Maryland Offshore Wind Project Essential Fish Habitat Assessment

For the National Marine Fisheries Service
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U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

BOEM
Bureau of Ocean Energy Management

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Abbreviations and Acronyms

µpa	micropascal
AC	alternating current
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
COP	construction and operations plan
CTV	crew transfer vessel
dB	decibels
DelDOT	Delaware Department of Transportation
DNREC	Department of Natural Resources and Environmental Control
DOI	U.S. Department of the Interior
EA	environmental assessment
EEZ	exclusive economic zone
EFH	essential fish habitat
EIS	environmental impact assessment
EMF	electromagnetic force
EPA	U.S. Environmental Protection Agency
FHWG	Fisheries Hydroacoustic Working Group
FMP	Fishery management plan
GW	gigawatt
FONSI	Finding of No Significant Impact
HAPC	Habitat Areas of Particular Concern
HDD	horizontal directional drilling
IPF	impact-producing factor
kJ	kilojoule
LME	Large Marine Ecosystem
L_{pk}	Zero-to-peak sound pressure level
MAFMC	Mid Atlantic Fisheries Management Council
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	Megawatt
NBDC	National Buoy Data Center
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
OCS	Outer Continental Shelf
OEM	Original equipment manufacturer
O&M	operations and maintenance
OREC	offshore renewable energy credit
OSRP	oil spill response plan

OSS	offshore substation
PAH	polycyclic aromatic hydrocarbons
PDE	project design envelope
POI	point of interconnection
re	referenced to
ROV	remotely operated vehicle
ROW	right-of-way
SAFMC	South Atlantic Fishery Management Council
SAP	site assessment plan
SAV	submerged aquatic vegetation
SEL_{24hr}	sound exposure level
TP	transition piece
TSHD	trailing suction hopper dredge
TSS	total suspended solids
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
UXO	unexploded ordinance
WEA	wind energy area
WTG	wind turbine generator

1 Introduction and Background

In the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Congress recognized that one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Congress also determined that habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States. As a result, one of the purposes of the MSA is to promote the protection of Essential Fish Habitat (EFH) in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat.

The 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 United States Code (U.S.C.) § 1855(b)(2). This process is guided by the requirements of the EFH regulation at 50 Code of Federal Regulations (CFR) 600.905. The Bureau of Ocean Energy Management (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) and/or the U.S. Environmental Protection Agency [EPA]).

The USACE intends to utilize this EFH Assessment to meet its responsibilities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. These permits may include the construction of offshore wind turbine generators (WTGs), scour protection around the base of the WTGs, submarine inter-array cables connecting the WTGs, offshore substations (OSSs), inter-array cables connecting the WTGs to the OSSs, and installation of export cables from the OSSs to the onshore interconnection facilities. US Wind submitted the initial draft application materials for all required USACE permits and approvals to the USACE in February 2023. US Wind submitted the permit application materials to the USACE in October 2023. The USACE issued a public notice on the application with a public comment period from October 6 to December 5, 2023.

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). The National Oceanic and Atmospheric Administration’s (NOAA’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.

2 Proposed Action

The Proposed Action is to construct, operate, maintain, and decommission an up to 2.2-GW wind energy facility in the Lease Area, 10.1 miles (16.2 kilometers) off the coast of Maryland. The project design envelope (PDE) would consist of up to 121 WTGs—ranging from 14 to 18 megawatt each, up to four offshore substations (OSSs), inter-array cables in strings of four to six linking the WTGs to the OSSs, and substation interconnector cables linking the OSSs to each other. The Proposed Action includes a 1 nautical mile (1.9 kilometer) setback from the traffic separation scheme (TSS) from Delaware Bay which removes 7 of the 121 WTG positions, resulting in a total of 114 WTGs in the Proposed Action. Up to four offshore export cables (installed within one Offshore Export Cable Route) would transition to a landfall at 3R's Beach via horizontal directional drilling (HDD). From the landfall, the cables would continue along the Inshore Export Cable Route within Indian River Bay to connect to an onshore substation adjacent to the point of interconnection (POI) at the Indian River substation owned by Delmarva Power and Light in Dagsboro, Delaware. The POI will include an expansion of the existing substation and construction of three new substations adjacent to the existing substation (US Wind 2023).

Development of the wind energy facility would occur within the range of design parameters (i.e., Project Design Envelope [PDE]). This EFH analyzes the maximum case scenario; any potential variances in the Project build-out, as defined in the PDE. The key components of the Project are summarized in Table 2-1 and the description of the geographic scope of potential impacts (e.g., total seabed area affected by project activities) is in Section 2.1. Sections 2.2 through 2.4 include a description of construction and installation, operations, and maintenance (O&M), and decommissioning activities to be undertaken for the Proposed Action that may affect EFH.

Table 2-1. Summary of the Proposed Action PDE

Project Parameter Details
General Project Layout and Size
• Up to 121 WTGs. • Project phases up to approximately 2 GW of nameplate capacity. • Target commercial operation date of MarWin is December 2025. • Target commercial operations for Momentum Wind and any future build out of the remaining Lease Area is 2026 and 2027.

Project Parameter Details
WTGs and Foundations
• WTG Size: 14.7 to 18 megawatt. • Spacing: 0.77 nautical mile (1.43 kilometer) east to west and 1.02 nautical mile (1.89 kilometer) north to south. • Monopile foundations: large diameter coated steel tubes driven into the seabed. • Foundation installation using hammered pile driving. • Layers of rock will be used for scour protection around the foundations.
OSSs and Foundations
• Up to four OSSs. • OSS foundations will be monopiles, jackets on piles, or jackets on suction buckets.
Met Tower
• 328-foot (100 meter) tall mast on a 3,000 square feet (279 square meters) deck atop a Braced Caisson foundation - includes measurement devices to record winds and waves.
Inter-array Cables
• 66 kV AC, 3-core cable. • Maximum length: 125.6 miles (202.2 kilometers). • Target burial depths: approximately 3.3 to 9.8 feet (1 to 3 meters), not more than 13.1 feet (4 meters). • Installed using towed or self-driving jet plow.
Offshore Export Cables
• Up to four 230 to 275 kV AC, 3-core cable. • Maximum length: 142.5 miles (229.3 kilometers). • Target burial depths: approximately 3.3 to 9.8 feet (1 to 3 meters), not more than 13.1 feet (4 meters). • Installed using towed or self-driving jet plow. • Cable crossings or hard bottoms may require additional protection such as mattresses, rock placement, or cable protection systems.
Landfall for the Offshore Export Cable
• Two potential landing locations, both in Delaware Seashore State Park parking lots at 3R's Beach and Tower Road. • Landfall cable transitions will be completed via HDD.

Project Parameter Details
Inshore Export Cable
• Up to four 3-phase 230 to 275 kV AC or 12 single-phase inshore export cables. • Maximum length of inshore export cable: 42.24 miles (68 kilometers). • Traverses Indian River Bay after landfall and connects to onshore substations next to the POI at Indian River Substation. • Inshore export cable installed using barge mounted vertical injector, which fluidizes the sediment. • Multiple barges and moved along the route using a six-point anchor system. • Target burial depths: approximately 3 to 7 feet (1 to 2 meters).
O&M Facility
• Located on two adjacent sites on the waterfront in West Ocean City, Maryland. • Comprised of onshore office, crew support, and warehouse spaces with associated parking • Quayside and berthing areas for four or more crew transfer vessels (CTVs) to support the onloading and offloading of parts, tools, and personnel needed for O&M on the WTGs and OSSs. • Site improvements would include the replacement of a timber pier and the existing bulkhead/quay wall.

Source: Appendix C, BOEM 2023a

AC = alternating current; GW = gigawatt; HDD = horizontal directional drilling; kV = kilovolt; MW = megawatt; OSS = offshore substation; POI = point of interconnection; WTG = wind turbine generator

2.1 Project Area

The Project area (Figure 2-1) comprises the project footprint for the WTGs, OSSs, MET tower, inter-array cables, offshore and inshore export cables, O&M facility, port facilities, and all areas affected by the construction and operation of these facilities.

The offshore Project components of the Proposed Action include WTGs and their foundations, OSSs and their foundations, Met Tower, scour protection for foundations, inter-array and substation interconnection cables, offshore export cables and seaward HDD exit pits (these elements collectively compose the Offshore Project area).

The onshore Project components include the landfall site, terrestrial onshore export cables, onshore substations and O&M facility (these elements collectively compose the Onshore Project area). The inshore Project components include the HDD exit pits in Indian River Bay, inshore export cables within Indian River Bay and Indian River from the landfall site to the connection with the onshore substation at the Point of Interconnection at the existing Indian River substation (these elements collectively compose the Inshore Project area).

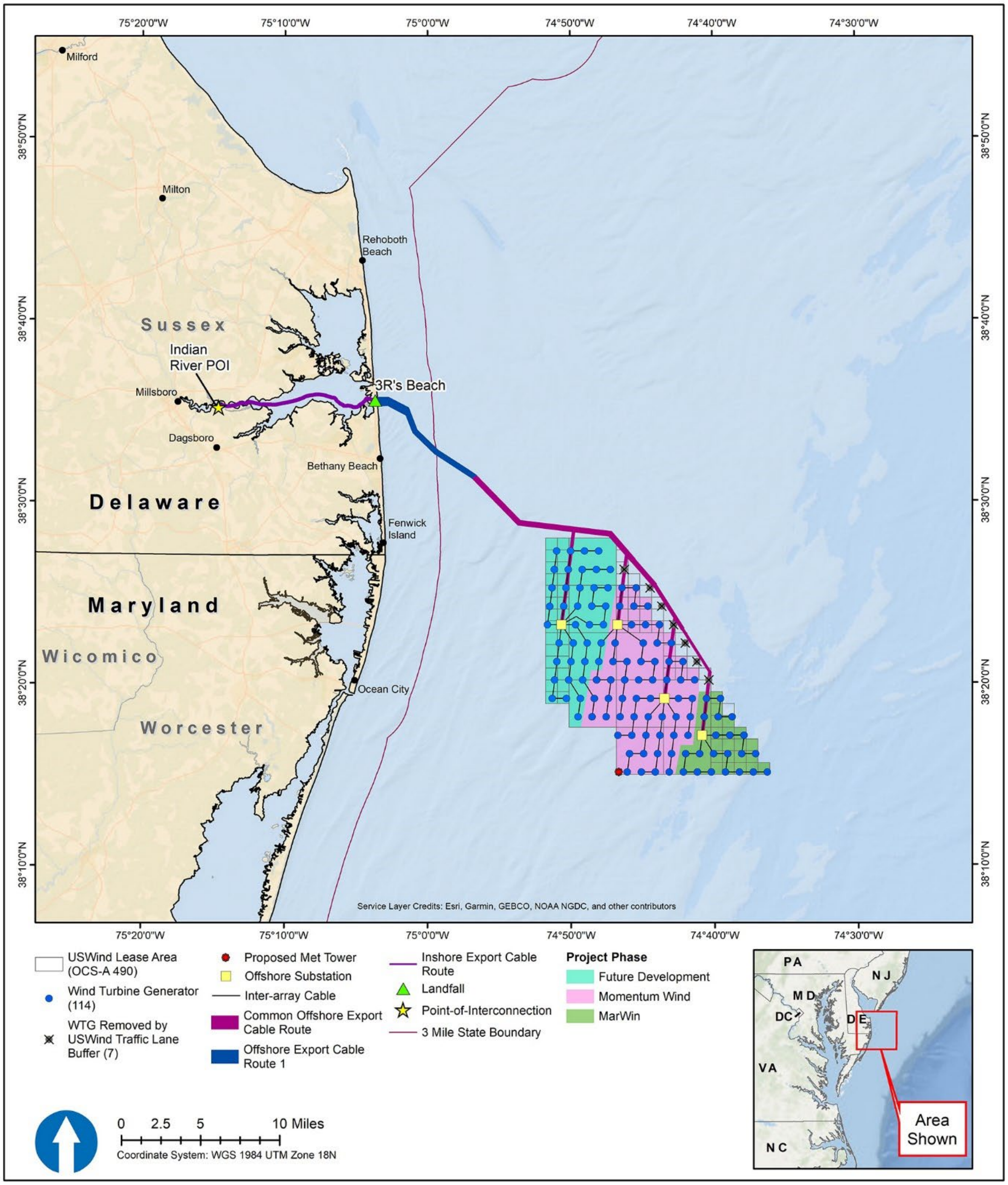

Figure 2-1. Maryland Offshore Wind Project

2.2 Construction and Installation Components and Activities

The Proposed Action would include the construction and installation of onshore, inshore, and offshore facilities with the proposed construction schedule targeted over four campaigns with in-water work (foundations, cables, and WTG installations) initiated in 2024 and completed in 2027. US Wind anticipates construction starting with MarWin and moving to the northwest in approximately 300- to 400-megawatt sections. The subsequent campaigns would comprise Momentum Wind and any future build out of the remaining Lease Area. The offshore elements of the MarWin construction campaign are scheduled to be initiated in 2024 and completed in 2025; the offshore elements of Momentum Wind construction campaign is scheduled to be initiated in 2025 and completed in 2026; and the offshore elements of the future development construction campaign is scheduled to be initiated in 2026 and completed in 2027. All of work associated with the installation of the inshore export cable within Indian River Bay is anticipated to be completed in 2024 and 2026. Construction and installation of the phased development is targeted for completion in 2027 depending on if the construction is staggered. An indicative Project schedule and alternative Project schedule for the phased development is included in COP Volume I, Chapter 1 (US Wind 2023) and summarized below for the proposed schedule. Timeframes are identified by the 3-month quarter (Q) of that respective year.

Initial Construction Campaign (MarWin)

Onshore Substation	Q1 of 2024 to Q3 of 2025
WTG and Met Tower Foundations	Q2 of 2025 to Q3 of 2025
Submarine Cable	Q3 of 2024 to Q4 of 2025
Inshore Cable	Q3 of 2024 to Q1 of 2026
Offshore Substations	Q1 of 2024 to Q2 of 2025
Wind Turbine Generators	Q2 of 2025 to Q4 of 2025

Second and Third Construction Campaigns (Momentum Wind)

WTG Foundations	Q2 of 2025 to Q3 of 2026
Onshore Substation	Q1 of 2024 to Q2 of 2026
Submarine Cable	Q3 of 2025 to Q3 of 2026
Inshore Cable	Q3 of 2024 to Q1 of 2026
Offshore Substations	Q3 of 2025 to Q3 of 2026
Wind Turbine Generators	Q2 of 2026 to Q4 of 2026

Fourth Construction Campaign

WTG Foundations	Q2 of 2027 to Q3 of 2027
Onshore Substation	Q1 of 2024 to Q2 of 2025
Submarine Cable	Q2 of 2026 to Q3 of 2027
Inshore Cable	Q3 of 2024 to Q1 of 2026
Offshore Substations	Q3 of 2026 to Q3 of 2027
Wind Turbine Generators	Q2 of 2027 to Q4 of 2027

2.2.1 Installation of WTG, OSS, and Met Tower Foundations

2.2.1.1 Seabed Preparation

Preparing a lease area for turbine installation may require jetting, plowing, or removal of soft sediments, as well as the excavation of rock and other material through various dredging methods. If seabed preparation is needed to provide a level surface for foundation installation, dredging equipment from a vessel would remove disturbed soil to create a firm and level base in the footprint of the foundation. In the unlikely event that the pile meets refusal prior to the embedment depth when installing OSS foundations, relief drilling of the pile may be required. Relief drilling would be conducted using a trailing suction hopper dredger (TSHD) which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. Upon completion of relief drilling to free up the pile, normal pile hammering would resume until the pile has reached target penetration. Any sediment removed during relief drilling will remain at the foundation location and will be placed in the general area where scour protection will be later installed.

2.2.1.2 Pile Driving

WTG Installation

Methodology for installation of OSS and WTG foundations is outlined in the following subsections. The pile driving operations would extend up to 2 days, including approximately 2 to 4 hours of pile driving operations. Pile driving will occur during daylight hours with operations beginning after sunrise and ending before dusk, unless a situation occurs where prematurely ending pile driving may cause a safety hazard or compromise the feasibility of the foundation installation.

The PDE includes the installation of up to 121 WTGs with an east-west spacing of 0.77 nautical mile (1.43 kilometers) and a north-south spacing of 1.02 nautical mile (1.89 kilometers) (Figure 2-1). US Wind would install the WTGs on monopile foundations which are large diameter coated steel tubes driven into the seabed. The diameter, weight, length, and wall thickness of the monopile vary based on water depth, geotechnical conditions, metocean conditions, and WTG size.

Additional WTG design details will be provided by US Wind in the FDR/FIR analysis, which is envisioned as occurring in an early stage of the pre-construction planning process. Approximate weights and dimensions of the monopile foundations within the Project Design Envelope are provided in Table 2-2.

