
		Juvenile	Benthic non-complex/complex	X	X		X	X	X	X			X
		Adult	Benthic non-complex/complex	X	X		X	X	X	X			X
Highly migratory species	Atlantic mackerel	Eggs	Pelagic	X		X							
		Larvae	Pelagic	X		X							
		Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Albacore tuna	Juvenile	Pelagic	X						X			
	Atlantic bluefin	Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Atlantic skipjack	Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Atlantic yellowfin	Juvenile	Pelagic	X						X			
Sharks	Blue shark	Neonate/YOY	Pelagic	X						X			
		Juvenile	Pelagic	X						X			
		Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Common thresher	Neonate/YOY	Pelagic	X						X			
		Juvenile	Pelagic	X						X			
		Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects					Long-Term Effects	Permanent Effects			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance (Soft Bottom)	Habitat Disturbance (Hard Bottom)	Operational Noise	EMF & Heat	Hydrodynamic	Habitat Conversion
Sharks (cont.)	Dusky shark	Neonate/YOY	Pelagic	X						X			
		Juvenile	Pelagic	X						X			
		Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Sand tiger shark	Neonate/YOY	Benthic complex/non-complex	X	X		X	X	X	X			X
		Juvenile	Benthic complex/non-complex	X	X		X	X	X	X			X
		Subadult	Benthic complex/non-complex	X	X		X	X	X	X			X
	Sandbar shark	Neonate/YOY	Benthic non-complex	X	X		X	X		X			X
		Juvenile	Benthic non-complex	X	X		X	X		X			X
		Subadult	Benthic non-complex	X	X		X	X		X			X
		Adult	Benthic non-complex	X	X		X	X		X			X
	Shortfin mako	Neonate/YOY	Pelagic	X						X			
		Juvenile	Pelagic	X						X			
		Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Tiger shark	Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			
	White shark	Neonate/YOY	Pelagic	X						X			
		Juvenile	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Smooth dogfish	Juvenile	Pelagic	X						X			
		Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			
	Spiny dogfish	Subadult	Pelagic	X						X			
		Adult	Pelagic	X						X			

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects					Long-Term Effects	Permanent Effects			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance (Soft Bottom)	Habitat Disturbance (Hard Bottom)	Operational Noise	EMF & Heat	Hydrodynamic	Habitat Conversion
Skates	Clearnose skate	Juvenile	Benthic non-complex/complex		X		X	X	X	X			X
		Adult	Benthic non-complex/complex		X		X	X	X	X			X
	Little Skate	Juvenile	Benthic non-complex/complex	X	X		X	X	X	X			X
		Adult	Benthic non-complex/complex		X		X	X	X	X			X
	Winter skate	Juvenile	Benthic non-complex/complex	X	X		X	X	X	X			X
		Adult	Benthic non-complex/complex	X	X		X	X	X	X			X
Invertebrates	Atlantic sea scallop	Eggs	Benthic complex	X	X		X		X				
		Larvae	Pelagic/benthic complex	X	X	X	X		X				
		Juvenile	Benthic complex	X	X		X		X		X		
		Adult	Benthic complex	X	X		X		X		X		
	Atlantic surf clam	Juvenile	Benthic non-complex	X	X		X	X			X		X
		Adult	Benthic non-complex	X	X		X	X			X		X
	Ocean quahog	Juvenile	Benthic non-complex	X	X		X	X			X		X
		Adult	Benthic non-complex	X	X		X	X			X		X
	Longfin squid	Eggs	Benthic complex	X	X		X		X				
		Juvenile	Pelagic	X									
		Adult	Pelagic	X									

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10. Appendices

10.1. List of Supporting Documents

The following documents support this EFH assessment.

- Transmitted to NMFS POC concurrent with transmittal of revised EFH assessment on February 13, 2023.
    - AECOM. 2022. Environmental Analysis of the South Brooklyn Marine Terminal Port Infrastructure Improvement Project. 225 pp.
    - AECOM. 2022. Permit Information Packet and Supporting Documentation: South Brooklyn Marine Terminal Port Infrastructure Improvement Project USACE Application # NAN 2022 00900 EMI. 102 pp.
    - AECOM. 2022. Permit Information Packet and Supporting Documentation: South Brooklyn Marine Terminal Port Infrastructure Improvement Project USACE Application # NAN 2022 00900 EMI. Appendix C: Full Benthic Macroinvertebrate Data. 3 pp.
- Transmitted to NMFS POC concurrent with transmittal of the PDEIS.
    - Empire Wind Construction and Operations Plan
- Transmitted to NMFS POC on August 10, 2022.
    - COP Appendix J, Sediment Transport Analysis, May 2022
    - COP Appendix M-1, Underwater Acoustic Assessment, June 2022
    - COP Appendix M-2, Acoustic Modeling 6-13-22
    - COP Appendix T, Benthic Resource Characterization Reports, May 2022
    - COP Appendix EE, Offshore EMF
    - Empire Wind Benthic Mapbooks, May 2022
    - Fisheries and Benthic Monitoring Plan Scope/Outline, August 2022

10.2. Data Collection and Mapping Methodologies

Empire conducted six site-specific geophysical, geotechnical, and benthic surveys that included the Lease Area and the submarine export cable siting corridors from March 2018 through May 2021 (Figure 3-1). Each survey was designed using guidance available at the time, publicly available databases, regional surveys, and resource reports relevant to the project area (e.g., Battista et al. 2019; NYSERDA 2017; Guida et al. 2017; NEFMC 2017; NOAA Fisheries 2017a; MAFMC 2016, 2017). Peer-reviewed literature was incorporated as appropriate, in keeping with BOEM guidance.

Empire augmented their site-specific surveys with the following data sources to characterize the distribution and relative abundance of fishes and invertebrates in the Project Area:

- Beam trawls and grab samples collected in 2016 by BOEM for preliminary characterization of the Lease Area (Guida et al. 2017);
- Northeast Fisheries Science Center (NEFSC) seasonal trawls and beam trawls (NEFSC 2007, 2009);
- Video and still images collected by National Ocean Service, National Centers for Coastal Ocean Science for BOEM at almost 400 locations in the Lease Area (Battista et al. 2019);

- NEFSC Sea Scallop Dredge and Habitat Camera Surveys, NEFSC Clam Survey (NEFSC 2018), NEFSC Ecosystem Monitoring Cruises (ichthyoplankton and zooplankton), New Jersey Department of Environmental Protection Division of Fish and Wildlife Ocean Trawl Survey, Northeast Area monitoring and Assessment Program Nearshore Trawl Survey (summarized in NYSERDA 2017); NEFSC Multispecies Bottom Trawls (NEFSC 2018, 2019); and
- Other reports and publications (e.g., NAS 2018; Walsh and Guida 2017; Hare et al. 2016; Walker et al. 2016 [scallop survey]), and others.

10.2.1. EW 1 and EW 2 Lease Areas

Empire conducted site-specific geophysical, geotechnical, and benthic surveys across the Lease Area from March 2018 through December 2018 (see Figure 3-1, above). Empire conducted additional geotechnical surveys of the Lease Area in July 2019 and again in June and July 2020. Empire designed the survey of the Lease Area in accordance with BOEM's site characterization requirements (30 CFR § 585.626) recommending that developers use existing data for characterizing benthic habitats to the extent feasible. NOAA and BOEM cooperated to conduct extensive acoustic and sediment sampling, and ground validation studies in the Lease Area to provide baseline habitat characterization suitable for impact assessment, including 400 benthic grab samples of the Lease Area (Battista et al. 2019). Empire's survey augmented the existing 400 grab samples and Lease-wide high-resolution geophysical data provided by NOAA and BOEM with 82 grab samples and still imagery and towed video to characterize the area surrounding each grab sample (Table 10-1). The resulting sample densities in the Lease Area were 1.7 samples per km^2 in the EW 1 Lease Area and 1.3 samples per km^2 in the EW 2 Lease Area.

Empire contracted Alpine Ocean Seismic Survey Inc. (Alpine) to perform the surveys of the Lease Area using survey vessels RV Shearwater and RV Ocean Researcher. The survey equipment and scope included, but was not limited to, the following:

- Gridded survey lines at a spacing of approximately 98 by 1,640 feet (ft, 30 by 500 meters [m]);
- Depth sounding (multibeam echosounder) to determine site bathymetry and elevations;
- Magnetic intensity measurements (gradiometer) for detecting local variations in the regional magnetic field from geological strata and potential ferrous objects on and below the bottom;
- Seafloor imaging (sidescan sonar survey) for seabed sediment classification purposes, to identify natural and man-made acoustic targets on the seabed, as well as any anomalous features;
- Shallow penetration sub-bottom profiler to map the near-surface stratigraphy (from seabed surface to 16.4 ft [5 m] below seabed) soils below the seabed;
- Medium penetration sub-bottom profiler to map deeper subsurface stratigraphy as needed (soils down to 246-328 ft [75-100 m] below seabed);
- Cone penetrometer tests and vibracores in the Lease Area and along the submarine export cable siting corridors; and
- Sediment grab samples and drop-down video images at 67 sampling locations to support the interpretation of geophysical data to characterize surficial sediment conditions and benthic habitat, including macrofaunal analysis with samples sieved at 0.5-millimeter mesh size.