Table 2-2. WTG Monopile Design Ranges

Approximate Foundation Parameters	Units	Project Design Envelope
Water depth[1]	m (ft)	14–41 (46–135)
Interface height	m (ft)	22 (73)
Maximum pile penetration	m (ft)	50 (164)
Maximum Monopile + Transition Piece length	m (ft)	110 (360) @ max depth
Maximum Monopile mass, primary steel	tonnes (ton)	2,200 (2,424) @ max depth
Maximum TP mass, primary steel	tonnes (ton)	364 (401)
Maximum Total mass, primary steel[2]	tonnes (ton)	2,200 (2,425)
Monopile diameter	m (ft)	8–11 (26-36)

Monopile foundations will be transported offshore to the installation site by self-floating or by using feeder vessels or direct installation vessels. The number of feeder vessels employed will be determined based on foundation size and installation rate. US Wind assumes that up to four feeder vessels could be employed to support monopile installation. The feeder vessels may be jack-up vessels or tug and barge units. The feeder vessels may employ anchors for positioning, utilizing mid-line anchor buoys. The feeder vessels will sail from Baltimore (Sparrows Point) to the Lease Area either via the Chesapeake and Delaware Canal and the Delaware Bay, or via the Chesapeake Bay. Installation of the monopile foundations offshore will be conducted using either a dynamically positioned crane vessel and/or a jack-up style installation vessel equipped with a hydraulic impact hammer to drive the monopiles into the seabed. As outlined in the COP (US Wind 2023), typical monopile foundation installation procedures are as follows:

- Foundation location is verified, any obstructions are removed, and leveled, if required.
- Feeder or installation vessel transports foundation to site; alternatively, monopiles are self-floating and towed to site.
- Installation vessel positions itself at foundation location including jacking and preloading as required. The use of anchors may be required in some instances.
- Monopile delivered to installation vessel, lifted from feeder vessel, upended (if necessary) and installed in pile gripper frame or temporary template placed on the seafloor.
- Monopile verticality verified, and pile allowed to penetrate seabed under its own weight.
- Noise mitigation procedures implemented.

[1] The same reference datum is assumed for both depth and interface height.
[2] Mass based on current design, subject to modification pending final design and site conditions.

- Pile hammer placed on monopile and soft start process commenced.
- Pile driven to target penetration depth, using as low impact energy as possible and no more than 4,400 kilojoules (kJ).
- In the unlikely event that the pile meets refusal prior to the embedment depth when installing OSS foundations, relief drilling of the pile may be required. Relief drilling would be conducted using a trailing suction hopper dredger (TSHD) which would suction sediments from around the pile. Whilst the main installation vessel continues with subsequent pile installations, a TSHD would be mobilized to site. Upon completion of relief drilling to free up the pile, normal pile hammering would resume until the pile has reached target penetration. Any soil removed during relief drilling will remain at the foundation location and will be placed in the general area where scour protection will be later installed.
- If a transition piece (TP) is included in the foundation design, the TP is lifted from installation vessel or feeder vessel and installed. If a TP-less monopile is used this step would be omitted from the installation procedure.
- For the TP-less monopile installation process, the internal and external platforms and boat landing would be lifted from feeder vessel and installed on monopile.
- If a jack-up vessel is used the installation vessel jacks down and moves to the next foundation position.
- Installation of scour protection as required.

US Wind intends to employ both near-field and far-field underwater noise mitigation technologies while the monopile is driven into the seabed. Near-field noise mitigation technologies could include AdBm Technologies Noise Mitigation System and using a damper between the hammer and sleeve to prolong the impact pulse. Far-field technologies could include a large double bubble curtain, deployed by a separate vessel mobilized to the installation location. See Project COP, Volume II, Section 9.3 (US Wind 2023) for discussion of proposed pile driving mitigation measures.

Offshore Substation Installation

The Proposed Action includes the installation of up to four OSSs for the Project, one for each grouping of approximately 300 to 400 megawatt of WTG capacity, deployed atop monopile or jacket foundations. US Wind is evaluating the combination of some or all OSS components onto one or two larger platforms. For this approach, equipment serving two or more arrangements of 300 to 400 megawatt (up to the full capacity of the Project) would be combined onto one or two large jacket foundations. At this time, US Wind continues to pursue up to four 400-MW (smaller) OSS at the locations identified. If a larger 800-MW OSS is pursued one or more of the other locations would be dropped from consideration. If one or two large (800 MW) OSS are pursued, at either of the interior locations within the lease area, those would be identified in the subsequent FDR/FIR that would be submitted to BSEE after the Record of Decision on the Final EIS. US Wind has presented the maximum case, reasonably foreseeable impacts for the purposes of the EFH consultation.

A monopile foundation for an OSS would be similar to a monopile for a WTG. A jacket is a multi-leg lattice structure that is connected to the seabed via piling or suction buckets. The PDE includes a three, four or six-leg jacket structure for the OSSs, depending on its capacity. In case of jacket foundations, these may be pre-installed using a temporary template on the seafloor, or post-installed through jacket pile guides. According to the Project COP (US Wind 2023), typical pre-piling installation procedures are as follows:

- Feeder or installation vessel transports foundation to site; if anchors are employed for positioning of vessels these may be installed ahead of vessel arrival.
- Piling template lifted from crane vessel deck and lowered to seafloor. The piling template is adjusted using the hydraulically actuated template legs to provide a level frame for pile installation.
- Pile is lifted from the feeder vessel and lowered into the piling frame and pile allowed to penetrate seabed under its own weight.
- Noise mitigation procedures are implemented.
- Pile driven to initial embedment depth with impact pile hammer.
- Remaining piles lowered into piling frame and driven to initial depth.
- All piles driven to target embedment depth.
- In the unlikely event the pile meets refusal prior to the embedment depth, removal of the soil plug or relief drilling of the pile may be required. Any soil removed during relief drilling will remain at the foundation location and will be placed in the general area where scour protection will be later installed.
- Soil plugs removed from piles to ensure adequate depth for jacket stabbing mechanism.
- Pile heights above seafloor are verified and piling template removed.
- Typical jacket installation procedures are as follows:
- Feeder or installation vessel transports foundation to site, if anchors are employed for positioning of the vessels, these are installed ahead of vessel arrival.
- Pre-installed piles inspected by remotely operated vehicle (ROV) to ensure that sufficient soil is removed to allow engagement of jacket stabbing mechanism and cleaned to ensure appropriate bonding surface for grout adhesion.
- Jacket lifted from feeder vessel and lowered onto piling.
- Jacket gripper and leveling system engaged to level and secure jacket, if required.
- Grouting process commenced to permanently attach jacket to piling.

In the case of a post-piled jacket, the jacket will be placed on the seafloor and piles will be stabbed into the jacket pile guides (skirts). An underwater hammer will be used to drive the piles to target penetration. The jacket will then be leveled, if needed, and the top of the piles rigidly connected to the pile guides of the jacket.

For the jacket on suction bucket configuration, the buckets are integrated into the jacket legs and the structure is installed as one piece. The Project COP (US Wind 2023) outlines typical jacket on bucket foundation installation procedures as follows:

- Feeder or installation vessel transports foundation to site; if anchors are employed for positioning of the vessels, these are installed ahead of vessel arrival.
- Jacket on suction buckets delivered to installation vessel, lifted from feeder vessel, and lowered in the target area on the seafloor.
- Verify correct orientation of the jacket.
- Activate and test the suction bucket dewatering pumps. Dewatering process commenced, drawing suction buckets to design embedment depth.

- Jacket verticality monitored during lowering, and suction pressure adjusted per bucket, if needed.
- Once the buckets have reached their target penetration, the suction pumps will be disconnected from the buckets by ROV and recovered to the vessel.
- Deploy scour protection, if applicable.

It is expected that OSS commissioning activities will be supported from either a floating hotel (flotel) or jack-up vessel. US Wind intends to include scour protection in the form of rock around the base of the OSS foundation, an area of approximately three times the diameter of the piles or buckets. Suction buckets with scour protection mats incorporated into the buckets may be used if available and feasible.

Met Tower Installation

Methodology for installation of Met Tower foundations is provided in the following subsection. The scheduled duration of pile driving during Met Tower installation is anticipated to span approximately 2 days. Pile driving operations will occur only during daylight hours with a start of operations planned after sunrise. Piling operations will cease at dusk unless a situation occurs where ceasing the pile driving could cause a safety hazard or compromise the integrity of the Met Tower.

The Proposed Action also includes the installation of a Met Tower at the western edge of the southernmost row of the array. All locations under consideration would be the only structures considered outside of the Project’s regular 0.77 nautical mile (1.43 kilometers) east to west and 1.02 nautical mile (1.89 kilometers) north to south array layout. The locations were selected to be in line with the east-west turbine row to limit any additional obstruction to fishing and other vessel traffic transiting across the Lease Area. The Met Tower will serve as a permanent metocean monitoring station to support project operations and long-term monitoring and is planned to include a robust suite of monitoring, data logging, and remote communications equipment, as well as associated power supply, lighting, and marking equipment.

The Met Tower would be a bottom-fixed structure consisting of a steel, lattice mast fixed to a steel deck supported by a steel braced caisson style foundation. The main caisson is a 72 inches (1.8 meters) diameter pile that tapers to 60 inches (1.5 meters) diameter above the mudline. The pile will be driven to an anticipated maximum depth of 175 feet (53 meters). The two bracing piles are 60 inches (1.5 meters) diameter each. These piles will be driven to an anticipated maximum depth of 166 feet (51 meters). The Project COP (Volume I, Section 3.5.1, US Wind 2023) describes the Met Tower installation sequence as follows:

- Prior to jacking into position at site, a brief bottom visual survey will be carried out to ensure the area is free of debris or any other impediments to the vessel legs.
- After ensuring the site is clear of debris, the lift-boat will jack up until it is in a secure and correct position to commence operations.
- The main 72-inches (1.8 meters) diameter main caisson will be lifted into place from the materials barge to a driving template guide on the vessel ready for piling.
- Once the caisson is penetrated in the seabed, it will be driven to its design depth or refusal using either a hydraulic or diesel driven impact hammer rated at approximately 500 kJ.

- With the main caisson installed, the bracing pile guide will be lifted from the materials barge and set onto the caisson.
- The two bracing piles, each 60 inches (1.5 meters) in diameter, will then be driven to design depth or refusal.
- The steel deck and boat landing appurtenances will then be installed onto the braced caisson configuration.
- Once the deck has been checked for level and is secure in place, the met mast and all ancillary equipment shall be installed.

2.2.1.3 Installation of Scour Protection

US Wind intends to include scour protection in the form of rock around the base of the WTG and OSS monopile foundations, an area of approximately three times the diameter of the piles or buckets which translates in approximately 0.19 acres (0.08 hectares) per WTG and 0.13 acres (0.05 hectares) per OSS large-pile jacket (COP, Volume II, Section 1.3, US Wind 2023). No scour protection is anticipated at the Met Tower foundation. Suction buckets with scour protection mats incorporated into the buckets may be used if available and feasible. The first layer of scour protection rocks will be deployed in a circle around the pile location. This layer of small rocks, the filter layer, will stabilize the sandy seafloor, avoiding the development of scour holes. The rocks will be placed by a specialized rock dumping vessel with a layer thickness of up to 2 feet (0.5 meters). Once the inter-array cables have been pulled into the monopile, a 2 to 7 feet (1 to 2 meters) thick second layer of larger rocks, the armor layer, will be placed to stabilize the filter layer around the monopile.

2.2.1.4 Vessel Activity

A number of vessels will be required to support activities carried out during the development, construction, and operation phases of the Project (COP, Volume II, Table 4-1, US Wind 2023). Specific vessels are required for surveying activities, foundation installation, OSS installation, cable installation, WTG installation, and support activities. Table 2-3 below contains a summary of the maximum number of vessels required for the Project.

The vessels will vary in size and complexity based on their function on the Project (Table 4-1, US Wind 2023). The majority of the vessels are expected to have conventional propeller- or thruster-based propulsion systems. Smaller vessels designed primarily for crew transfer applications are expected to employ water jet-drive based systems. If anchors are used, US Wind would utilize mid-line anchor buoys.

For monopile foundation installation, US Wind assumes that up to four feeder vessels could be employed to support monopile installation. The feeder vessels may be jack-up vessels or tug and barge units, and they may employ anchors for positioning, utilizing mid-line anchor buoys.

For cable installation, a cable barge will lay and bury the cable between the two end points maneuvering along the cable route using its six-point anchoring system (assisted by an anchor handling tug) and positioned using spuds as required.

Table 2-3. Summary of the maximum number of vessels required for the Project

Vessel	Maximum Number of Simultaneous Vessels
WTG Foundation Installation	
Scour protection vessels	1
Installation vessels	1
Support vessels	5
Transport/feeder vessels (including tugs)	4
Structure Installation	
Installation vessels	1
Transport/feeder vessels	3
Other support vessels	3
OSS Installation	
Primary installation vessels	1
Support vessels	4
Transport vessels	3
Inter-array Cable Installation	
Main laying vessels	1
Main burial vessels	1
Support vessels	5
Offshore Export Cable Installation	
Main cable laying vessels	1
Main cable burial vessels	1
Support vessels	5
Inshore Export Cable Installation (Indian River Bay)	
Main cable laying vessels	TBD
Main cable jointing vessels	TBD
Main cable burial vessels	TBD
Support vessels	TBD

Source: Appendix C, BOEM 2023a

2.2.2 Inter-Array and Offshore Export Cable Installation

The Proposed Action includes inter-array cables connecting the WTGs to the OSS and will be run in a primarily North/South direction connecting up to 4 to 6 WTGs in a string. The cables will transition from their primary North/South direction to an East/West direction as required to connect the WTG strings to the OSSs.

The inter-array cables will be 66 kV Alternating Current (AC), three-core cables with a maximum length of up to 125.6 miles (202.2 kilometers).

The Proposed Action includes up to four offshore export cables, one originating from each OSS within a single 1,968-foot (600-meter) wide Offshore Export Cable Route to the planned landfall at 3R's Beach. The offshore export cables will include 230 to 275 kV AC, three-core cable each with a combined length of approximately 142.5 miles (229.3 kilometers).

2.2.2.1 Seabed Preparation

Seabed preparation for inter-array and offshore cables including route clearance activities will be conducted prior to cable installation including a pre-installation survey and grapnel run. The pre-installation survey and grapnel run will be conducted along the cable routes to remove debris such as lost fishing nets or other objects that could impact the cable lay and burial. Collected debris will be recovered and disposed of in appropriate shore side facilities. Pre-installation seafloor preparation, such as levelling, pre-trenching or boulder removal, is not currently expected (COP, Volume I, Section 3.6.1; US Wind 2023).

2.2.2.2 Trenching and Cable Installation

Based on the sandy seafloor observed along the inter-array and export cable routes, it is expected that the cables will be installed utilizing a towed or self-driving jet plow which allows for the direct installation and burial of the cable. The jet plow uses a combination of high-pressure water to temporarily fluidize the sediment and the cable subsequently settles into the area opened by the jets through a combination of its own weight and a depressor arm. As the cable is simultaneously placed into the trench, displaced sediment is either mechanically returned to the trench and/or backfills naturally under hydrodynamic forcing. As the trench is created with this technique, the 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 because it minimizes the extent and duration of bottom disturbance for the significant length and water depths along the export cable route. If soil conditions do not permit the use of the jet plow, a mechanical cutting/trenching tool or conventional cable plow may be employed. Plowing involves a cable plow being dragged along the seafloor. As the plow moves along the route, a small trench is created with cable simultaneously laid within the trench. US Wind plans to bury cables between 3.3 to 6.6 feet (1 to 2 meters), but no more than 13.1 feet (4 meters). If post-lay surveys determine insufficient burial depth, cable protection structures may be installed to protect inadequately buried or exposed cables (i.e., concrete mattresses). Based on the PDE layout, up to 125.6 miles (202.2 kilometers) of inter-array cable will be installed.

Sediment suspension and transport modeling for the Offshore Export Cable Route indicated that most sediment suspended by the jet plow will stay within 300 feet (91 meters) of the active trench (Appendix A, *Offshore Sediment Transport Modeling Report*). Suspended sediment concentrations would be less than 200 mg/L at 450 feet (137 meters) from the Offshore Export Cable Route and the inter-array cables of the WTG. Concentrations of suspended sediments of 10 mg/L would settle to the seafloor within hours. All suspended sediments would disappear within hours and would extend up to

1.2 nautical miles (2.2 kilometers) from the inter-array cable centerline and be suspended at any given location for less than 4 hours (COP, Volume II, Appendix B2, US Wind 2023). The results of the sediment dispersion component of the modeling showed that deposition thicker than 0.2 mm will mostly occur within 300 feet (91 meters) of the Offshore Export Cable Route centerline. Most of the fluidized sediments lost to the water column are predicted to quickly settle back to the seafloor (Appendix A).