Site-specific and Project-specific geophysical survey data (multibeam echo sounder and side-scan sonar) were used to support the characterization of seabed conditions. Sediment grab samples were analyzed for grain size distribution, total organic carbon, and benthic infauna (identified and classified according to the

Coastal and Marine Ecological Classification Standard [Federal Geographic Data Committee 2012]). Digital imagery was reviewed to aid in identification of key habitat types, macroinvertebrates, and fish.

Empire's survey results were consistent with Battista et al. (2019): substrate is relatively uniform throughout the Lease Area and benthic species assemblages are not well-correlated with small variations in substrate type. Based on these observations, Empire concluded that no additional benthic surveys in the Lease Area were necessary.

10.2.2. Submarine Export Cable Siting Corridors

Empire conducted two benthic surveys in the 10.8-km EW 1 export cable siting corridor, which included full high-resolution geophysical coverage, sediment grab and SPI samples, and underwater photos and video (see Table 10-1). Empire contracted Inspire, LLC (Inspire) to conduct benthic sampling along the entirety of the EW 1 siting corridors in July 2019 (see Figure 3-1, above). The sampling methods differed from the initial survey of the Lease Area in that sediment profile imagery (SPI) rather than grab samples was used to characterize benthic habitats. The interpretation of benthic substrate indicated by backscatter was well-correlated with SPI results. Grain size distribution was analyzed in sediment grab samples to ground-truth the SPI results; no infauna or epifauna were sampled. Empire conduced additional surveys in the EW 1 siting corridor in November and December 2020 (see Figure 3-1, above). Altogether, 117 benthic samples were collected within what is currently defined as the EW 1 siting corridor (10.8 samples per km).

Empire conducted three benthic surveys in the 39.6-km EW 2 export cable siting corridor, which included full high-resolution geophysical coverage, sediment grab and SPI samples, and underwater photos and video (see Table 10-1). In addition to the July 2019 survey, which included the portion of the EW 2 siting corridor in state waters, additional surveys were conducted in 2020 and 2021 to characterize previously unsurveyed portions of the EW 2 siting corridor (see Figure 3-1, above). Empire contracted Gardline Limited to characterize surficial sediment and provide benthic habitat classifications in the offshore portion of the EW 2 siting corridor. The survey spanned from October 2020 through April 2021 and employed multi-beam echo sounder, side scan sonar, magnetometer, shallow- and medium-penetration sub-bottom profiler, shallow water camera system, modified Van Veen grab and Day grab, and water quality profiler data. Additionally, Empire contracted Alpine to perform a high-resolution geophysical survey at the EW 2 landfall. The survey was conducted in April and May 2021 and employed multi-beam echo sounder, ultra-short baseline, sound velocity profiler, modified Van Veen grab, shallower water camera system, and water quality profiler data. The surveys corroborated characterizations of softbottom habitat in previously surveyed portions of the EW 2 siting corridor and detected novel hardbottom (e.g., cobbles, boulders) in previously unsurveyed portions of the corridor. Altogether, Empire conducted full high-resolution geophysical surveys and collected grab samples and underwater still and video images at 104 locations along the 39.6-km EW 2 export cable siting corridor (2.6 samples per km).