2.2.2.3 Cable Protection

US wind estimates that a maximum of 10% of the offshore export cable and inter-array cables would require additional protection (e.g., mattresses, rock placement, cable protection systems [CPSs]) and is likely to be significantly less. Any areas in the Offshore Export and inter-array cable routes that may have cable crossings or hard bottoms would likely require additional protection means. Inter-array cables will be buried in the seabed; however, the cable ends will be installed in CPSs close to the WTG foundations where burial may not be possible. At this time, US Wind has not defined specific cable protection measures or locations. Details of the cable protection measures would be provided in the FDR/FIR process.

2.2.2.4 Vessel Activity

See Section 2.2.1.4 for a discussion of expected vessel activity during the Project including a summary of the maximum number of vessels required (Table 2-3).

2.2.2.5 Horizontal Directional Drilling

HDD operations associated with the offshore export cable will be employed to install cable ducts that allow for the installation of the export cables at the transition points between water and land. The Project as proposed includes HDD associated with the offshore export cable at one location: between the Atlantic and landfall location at 3R's Beach.

Waterside HDD equipment will vary based on the installation location but will generally consist of a work platform (either a barge or small jack-up) and associated support vessels (such as tugs and small work boats). The work platform will be equipped with a crane, excavator, winches, and auxiliary equipment including generators and lights. An anchor spread may be employed if required. The offshore (ocean based) HDD works may be supported by either a jack-up or barge. Final HDD lengths will depend on factors such as soil conductivity, cable design, and available installation methods to minimize disturbance in the shallow areas of the bay close to the landfall locations. The water side of the HDD duct may employ temporary gravity cells, or a casing pipe to facilitate the installation of the cables, retain cuttings and drilling fluids, and to ensure that the HDD duct remains free of debris prior to installation of the export cable. A gravity cell is a temporary metal containment with an open bottom and top structure that is lowered to the seafloor. The gravity cell is typically lowered from a barge and does not require the walls of the cell to be driven into the seabed. It is expected that the gravity cells for in water operations would be up to 197 feet (60 meters) long and 33 feet (10 meters) wide. The gravity cells will be designed to minimize the release of drilling cuttings and fluids and would be open on the seaward (outbound) side to facilitate the installation of the export cables.

HDD drilling operations commence with a pilot hole that is progressively enlarged by using progressively larger reaming tools. During drilling operations, the drilling mud will be injected to cool the drill bit, provide lubrication, and stabilize the bore hole. The drilling fluid (mud) is an inert bentonite slurry and will carry the cuttings back to the shoreside excavation pit for collection/removal of the cuttings and reuse. The HDD operation will include monitoring of the downhole water/bentonite slurry to minimize the potential of drilling fluid breakout. A drilling fluid fracture contingency plan will be provided to managing agencies prior to any HDD operations. Disposal of drilling fluids and cuttings will follow Best Management Practices (BMPs) for the disposal of solid waste or inert fill materials related to the drilling operations and will follow State and Federal regulations. A series of reamers will be added to the drill string as soil conditions allow to progressively increase the size of the bore hole until it is large enough to accept the final export cable duct. When the required borehole diameter is achieved, a pulling head is attached to the drill string at the in-water end of the bore. Prefabricated sections of duct are attached to the drilling head and pulled into the borehole. The duct sections are expected to be fabricated on shore and floated to the barge or jack-up for installation. A duct of approximately 24 inches (60 centimeters) in diameter is planned and final sizing of the duct will be confirmed based on cable sizing and thermal properties of the soils.

2.2.3 Inshore Export Cable Installation

The Proposed Action includes up to four inshore export cables connecting the planned landfall at 3R's Beach, traversing Indian River Bay, with the onshore substation at Indian River substation. Similar to the offshore export cables the inshore export cables will include 230 to 275 kV AC, three-core cables with a combined length across Indian River Bay of approximately 42.3 miles (68.1 kilometers).

US Wind proposes to install the cables along the southern Inshore Export Cable Route through Indian River Bay (see Figure 2-2). The southern route avoids the dynamic nature of the area west of the Indian River Inlet and the Indian River Bay Federal Navigation Project, essentially deconflicting the eastern portion of the Inshore Export Cable Route. The Inshore Export Cable Route is 131 feet (40 meters) wide, with a potential temporary construction disturbance area (anchoring) of an additional 250 feet (76 meter) extending from either side of the route.

Cable installation operations would be planned, to the greatest extent practicable, during periods of higher water in the shallow portions of Indian River Bay. Construction operations would be paused during low water conditions. By increasing the size of a cable lay barge to distribute weight of the cable and by accepting downtime during construction, US Wind would avoid the need for dredging for barge access in the shallow, southern/eastern portions of Indian River Bay.

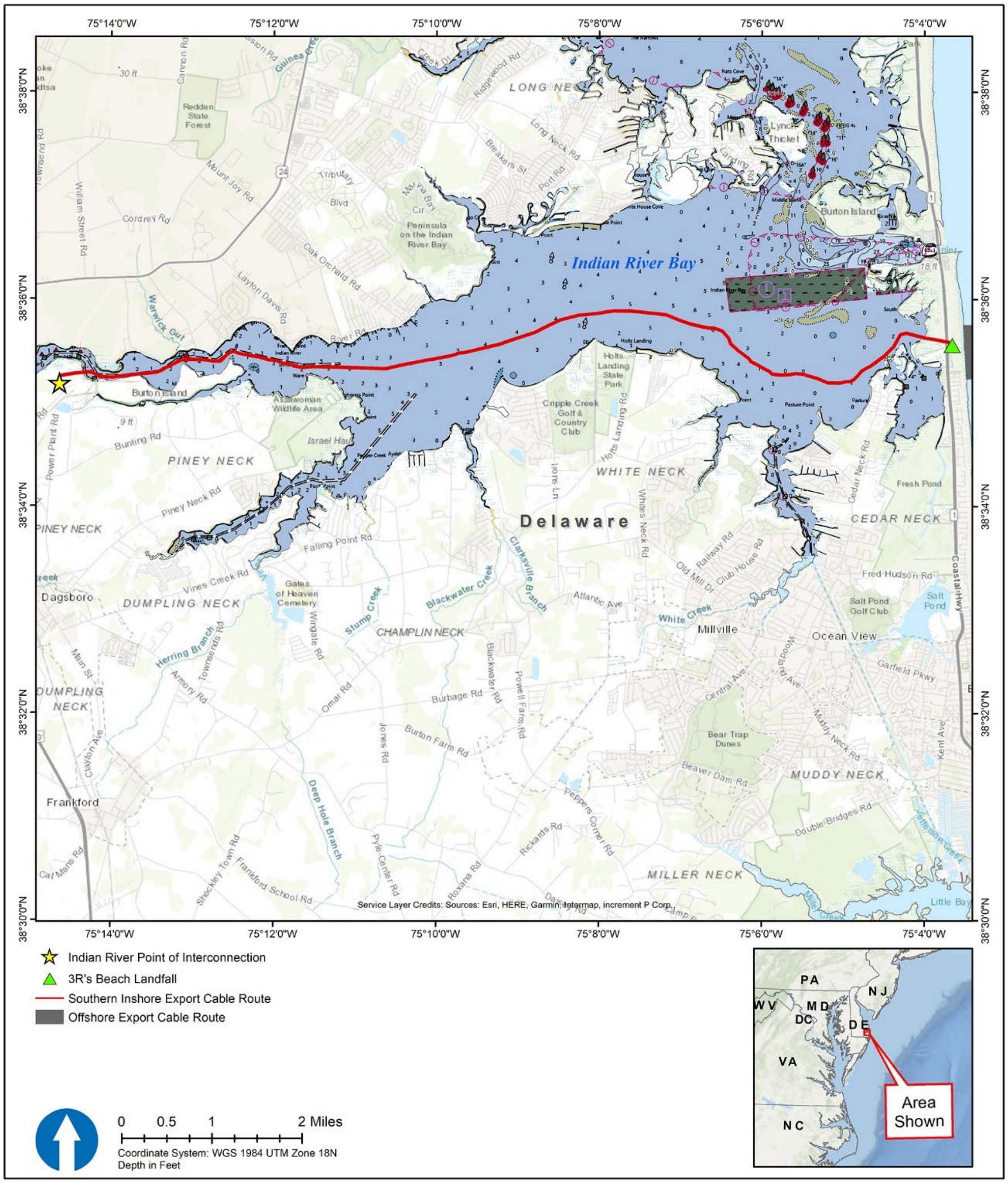

Figure 2-2. Proposed Inshore Export Cable Route through Indian River Bay

2.2.3.1 Dredging and Dredge Material Disposal associated with Barge Access

To achieve the target burial depth, US Wind and its contractors have determined dredging for barge access in locations along the Inshore Export Cable Routes would be necessary preceding cable installation (US Wind, Maryland Offshore Wind Project, Indian River Bay, Export Cables Dredging Plans, January 16, 2024). Maximum dredging disturbance is assumed to be within 249 foot (76 meter) wide along the Inshore Export Cable Route. US Wind assumes that cable installation in Indian River Bay would occur over two construction seasons (Campaign 1 – one cable, associated with MarWin and Campaign 2 – up to three cables, associated with Momentum and future development). Dredging would be conducted using hydraulic means. During Campaign 1 an estimated 30,278 cubic yards (23,149 cubic meters) of material will be dredged and in Campaign 2, approximately 43,398 cubic yards (33,1808 cubic meters) will be dredged. The maximum volume of dredging, assuming all four cables were installed within the southern Inshore Export Cable Routes is estimated to approximately 73,676 cubic yards (56,329 cubic meters). The dredging volume estimates provided here also assume the potential for re-filling of trenches between Campaigns 1 and 2. Therefore, the total maximum dredge volume from both campaigns is likely an over-estimation for the reasons provided.

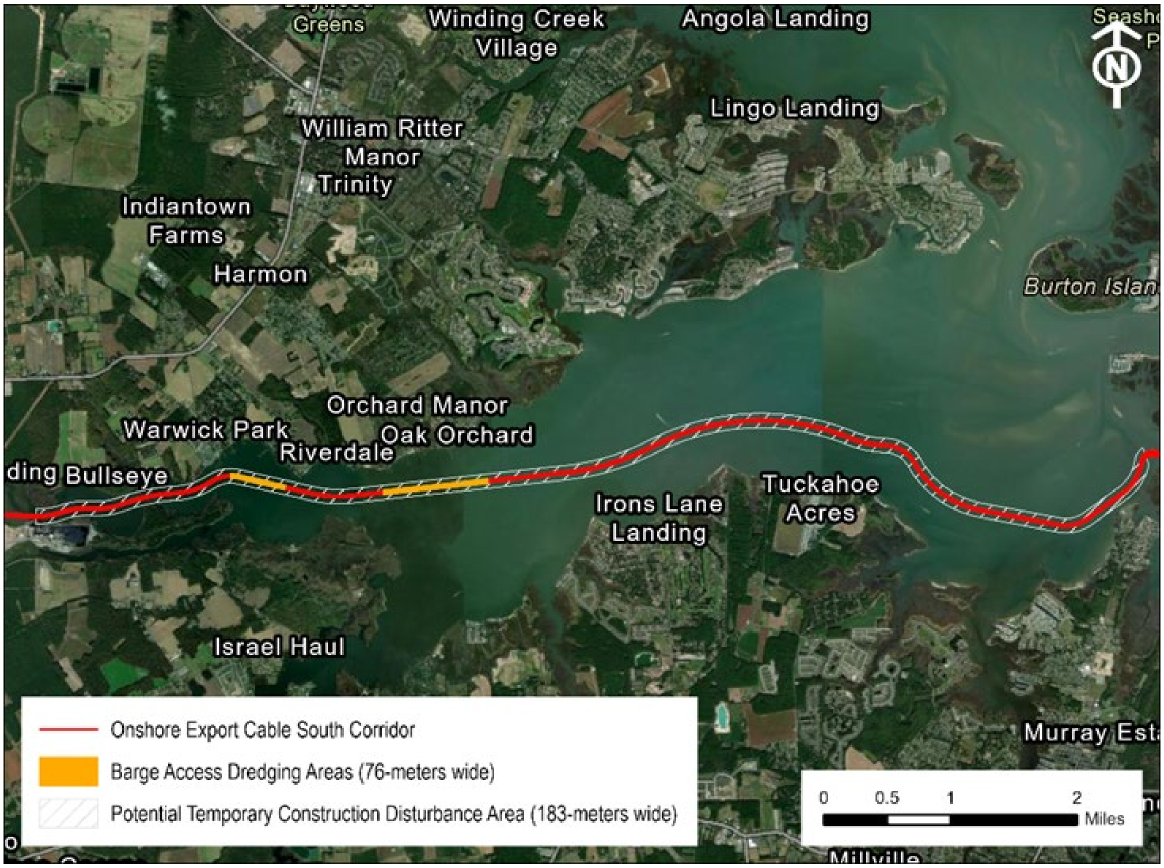

Figure 2-3. Barge access dredging areas within Indian River Bay

Additionally, based on feedback from DNREC, US Wind will implement the following time of year restrictions to minimize impacts of sediment disturbance, including no in-water work (e.g.; cable installation, HDDs, dredging) within Indian River Bay between March 1 and September 30, and no HDD activities at the beach landfall from April 15 through September 15.. This window accommodates the general time of year restrictions for summer flounder (March 1st to September 30th) which would allow time for young of the year summer flounder to grow large enough to be less vulnerable to habitat-altering activities and then migrate out of the system. In addition, the construction window avoids impacts to horseshoe crabs (*Limulus polyphemus*) during their spawning season (April 15th to June 30th). Since the Indian River is used by large numbers of American Eel (*Anguilla rostrata*), DNREC also requested that in-water work not take place from March 1st to May 15th to allow upstream passage of elvers (young eels).

Dredged material will be piped via temporary dredge pipeline to a dewatering staging area at the US Wind substations, within the planned limits of construction disturbance. Dredged materials will be dewatered and placed in trucks for disposal/placement at an upland landfill location within 100 miles (161 kilometers) of the US Wind substations area. Dewatering will be achieved by a passive method using large geobags which would allow dredged material to dewater over approximately 30-60 days prior to removal and placed into dump trucks. Alternatively, mechanical dewatering using a temporary system of separators (shakers), clarifiers, mixing tanks, and belt presses could be sized to meet target daily dredge production and continuously remove material to one or more upland disposal facilities. A combination of passive and mechanical dewatering methods may be used, pending final design.

US Wind will continue to evaluate the opportunity for beneficial reuse of dredged material using thin layer deposition on tidal marsh areas around the US Wind substations site. However, US Wind has not applied for approval of beneficial reuse of dredged material, thus any such action would be subject to future permitting action and an evaluation of that activity in regards to applicable regulations, including an assessment of potential impacts to essential fish habitat.

2.2.3.2 Seabed Preparation

Seabed preparation for inshore cables including route clearance activities will be conducted prior to cable installation including a pre-installation survey and grapnel run. The pre-installation survey and grapnel run will be conducted along the cable routes to remove debris such as lost fishing nets or other objects that could impact the cable lay and burial. Collected debris will be recovered and disposed of in appropriate shore side facilities. Pre-installation seafloor preparation, such as levelling, pre-trenching or boulder removal, is not currently expected (COP, Volume I, Section 3.6.1; US Wind 2023).

2.2.3.3 Trenching and Cable Installation

The cable installation spread will be arranged to maintain a limited draft and may be arranged on multiple barges. A cable storage barge will be equipped with a turntable, loading arm, and cable roller highway towards a cable installation barge. The barges would be suitable for positioning close to the HDD exit points (Old Basin Cove -Indian River Bay and Deep Hole – Indian River) due to the flat bottom and shallow draft. It is expected that the barge will be moved along the cable route using a six-point anchor system, assisted by an anchor handling tug, in combination with spud piles.

The inshore export cable will be fed to the HDD ducts using small boats and floatation where it will subsequently be pulled through the ducts into the jointing/transition bays. If necessary, a temporary cable roller highway (used to reduce cable tension) will be pre-installed in shallow water. The cable barge will lay and bury the cable between the two end points maneuvering along the cable route using its anchoring system and positioned using spuds as required. Based on the sediments observed along Inshore Export Cable Route in Indian river Bay, it is assumed that a barge mounted vertical injector, which fluidizes the soil, will be the primary burial tool for the cable. The use of a cable plough or barge mounted excavator may be required in some areas. In shallow water, a self-driving or towed post-lay cable burial tool may be used.

No cable or pipeline crossings have currently been identified within the Inshore Export Cable Route based on currently available information. It is anticipated that the cable will be installed in a continuous length, however if operational needs warrant, the cable can be installed in smaller sections and spliced. US Wind will optimize the cable installation and construction methodologies and include the details in the Facility Design Report (FDR) and Fabrication and Installation Report (FIR) process.

With any of the cable burial methods within the Inshore Export Cable Route, the trench in the bay bottom would be narrow and would collapse immediately after the cable has been depressed into the trench. The required burial depth will be based on the anticipated long-term bay bottom morphology and is expected to be 3 to 7 feet (1 to 2 meters). Up to 4 export cables may be laid in Indian River Bay with spacing of 32 to 98 feet (10 to 30 meters) between the parallel alignments to allow for construction and any future maintenance. Construction would be confined to an approximately 1,640-foot (500-meter) corridor along the Inshore Export Cable Route within Indian River Bay.

2.2.3.4 Cable Protection

US wind does not anticipate the need for cable protection structures (e.g., mattresses, rock placement, cable protection systems [CPSs]) along the Inshore Export Cable Route. No cable or pipeline crossings have currently been identified based on currently available information.

2.2.3.5 Vessel Activity

Vessels used for the installation of the inshore export cable within Indian River Bay will be primarily barges with support tugs. The cable installation spread will be arranged to maintain a limited draft and may be arranged on multiple barges. A cable storage barge will be equipped with a turntable, loading arm, and cable roller highway towards a cable installation barge. The barges would be suitable for positioning close to the HDD exit points due to the flat bottom and shallow draft. It is expected that the barge will be moved along the cable route using a six-point anchor system, assisted by an anchor handling tug, in combination with spud piles.

2.2.3.6 Horizontal Directional Drilling

HDD operations associated with the inshore export cable within Indian River Bay will be employed to install cable ducts that allow for the installation of the export cables at the transition points between water and land. The Project as proposed includes HDD associated with the inshore export cable at up to two locations: from 3R's Beach landfall into Indian River Bay; and, from Indian River to the proposed Onshore substations.

HDD In-water Preparation

The limited water depth in Indian River Bay is expected to require in-water operations to be based on a barge equipped with spuds for positioning. The offshore or in water end of the HDD duct may employ gravity cells, or a casing pipe in order to facilitate the installation of the cables, retain cuttings and drilling fluids, and to ensure that the HDD duct remains free of debris prior to installation of the export cable. The requirements for the gravity cells will be determined as the design and sequencing of the Project is finalized. It is expected that the gravity cells for in-water operations would be up to 60 meters long and 10 meters wide (197 feet long and 33 feet wide). The gravity cells will be designed to minimize the release of drilling cuttings and fluids and would be open on the seaward (outbound) side to facilitate the installation of the export cables.

HDD Indian River Bay

Gravity cells, if employed in Indian River Bay, would remain in place until the onshore export cable is installed in order to prevent silting in the HDD duct. Any structures installed in Indian River Bay will be marked and lighted as required in accordance with safety of navigation regulations. The gravity cell will be removed upon completion of the HDD duct installation. Any material excavated will be reused on site or disposed of at an appropriate offsite location based on the quality of the material. The excavation will be backfilled with the excavated material and/or the appropriate clean fill upon completion of the work.

HDD Offshore

Materials removed from the gravity cell for the installation of the HDD duct will be reused on site or disposed of at an appropriate offsite location based on the quality of the material. The excavation will be backfilled with the excavated material and/or appropriate clean fill upon completion of the work. The gravity cell will be removed upon completion of the HDD duct installation.

HDD Transition Vaults

Upon completion of HDD operations, the transition vaults will be installed. Up to 4 HDD ducts and subterranean transition vaults may be installed at the landfall location. When fully installed the shore end of the HDD ducts will terminate in a transition vault and the water end will be sealed and buried to the installation depth of the offshore export cables. The proposed vaults are each approximately 12 meters long, 3 meters wide, and 3 meters deep (40 feet long, 10 feet wide, and 10 feet deep). The HDD ducts will be connected to the transition vaults and backfilled. The transition vaults when fully installed will be accessed from ground level access points.

2.2.4 Port Facilities

A series of ports have been identified for the supporting the construction of the Project, including the primary ports located in Baltimore (Sparrows Point) and Ocean City in Maryland; Gulf of Mexico (e.g., Ingleside, Texas, Houma/Harvey, Louisiana) and Brewer, Maine. Other alternative port facilities could be utilized to support the Project and will be considered by US Wind on an as-needed basis (Table 2-4). Development of some infrastructure at the potential port sites likely will be required. However, infrastructure improvements and modifications of these ports are specifically not included as part of the Proposed Action because no expansions or modifications to the ports are needed to support vessels, equipment, or supplies associated with Project activities.

It is expected that component fabrication and facility preparation will commence 2 to 3 years prior to offshore construction and that Project construction activities will occur over a period of between 2 to 5 years.

Table 2-4. Proposed construction activities and related port facilities

Port Facility	Project Element	Activity
Baltimore, Maryland (Sparrows Point)	WTG – Primary	Delivery, storage, pre-assembly and load out to feeder vessel
	Foundation – Primary	Fabrication, assembly of components, load out to feeder vessel or self-floating and mobilization of fallpipe vessel for scour protection
	OSS – Alternate	Fabrication, assembly of components, load out to feeder vessel
	Cable – Primary	Storage, load out to installation vessel including export and inter-array cables
	Inshore Cable – Primary	Storage, load out to installation vessel (Indian River Bay crossing)
Hampton Roads area, Virginia	WTG – Alternate	Delivery, storage, pre-assembly and load out to installation or feeder vessel
	Foundation – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Support – Alternate	Large support vessels, assembly of components, load out to feeder vessel, including Jack-up vessels and Multipurpose OSVs
Ocean City, Maryland	Support – Primary	Support services, crew transfer including commercial fishing vessels, CTVs, dive support vessel, rigid inflatable boats and sport fishing boats
Port Norris, New Jersey	Support – Alternate	Support services, crew transfer
Lewes, Delaware	Support – Alternate	Support services, crew transfer

Port Facility	Project Element	Activity
Cape Charles, Virginia	Support – Alternate	Assembly of components, load out to feeder vessel including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Port of New York/ New Jersey	WTG – Alternate	Delivery, storage, pre-assembly and load out to installation or feeder vessel
	Foundations – Alternate	Assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
	Support – Alternate	Support services including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Charleston, South Carolina	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
Delaware River and Bay (e.g., Paulsboro, New Jersey, Hope Creek, New Jersey, Wilmington, Delaware	Foundations – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel and mobilization of fallpipe vessel for scour protection
	Cables – Alternate	Storage, load out to installation vessel including export and inter-array cables
	Support – Alternate	Support services including commercial fishing vessels, Jack-up vessels, Multipurpose OSVs
Gulf of Mexico (e.g., Ingleside, Texas, Houma/Harvey, Louisiana)	OSS Foundations – Alternate	Fabrication, assembly of components, load out to feeder or installation vessel
	Met Tower Foundation – Primary	Fabrication, assembly of components, load out to feeder or installation vessel
Brewer, Maine	OSS topside – Primary	Fabrication, assembly of components, load out to feeder or installation vessel

Source: US Wind 2023

2.3 Operations and Maintenance Components and Activities

As the owner and operator of the Project, US Wind will be responsible for daily operations, which includes planned and unplanned maintenance. US Wind’s maintenance strategy assumes an integrated maintenance approach that incorporates the maintenance activities of all Project components in order to minimize the time technicians spend offshore and to minimize downtime.

The planned O&M Facility is intended to serve as the primary access point for Project maintenance activities. The 24/7 monitoring of the Project will be conducted at both the O&M Facility and at the original equipment manufacturer’s (OEM’s) remote operations center, which will monitor the WTGs and electrical systems and coordinate with the grid operator, PJM.

2.3.1 Operations and Maintenance Facility

US Wind's operations and maintenance facility (O&M Facility) will provide a suitable location to plan and coordinate WTG and OSS maintenance and servicing operations for the Project from the Ocean City, Maryland region. The O&M Facility will be comprised of onshore office, crew support, and warehouse spaces with associated parking in the Ocean City commercial harbor and will include quayside and berthing areas for four or more crew transfer vessels (CTVs). The O&M Facility will also house a Marine Coordination Center, which will serve to monitor the status of the WTGs and OSSs via SCADA systems, plan maintenance operations and dispatch CTVs, monitor marine activity in the Project area, coordinate drills and exercises, and communicate with outside agencies.

The proposed O&M facility location is likely to be located on two adjacent sites on the waterfront in West Ocean City, Maryland. The waterfront sites together are approximately 1.5 acres (0.61 hectares) in size. Specifically, both potential parcels are waterfront properties with suitable water depth and mooring space in the commercial harbor to safely support four or more CTVs. The two waterfront properties currently under consideration are 12933 Harbor Road and 12929 Harbor Road.

US Wind would grade portions of the sites to prepare for construction of new buildings approximately three stories and no more than 45 feet (13.7 meters) high, set back at least 25 feet (7.6 meters) from the tidal waters. New buildings would include a crew support facility and a temporary warehouse, as well as a combined administrative building and warehouse to be completed later in the Project. Expansion or replacement of the existing waterfront access points would be undertaken in consultation with the Maryland Department of the Environment (MDE) and U.S. Army Corps of Engineers (USACE), including for the replacement or expansion of pavement to allow for vehicle parking and vehicular/forklift access to new cranes or davits that would load materials onto the CTVs stationed at the berth/quayside.

The waterfront property will support the onloading and offloading of parts, tools, and personnel needed for operations and maintenance on the WTGs and OSSs with ingress/egress to the Project area via the Ocean City Inlet. Site improvements would include the replacement of a timber pier and the existing bulkhead/quay wall. The pier is anticipated to be up to 625 feet (191 meters) long and 28 to 32 feet (8.5 to 9.7 meters) wide. The existing bulkhead/quay wall would be replaced from the end of the pier to 175 feet (53 meters) west. Equipment deployed on the pier deck would include jib cranes and mooring hardware to allow for CTVs to dock and receive the necessary crew and equipment. The pier would allow for a truck to assist in loading equipment on to vessels.

Ports supporting the O&M activities include the primary ports located in Ocean City, Maryland, Lewes, Delaware, Hampton Roads area, Virginia, Baltimore (Sparrows Point), Maryland, Hope Creek, New Jersey and the Port of New York/ New Jersey (Table 2-5). Similar to the construction ports, any infrastructure improvements and modifications of these O&M ports, other than at Ocean City, are specifically not included as part of the Proposed Action.

Table 2-5. Potential O&M ports

Ports	Potential O&M Activities
Ocean City, Maryland	Maintenance activities for WTGs, OSSs, and routine inspections
Lewes, Delaware	Maintenance activities for WTGs, OSSs, and routine inspections
Hampton Roads area, Virginia	Major maintenance activities requiring deep draft or jack-up vessels
Baltimore, Maryland (Sparrows Point)	Major maintenance activities requiring deep draft vessels
Hope Creek, New Jersey	Major maintenance activities requiring deep draft or jack-up vessels
Port of New York/New Jersey	Major maintenance activities requiring deep draft or jack-up vessels

Source: US Wind 2023

2.3.2 Onshore Activities and Facilities

Maintenance of the onshore substation primarily consists of non-intrusive inspections of switchgear, transformers, control systems, conductors, and support structures. Similar to the OSS, the scheduled maintenance of the onshore substation components will take place at predefined intervals, in accordance with the manufacturer's recommendations and in coordination with PJM.

2.3.3 Offshore and Inshore Activities and Facilities

WTGs are designed to be operated remotely and only accessed by technicians for routine maintenance and inspections, or in the event of a fault that requires local reset or intervention. The monitoring of the operations will be performed remotely from the O&M Facility and from the remote OEM's operations center. The scheduled maintenance of the OSS components will take place at predefined intervals in accordance with the manufacturer's recommendations. Planned maintenance outage will be scheduled with PJM to avoid peak load periods. Scheduled maintenance will include high voltage protection functional testing, switchgear tests, and detailed transformer inspections. Planned maintenance operations for foundations include visual inspections of the topside portions of the foundations and ROV supported inspection of the underwater portions of the foundation, including cable protection and cable entry, cathodic protection, and scour systems. During the initial operational period of approximately 2 years, foundations will be inspected visually above and below the waterline at least once. The findings of the initial inspections will inform the frequency of inspections to be completed later in the project life cycle, which is expected to be every 4 or 5 years.

Cable surveys are anticipated in year 1, year 3, and then every 5 years after. The frequency of the surveys may be adjusted based on the results of the first survey. The determination of cable burial depths may be derived indirectly from observed bathymetric changes with respect to the as-built situation.

2.4 Conceptual Decommissioning Components and Activities

Under 30 CFR 285 and commercial Renewable Energy Lease OCS-A 0498, US Wind would be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by the Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR 285.910(a)). Absent permission from BOEM, US Wind would have to achieve complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. US Wind has submitted a conceptual decommissioning plan as part of the COP (Volume I, Section 7.0; US Wind 2023), and the final decommissioning application would outline US Wind's process for managing waste and recycling for Project components.

BSEE would require US Wind to submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease, 90 days after completion of the commercial activities on the commercial lease, or 90 days after cancellation, relinquishment, or other termination of the lease (see 30 CFR 285.905). Upon completion of the technical and environmental reviews, BOEM may approve, approve with conditions, or disapprove the lessee's decommissioning application. This process would include an opportunity for public comment and consultation with municipal, state, and federal management agencies. US Wind would need to obtain separate and subsequent approval from BOEM to retire in place any portion of the Project. Approval of such activities would require compliance under the National Environmental Policy Act (NEPA) and other federal statutes and implementing regulations.

If the COP is approved or approved with modifications, US Wind would have to submit a bond (or another form of financial assurance) that would be held by the U.S. government to cover the cost of decommissioning the entire facility in the event that US Wind would not be able to decommission the facility.

2.4.1 Offshore and Inshore Activities and Facilities

The inter-array, offshore and inshore export cables will be disconnected from the WTGs and the OSS, and, subject to discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts, either retired in place or removed from the seabed, and recovered onto a barge or suitably equipped vessel. The cable routes will be exposed as needed to dislodge the cables and allow for the cable to be recovered. When the cable has been recovered it will be transported to shore for disposal and/or recycling.

The OSSs will be decommissioned in a sequential manner similar to the manner in which they were installed. The equipment on the platforms will be de-energized and made safe for removal. Any cabling connections to the OSS will be removed. Hazardous materials will be removed from the platform(s) and transported to shore in accordance with the Oil Spill Response Plan (OSRP) to prevent contamination of the environment. It is expected that OSS removal will be conducted using a combination of floating crane vessels, jack-up vessels, and associated support vessels. The OSS topside can be removed in its entirety or on a component-by-component basis. Foundation piling will be removed to 15 feet (5 meters) below the seafloor in accordance with the conditions of the Lease.

The WTGs, including the nacelles, towers, and turbine blades, will be decommissioned using equipment that is similar to the equipment employed for installation. The turbines will be shut down and any oils associated with the turbines will be drained in accordance with the OSRP. A jack-up or floating crane vessel will be utilized to remove the blades, nacelle and tower, and the components will be transported to shore for recycling and/or disposal. The Project may utilize different types of foundations for WTGs from those used for OSSs. The removal of each foundation type will include the removal of the TP (if applicable) and the subsequent removal of the foundation structure as required, potentially to 15 feet (5 meters) below the seafloor. It is expected that foundation removal will be conducted using a combination of floating crane vessels, jack-up vessels, and associated support vessels. Monopile and piled jacket foundations would be removed to a level below the mudline of the seafloor in accordance with the conditions of the Lease. In the case of an OSS foundation consisting of a jacket with suction buckets, the buckets would be removed by reversing the installation process, pushing the buckets out of the seabed. Once the foundations are free from the seabed, they will be lifted onto transport vessels for subsequent recycling and/or disposal onshore.

Based on the approval of the agencies, scour protection systems utilized to protect foundations and cables may be left in place to provide seafloor habitat. If removed, a crane will pick up the material and place it on a barge. The rock utilized in these systems can be reused for other projects and will not require disposal in a landfill. If required, the scour systems will be removed in such a manner that the seafloor will be returned to pre-project conditions with no obstructions remaining to future activities.

The Met Tower decommissioning will include removal of small ancillary equipment, then a heavy lift derrick barge will be mobilized to the site to lift the met mast and the heavier ancillary equipment from the Met Tower deck and placed on either the lift barge or a materials barge. The Met Tower foundation piles will be cut to a depth of 15 feet (5 meters) below the surveyed datum in accordance with 30 CFR 585.910 and removed to the deck of the derrick barge or materials barge and will be transported to shore for processing at a licensed recycling facility.

3 Existing Environment

This section discusses habitats within and adjacent to the Project area that may be affected by any phase of the Project (i.e., the geographic analysis area). The geographic analysis area includes the Northeast Shelf Large Marine Ecosystem (LME), which extends from the southern edge of the Scotian Shelf (in the Gulf of Maine) to Cape Hatteras, North Carolina, and the Southeast Shelf LME, which extends from Cape Hatteras to Florida. These LMEs are likely to capture the majority of movement ranges for most invertebrates and finfish species. The entirety of the geographic analysis area includes only U.S. waters (Figure 3-1).