Table 10-1. Site-specific benthic surveys conducted by Empire

		Sediment Grabs (Benthic Infauna)		Benthic Imagery		Description of Survey	
Project Subarea	Sediment Grabs (Grain Size)	Method	Sample Number	Method	Sample Number	Sample Dates	Surveyor
Lease Area							
Site Assessment Report	15 (3 grabs at 5 stations)	0.1-m^2 Day grab	15 (3 grabs at 5 stations)	Drop-down still images	80	2018 Mar-Apr	Alpine/Gardline
COP Benthic Habitat Characterization Report	67	0.04-m^2 Ted Young modified van Veen sampler; µm sieve; CMECS	67	Drop-down still images and 600-m towed video transects	3,082 images (2,469 still images and 613 video snapshots)	2018 Jun-Dec	Alpine/Gardline
Offshore Export Cable Corridors							
Benthic Assessment Survey Report (EW 1 and EW 2)	16	No organisms collected		SPI/SPV	172	2019 July	Inspire
2020 Benthic Survey Report (EW 1)	74 (3 grabs at 26 stations)	0.1-m^2 modified van Veen sampler	26	600-m towed video transects	26 transects; 18 hours of video; 2,222 still images and 370 video snapshots	2020 Nov-Dec	Alpine/RPS
Habitat Characterization Report (EW 2)	37	Modified Day Grab/van Veen	37	Drop-down still images and 600-m towed video transects	15 transects; 1,683 still images and 227 video snapshots	2020 Oct-2021 Apr	Gardline
2021 Benthic Survey Report (EW 2)	36 (3 grabs at 12 stations)	0.1-m^2 modified van Veen sampler	36 (3 grabs at 12 stations)	Drop-down still images and 600-m towed video transects	12 transects (5 with useable images); ~3 hours of video; 712 still images	2021 Apr-May	Alpine/RPS

10.3. Additional EFH Information

10.3.1. Summary of Benthic Habitat Impacts within the Project Area

Proposed Project Design			Alternative	Benthic Habitat Impacts (acres)			
				Soft Bottom	Heterogeneous	Complex	Total
Wind Turbine Area, Alternative A – Proposed Action							
Wind Turbine Generators	Permanent	Foundations	9.6-m Monopile	2.3	0.0	0.3	2.6
			11-m Monopile	3.0	0.0	0.4	3.4
		Scour Protection	9.6-m Monopile	111.5	0.7	12.1	124.2
			11-m Monopile	115.6	0.7	12.5	128.8
	Temporary	Seafloor Disturbance	9.6-m Monopile	65.1	0.3	6.6	71.9
			11-m Monopile	65.1	0.3	6.6	71.9
Offshore Substation Foundations	Permanent	Foundations	2.5-m Piled Jacket	1.8	0.0	0.0	1.8
		Scour Protection		2.5	0.0	0.0	2.5
	Temporary	Seafloor Disturbance		1.0	0.0	0.0	1.0
Inter-Array Cables	Permanent	Cable Protection	--	37.2	1.1	3.5	41.7
	Temporary	Cable Installation	--	740.5	21.2	69.2	830.9

Proposed Project Design			Alternative	Benthic Habitat Impacts (acres)			
				Soft Bottom	Heterogeneous	Complex	Total
Empire Wind 1 Offshore Export Cable, Alternative C1 – Gravesend Anchorage Area							
Offshore Export Cables	Permanent	Cable Protection	--	29.1	2.6	10.6	42.4
	Temporary	Cable Installation	--	264.7	23.8	96.6	385.2
Empire Wind 1 Offshore Export Cable, Alternative C2 – Ambrose Navigation Channel							
Offshore Export Cables	Permanent	Cable Protection	--	28.2	3.2	10.6	42.0
	Temporary	Cable Installation	--	256.6	29.3	95.9	381.8
Empire Wind 2 Offshore Export Cable, Landfall A – Riverside Boulevard in City of Long Beach							
Offshore Export Cables	Permanent	Cable Protection	--	24.8	0.0	17.3	42.1
	Temporary	Cable Installation	--	224.7	0.0	158.9	383.6
Empire Wind 2 Offshore Export Cable, Landfall B – Monroe Boulevard in City of Long Beach							
Offshore Export Cables	Permanent	Cable Protection	--	23.8	0.0	17.4	41.2
	Temporary	Cable Installation	--	215.4	0.0	159.7	375.0
Empire Wind 2 Offshore Export Cable, Landfall C – Lido Beach in Town of Hempstead							
Offshore Export Cables	Permanent	Cable Protection	--	24.1	0.0	15.1	39.2
	Temporary	Cable Installation	--	218.3	0.0	138.3	356.6
Empire Wind 2 Offshore Export Cable, Landfall C, Alternative D – Cable Route Options to Minimize Impacts on the Sand Borrow Area							
Offshore Export Cables	Permanent	Cable Protection	--	25.8	0.0	17.3	43.1
	Temporary	Cable Installation	--	234.2	0.0	158.4	392.6
Empire Wind 2 Offshore Export Cable, Landfall E – Corner of Laurelton Boulevard and West Broadway in City of Long Beach							
Offshore Export Cables	Permanent	Cable Protection	--	25.0	0.0	17.4	42.4
	Temporary	Cable Installation	--	226.8	0.0	159.6	386.4