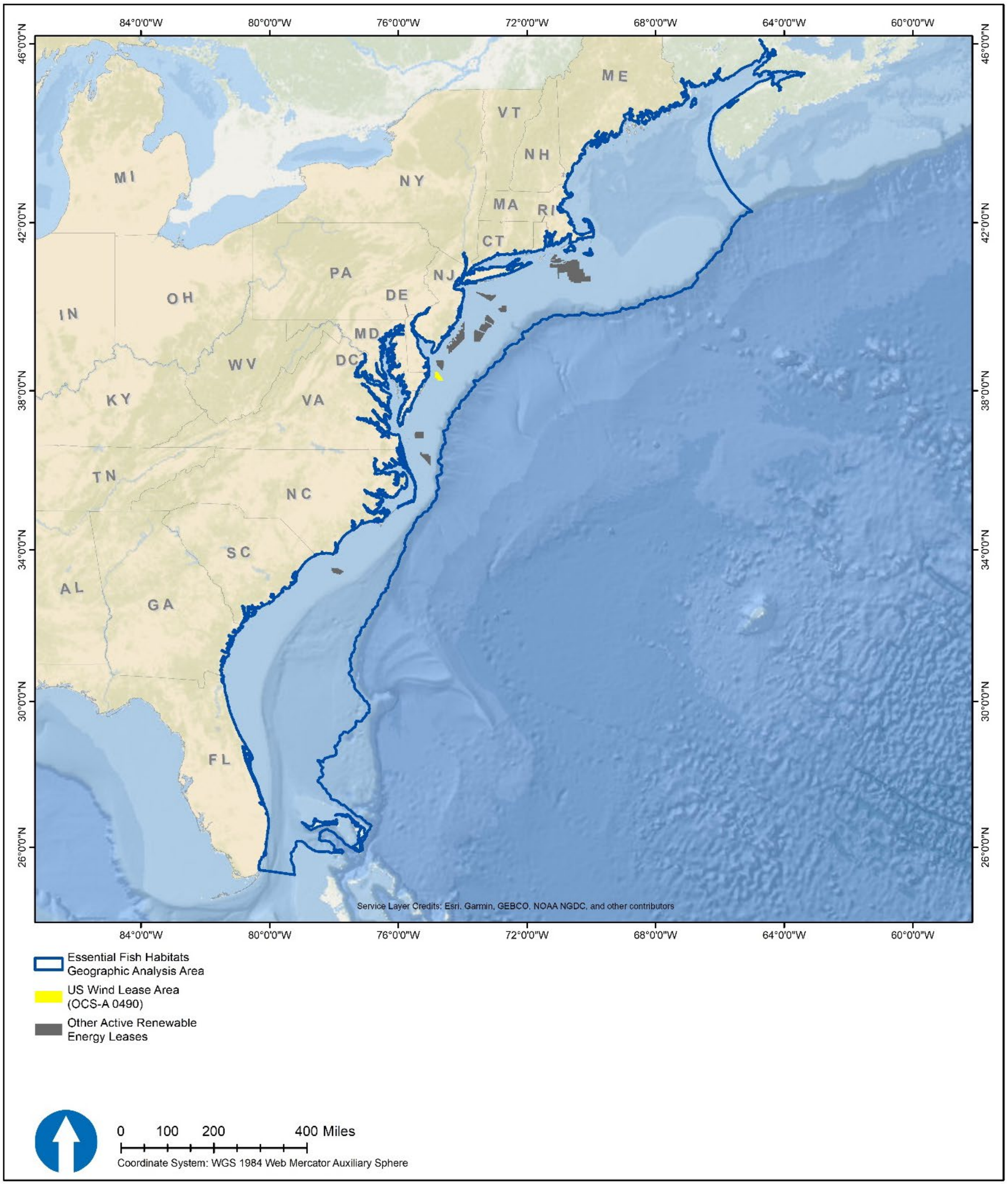

Figure 3-1. EFH geographic analysis area

The Maryland Wind Energy Area (WEA) is approximately 10 to 22 miles (16 to 35 kilometers) east of Ocean City, Maryland. The Project area falls within the southern extent of the Mid-Atlantic Bight and includes three managed species of finfish and invertebrates and their EFH in offshore waters and the Offshore Export Cable Route as well as the Inshore Export Cable Route within the Indian River Bay. The Lease Area covers approximately 80,000 acres (32,374 hectares) of seafloor with water depths up to 135 feet (41 meters). Water depths in the Offshore Export Cable Route range from 36 to 104 feet (11.1 to 31.8 meters) in federal waters, and 49 feet (15 meters) or less in state waters (COP, Volume II, Appendix K7, US Wind 2023).

The regional oceanography is driven by multiple factors, with currents below the surface as the most influential. The Gulf Stream waters move warm water from the south northward along the shelf, and the cold waters of the Labrador current move south along the coast. This combination creates consistent eddies and gyres in the Mid-Atlantic Bight. Fresh water flow from Delaware Bay also influences the regional currents. The cold, northern waters sink under the warmer waters, creating the Mid-Atlantic Bight Cold Pool. The Cold Pool develops in the spring and ensures vertical stratification through the summer and fall (Friedland et al. 2021; Miles et al. 2017; Lentz 2017).

The inner continental shelf is characterized by a counterclockwise gyre created by large tropical and extra-tropical storms, circulating the ocean currents. This in turn causes the north-to-south coastal currents and forms NNE-SSW oriented sand shoals. This predominant morphological feature of the inner shelf can run tens to hundreds of kilometers long, with wavelengths of 6.6 to 16.4 feet (2 to 5 meters), and crest height up to 32.8 feet (10 meters). These shoals may be spaced 1.2 to 2.5 miles (2 to 4 kilometers) apart and extend tens of kilometers from end to end. Maximum relief of the ridges is 16 to 32 feet (5 to 10 meters). The Offshore Export Cable Route traverses the northern periphery of these ridges where the relief is generally less pronounced and takes the form of broad flats in some areas. The western one-third of the Lease Area lies within these shoals (COP, Volume II, Appendix A1; US Wind 2023). Surficial sediment types are generally sand of varying coarseness with mixtures of silt or gravel (Williams et al. 2007). This aligns with the geophysical survey conducted in 2013 within the Lease Area which shows that seafloor elevation ranged from -33 to -148 feet (-10 to -45 meters) mean lower low water.

Offshore shoal complexes (two or more shoals and the trough separating them) provide a habitat and micro-habitats for adults, settled juveniles, and larvae for multiple fish and invertebrate species that use these shoal complexes for spawning, larval recruitment, foraging, and migration (Rutecki et al. 2014). However, a 2-year study conducted on the inner continental shelf of the Mid-Atlantic Bight showed greater species diversity, abundance, and richness in flat-bottom habitats than in shoal habitats (Slacum et al. 2011). They also noticed seasonal trends with lower values of all those indices during the winter than in the spring through fall (Slacum et al. 2011). Shoal habitats occur in high-energy environments and migrate in a generally southwest direction within the Mid-Atlantic Bight (Rutecki et al. 2014). Along with sand ridges, sand ripples and waves were observed over a large portion of the Lease Area. The proposed Project has been sited to avoid sensitive or rare habitats, such as artificial reefs, clam beds, submerged aquatic vegetation (SAV) beds, and hard-bottom habitats where practical.

Salinities at any given point in the water column are consistent year-round in offshore waters but vary between 27 and 31 parts per thousand near shore (USACE 2016).

The benthic habitat in the Project area is predominantly sandy sediment habitat and is almost homogenous in that the variations in sediment type observed only occur in small spatial scale. Benthic habitat is important for fish and invertebrate managed species habitat and influences site fidelity in managed species. The most notable benthic community located within the northern area of the Lease Area is called the Old Grounds. This area was observed to have the same sediment type but revealed low taxa richness comparatively to the rest of the Project area.

The most abundant taxa from samples collected within the Old Grounds were nematode roundworms, Aorid amphipods (*Pseudunciola obliguua* and *Unciola* spp.), the tanaid (*Salemia coeca*, the pea crab (*Dissodactylus mellitae*), and bean mussels (*Crenella* sp. [Guida et al. 2017]).

3.1 Description of Habitat Types by Project Component

3.1.1 Lease Area

The seafloor characteristics of the Lease Area are consistent with the larger Mid-Atlantic Bight region; soft bottom sediments characterized by sands with patches of gravel and silt/sand mixes. The primary morphological feature is the sand ridges and smaller sand waves. Benthic habitat in the Lease Area is generally characterized by mobile sandy substrates on gentle slopes, with shell hash frequently accompanying mineral substrates (Guida et al. 2017). A total of 93% of the seafloor slope within the Lease Area and Offshore Export Cable Route is one degree or less. Within the Offshore Export Cable Route, the slope did not exceed 5 degrees, and is therefore still classified as a gentle slope. Steeper slopes exceeding 20 degrees were identified in the western portion of the Lease Area. These slopes classified as very steep, would complicate cable laying activities (COP, Volume II, Appendix K5; US Wind 2023). It should be noted that slopes exceeding 20 degrees located within the southwest corner of the Lease Area are extremely limited and localized, and could be avoided by micro-siting WTG locations.

Benthic grab samples (120 samples) were collected to support the underwater imagery collected and determine grain size distribution. According to the NMFS-modified Coastal and Marine Ecological Classification Standard (CMECS), gravelly sand was the dominant substrate group observed (43%) followed by sand (37%) and gravel mixes (19%) (Appendix B, *Lease Area and Offshore Export Cable Corridors Benthic Report*). No fines were observed, however, patches of shell hash and gravel (including pebble/granule, cobble, and boulder clasts) were also documented in some of the transects, as well as larger solitary boulders and mounds of smaller boulders and cobbles, though rare (Appendix B). Some complex habitats contained a high enough fraction of shell to be classified as shell hash, and few hard-bottom patches are expected to be present (Guida et al. 2017; Cutter et al. 2000; Appendix B). One transect in the southwestern portion of the Lease Area, identified a cobble pile of suspected anthropogenic origin, and the presence of a worm reef was identified along a sandy transect on the western side of the Lease Area (Appendix B).

Although regional studies have documented muddy sands within portions of the central Lease Area, the most recent sampling did not observe any fines (muddy sands, sandy muds, and muds) (Appendix B, *Lease Area and Offshore Export Cable Corridors Benthic Report* and C, *Information not Support the EFH*). Sub-surface sediments are predominantly sands with occasional interlays of clay and gravel. Overall, although variations in sediment have been observed to occur over small spatial scales within the Lease Area, few hard-bottom patches are believed to be present (Guida et al. 2017; Cutter et al. 2000; Appendix B). These findings align with previous studies, which indicate that hard bottom benthic habitats are rare in the Lease Area and primarily occur as gravel or cobble dominated substrates (Guida et al. 2017; NOS 2015).

A total of 99 marine invertebrates were found within benthic samples (Appendix B, *Lease Area and Offshore Export Cable Corridors Benthic Report*). The benthic macrofaunal invertebrate community in the Lease Area and Offshore Export Cable Route are dominated by polychaetes, representing 26 taxonomic families, and accounted for roughly 45 to 50% of the observed macroinvertebrates (Appendix B). Crustaceans and mollusks each accounted for approximately 25% of the taxa in the Lease Area samples. Typical species commonly found in the area also include oligochaete worms, but also include common sand dollars (Clypeasteroida, *Echinarachnius parma*), sea stars (*Asterias* spp.), tube anemones (*Cerianthus* sp.), hermit crabs (*Pagurus* sp.), rock crabs (*Cancer* spp.), moon snails (Naticidae), and nassa snails (*Ilyanassa* [*Nassarius*] spp.) (COP, Volume II, Appendix D4, US Wind 2023). Surfclams (*Spisula solidissima*), sea scallops (*Placopecten magellanicus*), penaeid shrimp (Penaeidae), sand shrimp (*Crangon septemspinosa*), horseshoe crabs (*Limulus polyphemus*), and ocean quahogs (*Arctica islandica*) were also occasionally recorded in survey trawl data (Guida et al. 2017). Soft corals (sea whips) were found within the Maryland WEA, however no habitat enhancing hard corals were detected (Guida et al. 2017). As stated previously, hard-bottom benthic habitats are rare in the Lease Area and primarily occur as gravel- or cobble-dominated substrates (Guida et al. 2017). This is supported by 2021 sampling (Appendix B), which also observed sand dollars and ascidians congruently with the macrofauna. More detailed summaries of the methodology and the results of the benthic field survey are presented in the COP (Appendix C, *Information to Support EFH Assessmen*t).

The Carl N. Shuster Jr. Horseshoe Crab Reserve is a marine protected area where the harvest of horseshoe crabs is prohibited, as of March 7, 2001, in an effort to maintain sufficient numbers of horseshoe crab eggs to feed migratory shorebirds (Walls et al. 2002). The reserve is 1,593 square miles (4,127 square kilometers) and is located outside of Delaware Bay. The northern half of the Lease Area (approximately 41.9 square miles [108.6 square kilometers]) is located within the southern portion of the reserve.

As represented in Figure 3-2, approximately 56,090 acres (22,699 hectares) of the Lease Area is characterized as soft bottom, with the remaining 10,336 acres (4,183 hectares) are characterized as complex, heterogenous complex and large-grained complex habitat) (Appendix C, *Information to Support EFH Assessmen*t).

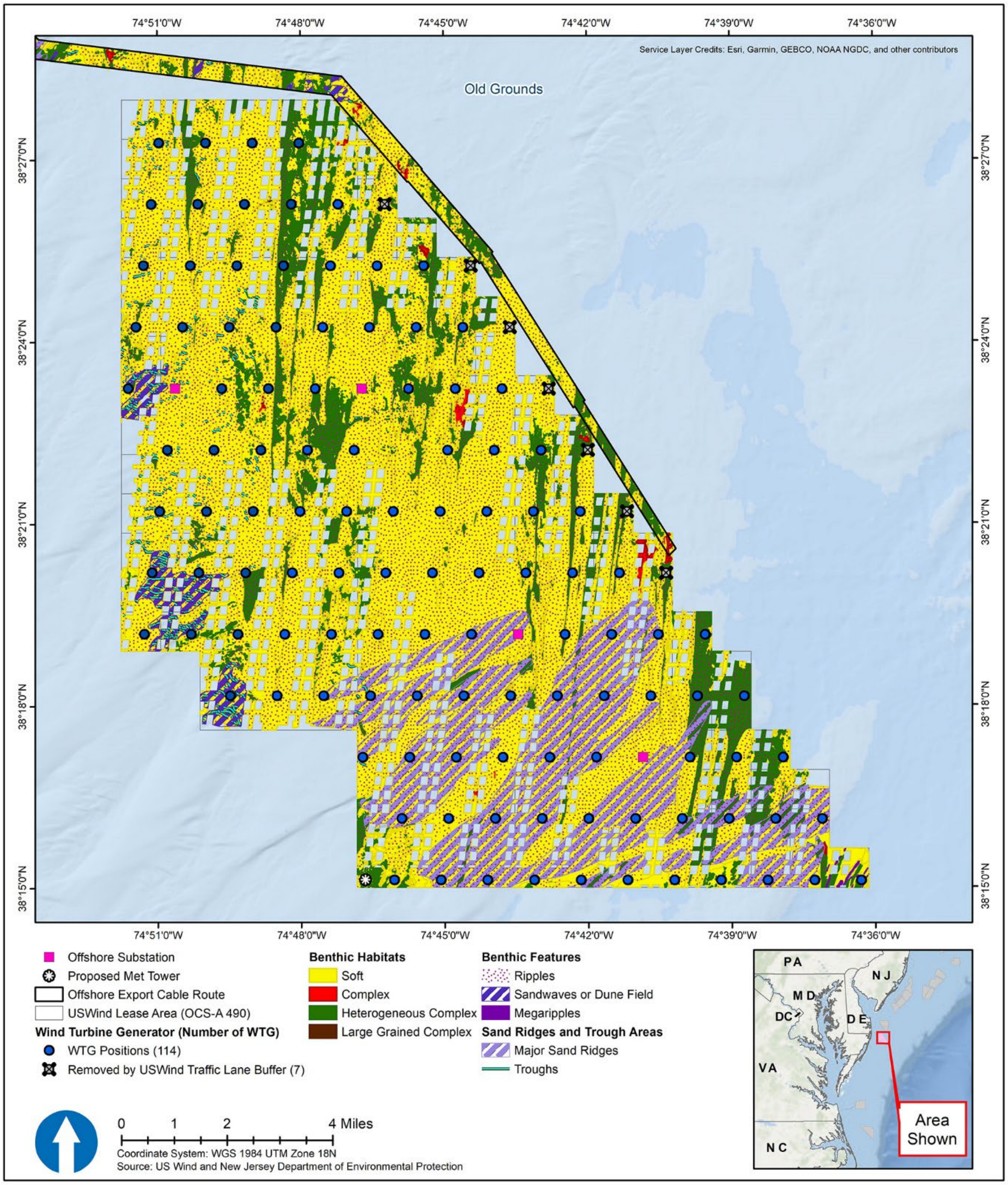

Figure 3-2. Benthic habitats mapped within the Lease Area

Source: Data from Appendix C; Information to Support EFH

3.1.2 Offshore/Inshore Export Cable Route

3.1.2.1 Offshore Export Cable Route

US Wind contractors conducted surveys in 2016 along a portion of the Offshore Export Cable Routes. Seafloor sediments characterized along this portion of the Offshore Export Cable Routes range from silt-clay, sand, gravel, cobbles, and possible small boulders. The sediment grab samples recovered predominantly fine to coarse-grained sand with some gravel and with occasional cobble. Fine-grained silt-clay was also observed. Sediment vibracore samples recovered silt, clay, peat, organics, sand, and gravel, confirming the sub-bottom data. Side-scan sonar also identified possible marine debris (tires, fishing gear, etc.). Of the six vibracores collected, one was found to exceed current Delaware Department of Natural Resources and Environmental Control's (DNREC) Division of Waste and Hazardous Substances screening levels for polycyclic aromatic hydrocarbons (PAHs) naphthalene and acenaphthene. In 2016, DNREC conducted sampling to analyze sediment physical and chemical characteristics. These samples were predominantly medium-fine-grained sand and silt, with 0.3 to 3.8% organic matter (COP, Volume II, Section 4.1.1; US Wind 2023). Arsenic was found to be common at low concentrations of 1 to 40 mg/kg throughout, likely from pesticide use on land and waste from metal refineries. The subsequent erosion along with natural environmental drivers of wind and rain carried these contaminants into the waterways. Arsenic and nickel both exceeded the Delaware Ecological Marine Sediment Screening Level and the NOAA effects range-low level for nickel. US Wind also conducted sediment sampling along the Offshore Export Cable Route and included both the northern and southern shore approach.

Horseshoe crabs were not observed during benthic field studies but are known to be present in the Project area along the Offshore Export Cable Route, which transits approximately 25 to 33 miles (40 to 52 kilometers) of the southwestern portion of the Carl N. Shuster, Jr. Horseshoe Crab Reserve, depending on the final route selection. Horseshoe crabs likely utilize areas in the vicinity of the Offshore Export Cable Route for overwintering habitat (Smith et al. 2017), and individuals may cross the Offshore Export Cable Route during annual migrations between breeding beaches and offshore areas.

Figure 3-3 shows the benthic habitats mapped along the Offshore Export Cable Route for the Project.

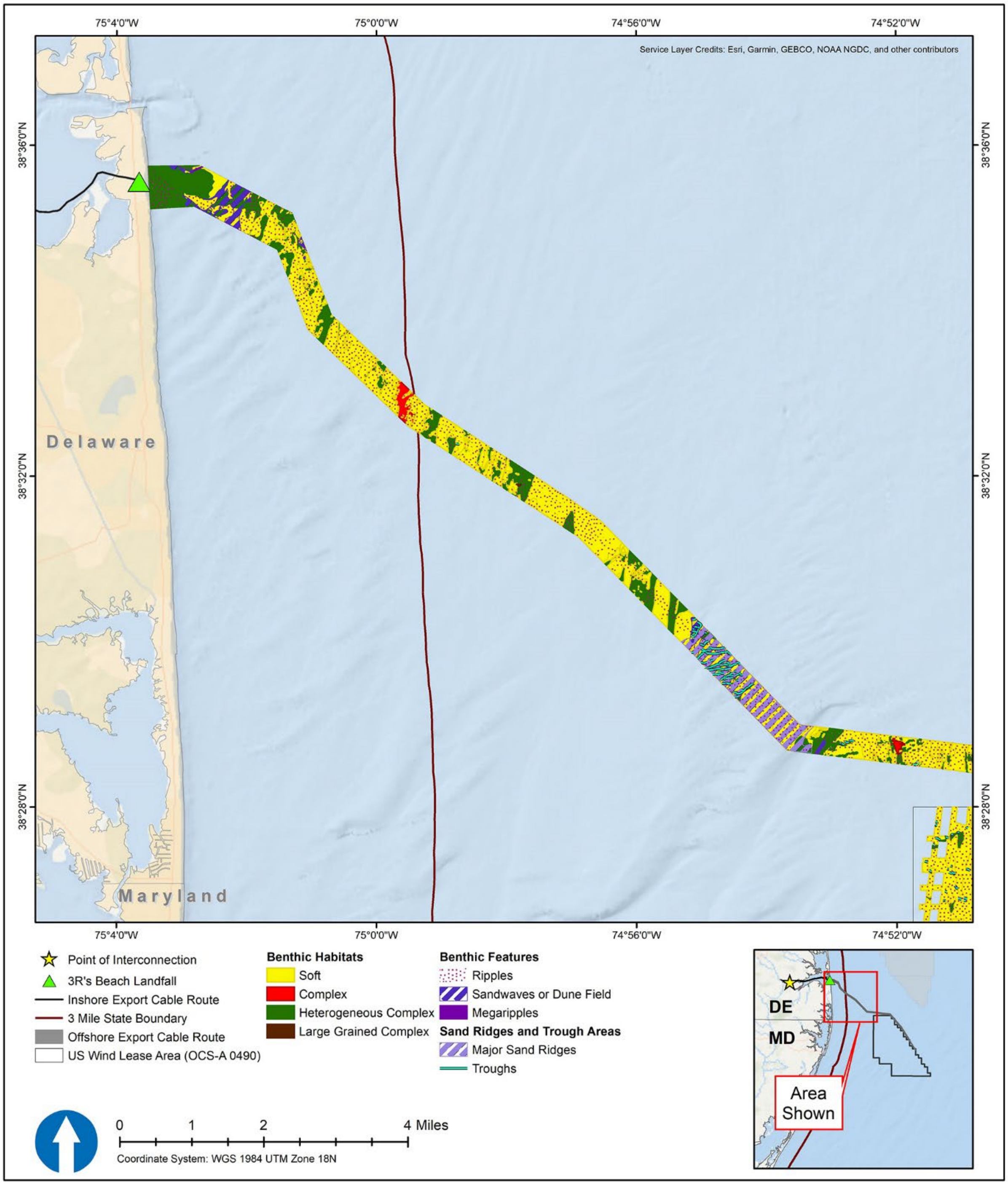

Figure 3-3 Benthic habitats mapped along the Offshore Export Cable Route

Source: Data from Appendix C; Information to Support EFH

3.1.2.2 Inshore Export Cable Route

The Inshore Export Cable Route begins at 3R's Beach landfall and crosses through Indian River Bay west into the upper estuary (i.e., the Indian River) to the POI in Millsboro, Delaware. US Wind contractors also sampled along the Inshore Export Cable Route in 2016. The bathymetry indicated that the bottom of Indian River Bay is relatively flat with an elevation that ranged between 2.3 and -30.5 feet (0.7 and -9.3 meters). Possible marine debris and/or fishing gear was also identified.

Local variations in surface sediments occur regularly, especially near the Indian River Bay Inlet which routinely shoals in with sand from updrift shoreline transport. Seafloor surface sediment texture and profiles in the nearshore and inlet areas of Indian River Bay can change dramatically due to its shallow water and tidal flat conditions. The inlet is characterized as a flood dominated inlet exhibiting highly mobile bed conditions and texture changes, particularly due to large coastal storm events or periods of high river discharge to the lower estuary.

The sediment grab samples recovered consisted of predominantly silty sand with some medium to coarse sand. Sediment vibracore samples recovered consisted of silt, clay, peat, organics, and sand, however, no gravel was found. The vibracore data aligns with the sub-bottom data collected. Soft bottom habitat consisted of sand, muddy sand, sandy mud, and mud. Hard bottom, biogenic, and submerged aquatic vegetation habitats were not observed in the Inshore Export Cable Route. Therefore, no areas of complex habitat, heterogeneous complex habitat, or large grained habitat were mapped along the Inshore Export Cable Route.

Sediment samples from landward reaches of the Indian River Bay generally contained higher organic matter (0.6 to 57% versus 0.3 to 3.8%). Elevated concentrations of arsenic and nickel were found in most of the samples collected from upper Indian River Bay, which may be indicative of metal loading from surrounding land use and agricultural runoff (Appendix C, *Information to Support EFH Assessmen*t). Salinity generally increases from west to east within the Indian River Bay, with the westernmost portions heavily influenced by watershed inputs.

The mouth of the Indian River Bay is a mix of muddy sand and sand, while the sandy mud transitions to mud further inshore (west) to the POI. Taxa richness was highest in the eastern part (in the open water, not directly at the mouth), as was density. Polychaetes accounted for the greatest percentage of total organism abundance, averaging 74% across Indian River Bay (86% in the western portion and 68% averaged across the two regions sampled in the eastern portion) (Appendix D, *Onshore Export Cable Corridors Benthic Report*). Included in Appendix D is the Indian River Bay Shellfish Density Survey Report (dated October 2022) which indicated crustaceans and mollusks were also present. Hard clams (*Mercenaria mercenaria*) were observed in all portions of Indian River Bay sampled, however sparingly. No taxa indicative of sensitive habitats (hard bottom areas, cold water coral reefs, seagrass beds, etc.) were observed in the samples collected in the vicinity of the Inshore Export Cable Route, and no SAV was observed during surveys. A previous seagrass mapping study conducted by the Delaware Center for the Inland Bays (McGowan, 2022) also found no SAV along the Inshore Export Cable Route within Indian River Bay.

Total suspended solids (TSS) data for the tidal portions of Indian River Bay has a seasonal average of 20 mg/L from March to the end of October. In the past two decades a wide range has been documented, from 6 mg/L to more than 150 mg/L in the course of one year. The water clarity is too low in Indian River to support the growth of submerged aquatic vegetation, although water clarity does improve in the eastern portion of Indian River Bay (COP, Volume II, Section 4.1.2; US Wind 2023).

Horseshoe crabs were not observed in Indian River Bay but are known to be present during the spawning season (May to June), when they deposit large numbers of eggs on nearby sandy beaches. Delaware has designated portions of Indian River Bay as shellfish aquaculture development areas for oyster production although natural oyster reefs are no longer present (Ewart 2013). The anticipated Inshore Export Cable Route does not intersect any of the aquaculture lease blocks.

Soft-bottom habitat consisted of sand, muddy sand, sandy mud, and mud. Hard-bottom habitats, including complex, heterogeneous, and large-grained habitats as well as biogenic and SAV, were not observed along the Inshore Export Cable Route (Figure 3-4).

3.1.3 Port Facilities

A series of ports have been identified for the supporting the construction of the Project, including the primary ports located in Baltimore (Sparrows Point) and Ocean City in Maryland; Gulf of Mexico (e.g., Ingleside, Texas, Houma/Harvey, Louisiana) and Brewer, Maine. Ports supporting the O&M activities include the primary ports located in Ocean City, Maryland, Lewes, Delaware, Hampton Roads area, Virginia, Baltimore (Sparrows Point), Maryland, Hope Creek, New Jersey and the Port of New York/ New Jersey. As stated in Section 2.2.4, it is assumed that development of some infrastructure at the potential port sites will be required. To the extent that upgrades or modifications at an existing port facility may occur, those upgrades or modifications would serve to support the U.S. offshore wind industry in general. Given the numerous states that are procuring, facilitating, and funding offshore wind development, both existing and upgraded as well as new port facilities are expected to serve multiple offshore wind projects and, potentially, also offshore wind-related and other maritime industries.

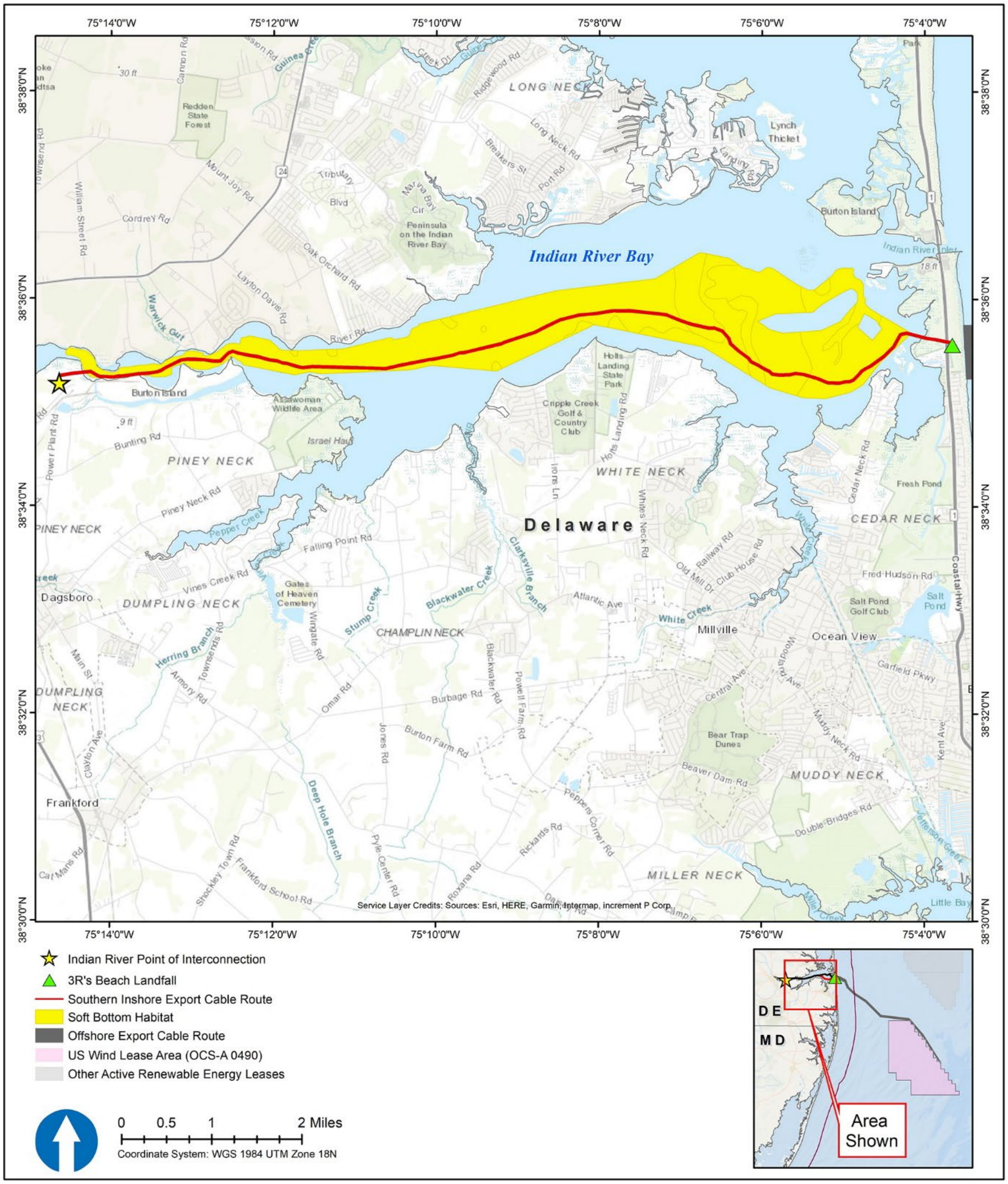

Figure 3-4. Benthic habitats mapped along Inshore Export Cable Route through Indian River Bay

Source: Data from Appendix C; Information to Support EFH

3.1.4 O&M Facility

The waterfront O&M facility will need to support the onloading and offloading of parts, tools, and personnel needed for operations and maintenance on the WTGs and OSSs with ingress/egress to the Project area via the Ocean City Inlet. US Wind plans to lease and/or acquire a suitable existing quayside space in the vicinity of Ocean City harbor that will be capable of berthing up to four CTVs. The proposed O&M facility is likely to be located on two adjacent developed sites on the waterfront in West Ocean City, Maryland. The waterfront sites together are approximately 1.5 acres (0.61 hectares) in size. Specifically, both potential parcels are waterfront properties used for fish processing and are comprised of a series of small buildings and gravel parking lots.

3.1.5 Habitat Types by Project Component Table

Based on the results from acoustic survey and benthic sampling program, US Wind provided the habitat types and extents (areas) within each project component area in Table 3-1 (consistent with the BOEM and NMFS EFH Assessment template for Offshore Wind Energy Projects, dated January 2023). The habitat types presented in Table 3-1 are referenced against CMECS (class, subclass and groups) as shown in Appendix E, *Habitat Table Group Reference against CMECES*.

In addition to presenting the habitat types and extents (areas) within each project component area in Table 3-1 (consistent with the BOEM and NMFS EFH Assessment template for Offshore Wind Energy Projects, dated January 2023), benthic habitats identified by US Wind for the offshore and inshore components of the Project as presented in Table 3-2 and 3-3, respectively (Appendix C, *Information to Support the EFH Assessment*). Habitat mapping for the Project area was primarily based on the results from acoustic survey and benthic sampling programs conducted in 2021 and 2023. The results of the fully processed acoustic mapping and targeted seafloor sampling were used to produce final data products that include both characterization and delineation of benthic habitat according to the NOAA Fisheries modified Coastal and Marine Ecological Classification System (NMFS-modified CMECS) taxonomic framework identified in GARFO's March 29, 2021 "Updated Recommendations for Mapping Fish Habitat."

Table 3-1. Table of habitat types by project component presented in acres

Habitat Types	Project Component Area								
	Total Project Area	Lease area	Offshore Export Cable Common Route	Offshore Export Cable Route 1	Offshore Export Cable Route 2	Inshore Export Cable North Route – Indian River Bay	Inshore Export Cable South Route – Indian River Bay	Port Modifications (not part of Proposed Action)	Operations & Maintenance Facility
Granule, pebble habitat (2 mm ≤ grain size <64 mm)	14,545	10,139	1,201	810	2,415	0	0	N/A	0
Cobble, boulder habitat (grain size 64 mm)	266	18	6	5	237	0	0	N/A	0
Soft bottom mud (e.g., intertidal mudflat, shallow-water, and deep)	222	0	0	0	0	108	114	N/A	0
Soft bottom sand (e.g., with and without sand ripple, shoals, waves/ridges)	62,397	56,339	3,291	1,366	1,400	45	39	N/A	0.41**
Submerged Aquatic Vegetation (SAV)	0	0	0	0	0	0	0	N/A	0
Tidal Marsh (e.g., saltmarsh and brackish marsh)	0	0	0	0	0	0	0	N/A	0

Habitat Types	Project Component Area								
	Total Project Area	Lease area	Offshore Export Cable Common Route	Offshore Export Cable Route 1	Offshore Export Cable Route 2	Inshore Export Cable North Route – Indian River Bay	Inshore Export Cable South Route – Indian River Bay	Port Modifications (not part of Proposed Action)	Operations & Maintenance Facility
Shellfish reefs and beds (e.g., hard clams, Atlantic surfclam, mussels, oysters)	0	0	0	0	0	0	0	N/A	0
Shell accumulations	196	135	61	0	0	0	0	N/A	0
Other biogenic (e.g., cerianthids, corals, emergent tubes – polychaetes)	0	0	0	0	0	0	0	N/A	0
Pelagic (offshore and estuarine)	90,435	79,766	4,273	2,180	3,880	168	168	N/A	0
Habitat for sensitive life stages (e.g., demersal eggs, spawning activity-discrete areas)*	90,435	79,766	4,273	2,180	3,880	168	168	N/A	0
Habitat Areas of Particular Concern (HAPC)	2,662	0	0	0	2,360	151	151	N/A	0

*This could occur anywhere within the Project, less than 50 meters in depth.

** Habitat type assumed and footprint based on proposed shoreside improvements

Table 3-2. Summary of habitats mapped in the offshore Project area

Habitat Type*	Entire Offshore Project Area		Lease Area		Common Offshore Export Cable Route		Offshore Export Cable Route 1		Offshore Export Cable Route 2 (alternative)	
	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
Soft bottom	250.98	80.6	226.99	84.4	13.06	71.9	5.29	60.1	5.63	36.5
Complex	1.28	0.41	0.80	0.30	0.25	1.36	0.23	2.63	0.00	0.00
Heterogeneous complex	58.90	18.92	41.00	15.3	4.86	26.7	3.28	37.2	9.77	63.3
Large-grained complex	0.07	0.02	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.20
Total	311.22	100	268.82	100	18.17	100	8.80	100	15.43	100

Source: Appendix C, Information to Support the EFH Assessment

Note: Offshore Export Cable Route 2 is an Alternative to Offshore Export Cable Route 1

*As defined in GARFO's March 29, 2021 "Updated Recommendations for Mapping Fish Habitat"

Table 3-3. Summary of habitats mapped in the inshore Project area (Indian River Bay)

Habitat Type*	Entire Inshore Project Area		Common Inshore Export Cable Route		Inshore Export Cable North Route		Inshore Export Cable South Route (alternative)	
	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
Soft bottom	12.83	100	6.02	100	3.0	100	3.81	100
Complex	0	0	0	0	0	0	0	0
Heterogeneous complex	0	0	0	0	0	0	0	0
Large-grained complex	0	0	0	0	0	0	0	0
Total	12.83	100	8.02	100	3.0	100	3.81	100

Source: Appendix C, Information to Support the EFH Assessment

Note: Inshore Export Cable Route South is the proposed Inshore Export Cable Route North

*As defined in GARFO's March 29, 2021 "Updated Recommendations for Mapping Fish Habitat"

4 Designated EFH

The EFH designations described in this section correspond to those currently accepted and designated by the New England Fishery Management Council (NEFMC), Mid Atlantic Fisheries Management Council (MAFMC), South Atlantic Fishery Management Council (SAFMC), and NOAA Highly Migratory Species Division (NEFMC 2017). Many EFH designations are determined for each cell in a 10’ latitude by 10’ longitude square grid in state and federal waters. The Lease Area intersects five cells, the offshore export cable intersects an additional two cells, and the Inshore Export Cable Route intersects an additional cell (Figure 4-1) for a total of eight cells for the Project area. The specific FMPs with protective designations of EFH include:

- NEFMC
  - Northeast Multispecies FMP
  - Atlantic Sea Scallop FMP
  - Monkfish FMP
  - Atlantic Herring FMP
  - Skate FMP
- MAFMC
  - Atlantic Mackerel, Squid, and Butterfish FMP
  - Spiny Dogfish FMP
  - Summer Flounder, Scup, and Black Sea Bass FMP
  - Bluefish FMP
  - Atlantic Surfclam and Ocean Quahog FMP
- NOAA Highly Migratory Species Division
  - Consolidated Atlantic Highly Migratory Species FMP
- SAFMC
  - Coastal Migratory Pelagics FMP

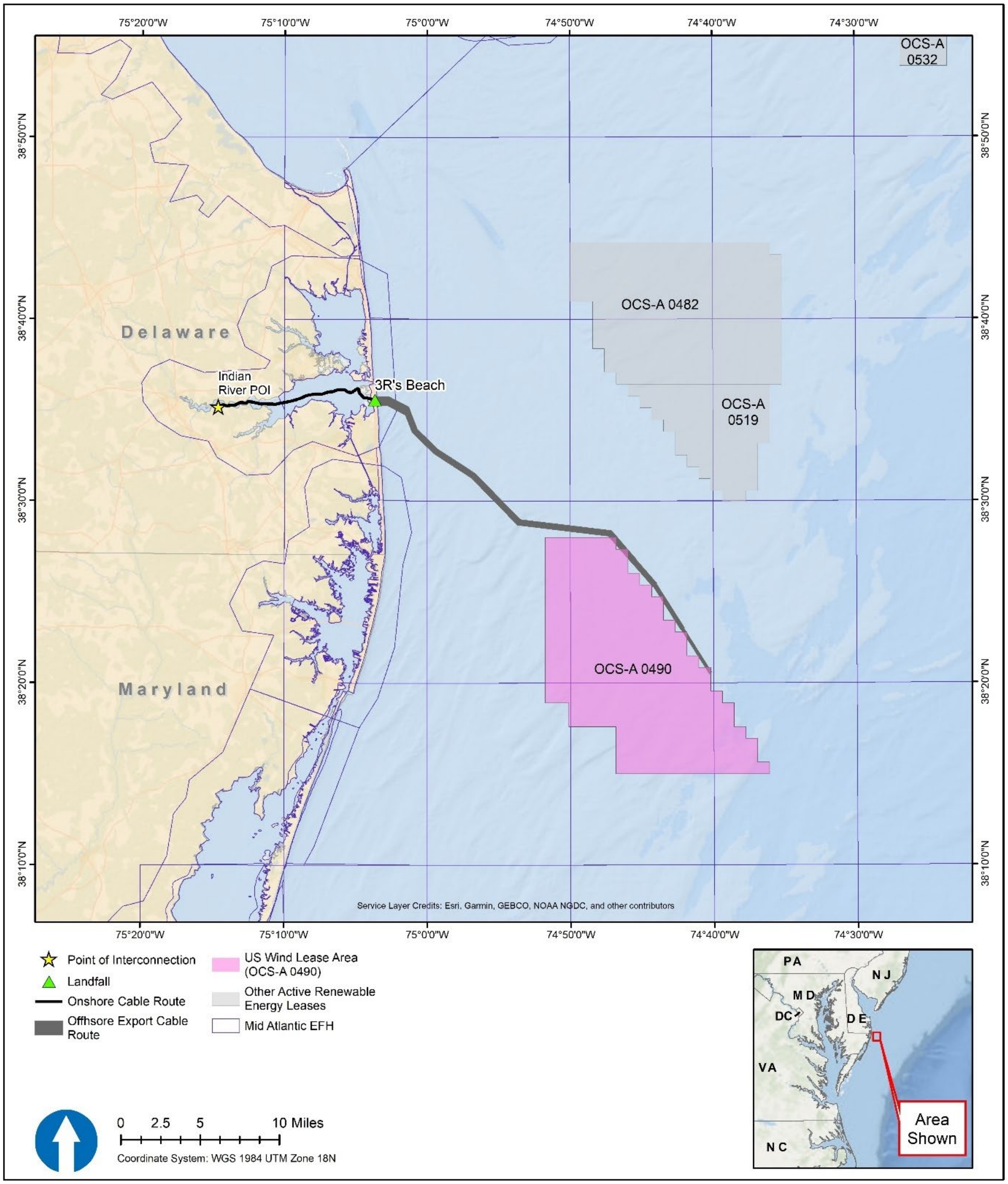

Figure 4-1. Essential Fish Habitat (EFH) grid units as designated by NOAA Fisheries that intersect with the Project area

4.1 EFH Designations Within the Project Area

Benthic and pelagic habitats are cited as EFH within the Project area that consists of 36 fish and 5 invertebrate species (see Appendix F, Table F-1). Species with EFH in the Project area were identified using the NOAA Fisheries EFH Mapper (2023), NEFMC Omnibus Amendment 2 (2017), MAFMC FMPs, NOAA Fisheries Highly Migratory Species Amendment 10 (2017), and NOAA Fisheries EFH source documents. US Wind prepared information to support the EFH assessment that was used as a source (Appendix C, *Information to Support the EFH Assessment*).

4.1.1 Habitat Areas of Particular Concern (HAPC)

The sandbar shark and sand tiger shark HAPCs are mainly located to the north of the Project area in the nearshore area off the Delaware coast and into Delaware Bay. Neither of the shark HAPCs intersect with the Lease Area but the sand tiger shark HAPC is close to if not contiguous with the proposed Offshore Export Cable Routes (Figure 4-2). Sandbar shark, sand tiger shark and summer flounder HAPCs have been designated within potential vessel transit routes from ports to the Project area. Summer flounder HAPC has not been spatially defined by NOAA but does overlap with native species of macroalgae, seagrasses, and freshwater and tidal macrophytes within their defined EFH and the MAB. The Inshore Export Cable Route in the Indian River Bay will overlap with the summer flounder HAPC.

Submerged aquatic vegetation has been observed to be sparse in Indian River Bay (DCIB 2016), but the presence/absence of vegetation has not been mapped for the Project area. No SAV has been identified during the surveys in areas susceptible to permanent or temporary disturbance.

4.1.1.1 Sandbar Shark HAPC

The Delaware Bay was established as an HAPC for the sandbar shark (*Carcharhinus plumbeus*) in 2006 and was later modified in 2017 (Rauch, 2017, NOAA Fisheries, 2017). Delaware Bay has been identified as an important secondary nursey ground for the sandbar shark (Merson and Pratt, 2001). Multiple tagging studies have shown that the sandbar sharks return to the Delaware during summer months after overwintering in estuary habitats of North Carolina, South Carolina, and Georgia (McCandless, et al. 2002, Merson, et al. 2007). Potential adverse effects of Project activities on the different life stages of sandbar sharks and the HAPC environment are analyzed in Section 5.

4.1.1.2 Sand Tiger Shark HAPC

The Delaware Bay and northern portion of the DelMarva Peninsula was established as an HAPC for the sand tiger shark (*Carcharias taurus*) in 2017 (Rauch, 2017, NOAA Fisheries, 2017). Tagging studies completed under the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey (NOAA Fisheries, 2017) demonstrated that sand tiger sharks show consistent and extensive use of the Delaware Bay and southern New Jersey estuarine habitats for all life stages of sand tiger sharks with high site fidelity within these areas. Male sand tiger sharks that utilize the Delaware Bay as a nursery have been shown to travel south to North Carolina and females have been shown to migrate east to the deeper habitats of the edge of the continental slope (Teter et al. 2015). Potential adverse effects of Project activities on the different life stages of sand tiger sharks and the HAPC environment are analyzed in Section 5.

4.1.1.3 Summer Flounder HAPC

Summer flounder (*Paralichthys dentatus*) HAPC is defined as 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 macrophytes are eliminated, then exotic species should be protected because of functional value.

Juvenile and adult summer flounder commonly inhabit seagrass beds within coastal bays and estuaries. In general, adult and older juveniles can be found in shallow, inshore and estuarine waters during the summer and fall and then move offshore to deeper waters in the winter and spring, although some juveniles will remain in the bays and estuaries for the winter (Packer et al. 1999; Smith and Daiber 1977; Able and Kaiser 1994; Reid et al. 1999b). Potential adverse effects of Project activities on eggs, larvae, juvenile, and adult summer flounder HAPC are analyzed in Chapter 5.

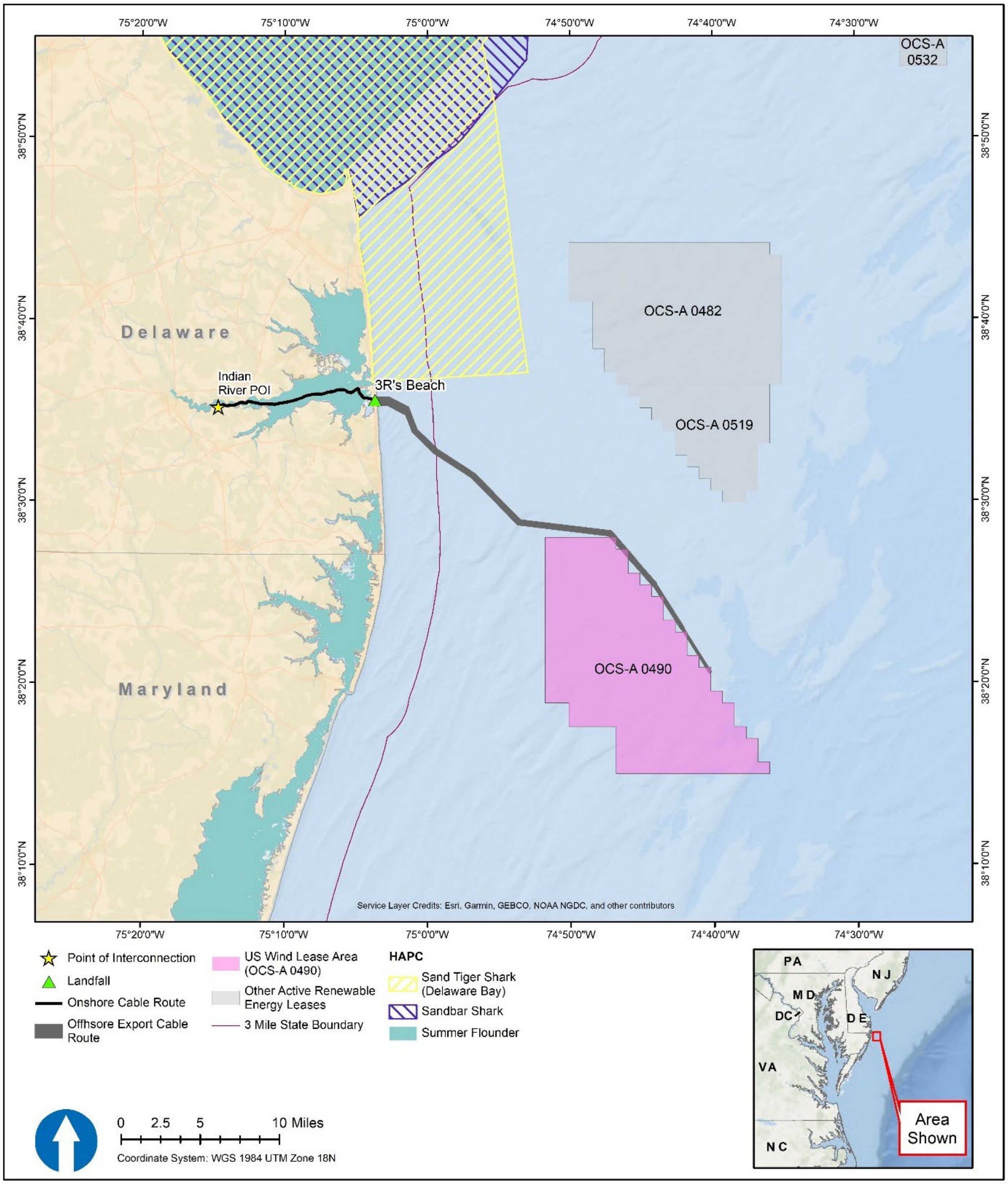

Figure 4-2. HAPC in the Project area

4.2 EFH Species Groups

Species groups, which are used throughout this assessment, are groups of EFH species and/or life history stages that predominantly share the same habitat type. Benthic/Epibenthic species groups are sorted into two habitat types (soft bottom or complex) based on the benthic habitat with which the species is most typically associated, with the potential for any species to be found in heterogenous complex as that habitat type could include both soft bottom and complex habitat.

Prey species are included as EFH species groups because they are consumed by managed fish and invertebrate species as prey, and thus are a component of EFH.

Sessile Benthic/Epibenthic – Soft bottom (includes slow-moving benthic/epibenthic species and/or life stages; could include heterogenous complex habitat)

- Atlantic sea scallop (eggs, larvae, juveniles, adults)
- Atlantic surfclam (juveniles)
- Longfin inshore squid (eggs)
- Ocean quahog (juveniles, adults)

Mobile Benthic/Epibenthic – Soft bottom (could include heterogenous complex habitat)

- Atlantic angel shark (neonates, juveniles, adults)
- Monkfish (eggs, larvae)
- Red hake (juveniles)
- Scup (juveniles, adults)
- Skates (juveniles, adults)
- Windowpane flounder (juveniles, adults)
- Witch flounder (juveniles, adults)

Sessile Benthic/Epibenthic – Complex Habitat (includes slow-moving species and/or life stages; could include heterogenous complex habitat)

- Longfin squid (eggs, adults)

Mobile Benthic/Epibenthic – Complex Habitat (could include heterogenous complex habitat)

- Atlantic cod (eggs, larvae, adults)
- Atlantic herring (juveniles, adults)
- Atlantic sharpnose shark (adults)
- Black sea bass (juveniles, adults)
- Clearnose skate (juveniles, adults)
- Common thresher shark (neonates)
- Dusky shark (neonates)
- Little skate (juveniles, adults)
- Red hake (juveniles, adults)
- Scup (juveniles, adults)
- Sandbar shark (neonates, juveniles, adults)

- Sand tiger shark (neonates)
- Shortfin mako shark (neonates)
- Smooth dogfish (neonates, juveniles, adults)
- Spiny dogfish (juveniles, adults)
- Summer flounder (eggs, larvae, juveniles, adults)
- Tiger shark (juveniles, adults)
- Winter skate (juveniles, adults)
- Yellowtail flounder (eggs, larvae, juveniles, adults)

Pelagic

- Atlantic albacore tuna (juveniles)
- Atlantic bluefin tuna (juveniles, adults)
- Atlantic butterfish (eggs, larvae, juveniles, adults)
- Atlantic herring (juveniles, adults)
- Atlantic mackerel (eggs, juveniles, adults)
- Atlantic skipjack tuna(adults)
- Atlantic yellowfin tuna (juveniles)
- Black seabass (larvae)
- Bluefish (eggs, larvae, juveniles, adults)
- Blue shark (juveniles, adults)
- Cobia (eggs, larvae, juveniles, adults)
- Common thresher shark (juveniles, adults)
- Dusky shark (juveniles, adults)
- Longfin inshore squid (juveniles, adults)
- King mackerel (eggs, larvae, juveniles, adults)
- Northern shortfin squid (juveniles)
- Pollock (larvae)
- Red hake (eggs, larvae)
- Sand tiger shark (juveniles, adults)
- Silver hake (eggs, larvae)
- Shortfin mako (juveniles, adults)
- Spanish mackerel (eggs, larvae, juveniles, adults)
- Tiger shark (juveniles, adults)
- Windowpane flounder (eggs, larvae)
- Witch flounder (eggs, larvae)

Prey Species – Benthic/Epibenthic

- Bivalves such as blue mussel (*Mytilus edulis*), eastern oyster (*Crassostrea virginica*), hard clams (*Mercenaria mercenaria*), soft-shell clams (*Mya arenaria*)
- Annelid worms
- Crustaceans – e.g., amphipods, shrimps, crabs

Prey Species – Pelagic

- Anchovy, bay (*Anchoa mitchilli*) and striped (*A. hepsetus*)
- River herring (alewife [*Alosa pseudoharengus*], blueback herring [*A. aestivalis*])
- Sand lance (Ammodytes americanus)

4.3 NOAA Trust Resources

The Atlantic States Marine Fisheries Commission, in cooperation with the states and NOAA Fisheries, manages more than two dozen fish and invertebrate species separately from the MSA; many of these species are also identified as NOAA Trust Resources. Of these species, the Project may potentially affect those listed in Table 4-1 and discussed in detail in Chapter 7, NOAA Trust Resource Species.

Table 4-1. NOAA Trust Resources within the Project area

Species	Scientific Name	Inshore	Offshore
Alewife	*Alosa pseudoharengus*		●
American eel	*Anguilla rostrata*	●	●
American shad	*Alosa sapidissima*	●	●
Atlantic menhaden	*Brevoortia tyrannus*	●	
Blueback herring	*Alosa aestivalis*	●	●
Striped bass	*Morone saxatilis*	●	
Blue crab	*Callinectes sapidus*	●	●
Blue mussel	*Mytilus edulis*	●	●
Eastern oyster	*Crassostrea virginica*	●	●
Horseshoe crab	*Limulus polyphemus*	●	●
Quahog	*Mercenaria mercenaria*	●	●
Soft-shell clam	*Mya arenaria*	●	●

5 Adverse Effects

This EFH Assessment analyzes the potential adverse effects of construction, operations, maintenance, and decommissioning activities for the proposed US Wind project offshore Delaware (see Table 5-1). These activities will occur within the Lease area, inter-array cable route, Offshore Export Cable Route, and the Inshore Export Cable Route within Indian River Bay (Figure 2-1). Potential adverse effects on EFH may be the result of project related activities or stressors which include noise, light, EMF, seafloor disturbance, habitat loss or conversion, entrainment/impingement, entanglement, routine vessel discharges, and vessel traffic. Each of these stressors will be assessed to determine how these activities affects the EFH-designated species during their life stages, and evaluate effects to pelagic, demersal, and benthic EFH managed species and their prey species within the project footprint as presented in Section 2.0. If a project component is likely to result in a short-term (less than 2 years), long-term (2 years to < life of Project), or permanent (life of Project) impairment of designated EFH or HAPC for a managed species and life stage, this would constitute an adverse effect on EFH.

Table 5-1. EFH effects analysis roadmap by project phase, activity, source, and duration

Project Phase	Activity	Sources	Duration	Analysis Sections
Construction and Installation	Seabed Preparation	• Habitat loss/conversion • Sediment suspension/redisposition • Entrainment • Underwater noise • Anchoring activities • Unexploded Ordinance	Short-term Short-term Short-term Short-term Short-term Short-term (Not Anticipated)	5.1.1.1, 5.1.2.1, 5.1.3.1
	Pile Driving	• Underwater noise	Short-term	5.1.1.2, 5.1.4.1
	Installation of Scour Protection	• Habitat loss/conversion • Sediment suspension/redisposition	Permanent Short-term	5.1.1.3
	Vessel Activity	• Habitat loss/conversion • Sediment suspension/disposition • Introduction of exotic/invasive species via ballast • Accidental fuel spills • Underwater noise	Short-term Short-term Short-term Short-term Short-term	5.1.1.4, 5.1.2.4, 5.1.3.4

Project Phase	Activity	Sources	Duration	Analysis Sections
Construction and Installation	Trenching and Cable Installation	• Habitat loss/conversion • Sediment suspension/redisposition • Entrainment • Underwater noise • Anchoring activities • Unexploded ordinance	Short-term Short-term Short-term Short-term Short-term Short-term	5.1.2.2, 5.1.3.2
	Cable Protection	• Habitat loss/conversion • Sediment suspension/redisposition	Permanent Short-term	5.1.2.3, 5.1.3.3, 5.1.6.2
	HDD	• Excavation of HDD entry/exit pits • HDD fluid release	Short-term Short-term	5.1.2.5, 5.1.3.5
	Artificial Substrate	• Community structure changes • Introduction of invasive Species	Permanent Short-term	5.1.4.1
	Underwater Noise	• Effects to species and species behaviors	Permanent	5.1.4.2
	Hydrodynamic Effects during Operations	• Effects from presence of structures and scour protection	Permanent	5.1.4.3
	Power Transmission (EMF, Heat)	• Migration and movement of managed fish and invertebrates from EMF • Community structure changes/invasive species from EMF and heat	Long -term Long-term	5.1.5.1, 5.1.6.1
	Power Conversion	• No HVDC conversion required	N/A	5.1.5.2

Project Phase	Activity	Sources	Duration	Analysis Sections
Operation & Maintenance	Operational Water Quality (Vessel and Facility Operations)	• Resuspension of contaminated material from seafloor disturbance from vessel activity • Resuspension of contaminated material from seafloor disturbance from scour and cable protection maintenance • Contaminants in discharge and thermal; discharge from power conversion • Releases of marine debris • Accidental spills	Short-term Short-term Short-term Short-term Short-term	5.1.5.3, 5.1.6.3
Monitoring	Marine Mammal Monitoring		No Adverse Effects	5.2.1
	Acoustics Monitoring		No Adverse Effects	5.2.2
	Fisheries Monitoring		Short-term effect for each monitoring effort	5.2.3
	Benthos and Benthic Habitat Monitoring	• No Benthic Monitoring Plan available	N/A	5.2.4
Conceptual Decommissioning	Anticipated Vessel Activity		Short-term	5.3.1
	Anticipated Treatment of Foundation Types, Scour Protection, Cables		Short-term	5.3.2
	Anticipated Effects from Proposed Treatment of EMF		Short-term	5.3.3

Adapted from: BOEM 2023b

5.1 Construction, Operation, and Maintenance Activities

US Wind provided the overall area and duration of benthic habitat impacts associated with each project component within the Offshore and Inshore Project areas as shown in Table 5-2 and 5-3, respectively (see Appendix C, *Information to Support the EFH Assessmen*t). In addition, Tables G-1 to G-5 in Appendix G provide the areal extent of impacts on benthic habitat types by project component and activity for each alternative, including the Proposed Action.

Table 5-2. Overall offshore area and duration of impacts to benthic habitat types

Habitat Type*	Entire Offshore Project Area		Lease Area		Common Offshore Export Cable Route		Offshore Export Cable Route 1		Offshore Export Cable Route 2 (alternative)	
	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)
Soft bottom	250.98	0.096	226.99	0.096	13.06	0	5.29	0	5.63	0
Complex	1.28	0.014	0.8	0.014	0.25	0	0.23	0	0.0	0
Heterogeneous complex	58.90	0.0	41.0	0.0	4.86	0	3.28	0	9.77	0
Large-grained complex	0.07	0.0	0.03	0	0	0	0.003	0.0	0.03	0
Total	311.23	0.11	268.82	0.11	18.17	0	8.803	0	15.43	0

Source: Appendix C, Information to Support the EFH Assessment

Note: Offshore Export Cable Route 2 is an Alternative to Offshore Export Cable Route 1

*As defined in GARFO's March 29, 2021 "Updated Recommendations for Mapping Fish Habitat"

Table 5-3. Overall inshore area and duration of impacts to benthic habitat types

Habitat Type*	Entire Inshore Project Area		Common Inshore Export Cable Route		Inshore Export Cable Northern Route		Inshore Export Cable Southern Route	
	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)	Temp Area (km^2)	Perm Area (km^2)
Soft bottom	12.83	0	6.02	0	3.0	0	3.81	0
Complex	0	0	0	0	0	0	0	0
Heterogeneous complex	0	0	0	0	0	0	0	0
Large-grained complex	0	0	0	0	0	0	0	0
Total	12.83	0	6.02	0	3.0	0	3.81	0

Source: COP Appendix II E-1, Table 7. US Wind 2023

Note: Inshore Export Cable Route could include cables in both common and southern Inshore Export Cable Routes

*As defined in GARFO's March 29, 2021 "Updated Recommendations for Mapping Fish Habitat"

5.1.1 Installation of WTG/OSS/Met Tower Structures and Foundations

5.1.1.1 Seabed Preparation (Boulder Relocation/Dredging/Grading)

Habitat Loss/Conversion from Seabed Preparation

Pre-installation seabed preparation for WTGs, OSSs, and Met tower installation under the Proposed action (Alternative B) such as levelling, boulder or UXO removal are not currently expected as part of the US Wind proposed construction activities (COP, Volume II, Section 3.1.2, US Wind 2023). US Wind does not anticipate seabed preparation would be necessary to provide a level surface at any of the post-piled jacket or jacket on suction bucket foundation locations for the OSSs. In the unlikely event that seabed leveling is needed, US Wind anticipates using equipment such as a TSHD to level the seabed and estimates a maximum case scenario of approximately 5,000 cubic yards (3,823 cubic meters) of dredge material at each OSS location. Dredged material would be placed or moved aside within the immediate vicinity of the defined OSS construction footprint. The habitat loss or conversion would be a small area consistent with the footprint of foundation of the structure (WTG, OSS, and Met Tower) and any scour protection systems installed around the foundations. For example, the habitat conversion for the WTGs and scour protection pad would result in 0.211 acres per WTG requiring seabed preparation (Maryland Offshore Wind DEIS, App C *Project Design Envelope*, BOEM 2023a). As with any operation that disturbs the seafloor, turbidity would be generated and sediment suspension and redeposition would occur, resulting in temporally short (within hours) and localized impacts on the Sessile and Mobile Benthic/Epibenthic – Soft bottom -Heterogeneous Complex EFH species group. The conversion of the benthic habitat could have a permanent (lethal) impact on sensitive life stages of demersal eggs, larvae, and adult life stages of invertebrate infauna managed species such as (i.e., ocean quahog, surfclams, Atlantic sea scallop). If dredging is the method used to modify the benthic habitat, the main source of injury would most likely be mechanical crushing and burial by the dredge equipment on the benthic habitat and entrainment of organisms through hydraulic dredge systems to be addressed in subsequent sections. These disturbances within the footprint of each WTG and OSS platform installation are considered local and temporally limited (short-term) and the benthic resources are expected to recover completely without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

Although large boulders are not expected in the Lease Area, US wind will prepare and submit a boulder relocation plan at least 90 days prior to WTG installation or foundation site preparation. The intent of the plan is to ensure potential impacts to essential fish habitat and commercial and recreational fisheries are adequately minimized.

The plan shall include the following:

- Identification of areas of active (within last 5 years) bottom trawl fishing, areas where boulders >7 feet (>2 meters) in diameter are anticipated to occur, and areas where boulders are expected to be relocated for project purposes.
- Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom trawl fishing, as identified in #1.

The Lessee must submit its boulder relocation plan to BOEM (at renewable_reporting@boem.gov) and the Bureau of Safety and Environmental Enforcement (BSEE) at OSWSubmittals@bsee.gov). DOI will review the Plan and provide comments, if any, on the plan within 45 calendar days, but no later than 90 days, of the Plan's submittal. The Lessee must resolve all comments on the Plan to DOI's satisfaction before implementation of the plan. If DOI does not provide comments on the Plan within 90 calendar days of its submittal, the Lessee may conclude that the Plan is not accepted and should not implement the plan.

Since US Wind does not anticipate relocating or removing any boulders no direct or indirect adverse effects are predicted for the EFH of benthic infauna, demersal finfish or invertebrate or pelagic species.

Sediment Suspension/Disposition from Seabed Preparation

Pre-installation seabed preparation for WTGs, OSSs, and Met tower installation under the Proposed Action (Alternative B) such as levelling, boulder or UXO removal are not currently expected as part of the US Wind proposed construction activities (COP, Volume II, Section 3.1.2, US Wind 2023). If seabed preparation is needed to provide a level surface for the OSS post-piled jacket or jacket on suction buckets, dredging equipment from a vessel would remove disturbed soil to create a firm and level base in the footprint of the foundation. The main sources of sediment suspension would be generated from potential dredging, UXO removal, and anchoring activities. Impacts from sediment suspension and deposition would be similar to impacts described in Section 5.1.1.4. The preparatory operations would not be occurring simultaneously and with distances 0.77 nautical miles (1.43 kilometer) east to west and 1.02 nautical miles (1.89 kilometer) north to south between each WTG, sediment deposition would most likely not overlap. The direct impacts would be associated with impacts related to grading and leveling and the conversion of the geomorphic features that required modifications. These suspended sediment impacts would be short-term and have a predominantly indirect effect on EFH species and early life stages which include the eggs and larvae of Atlantic herring, Atlantic sea scallops, Ocean quahogs, red hake, winter flounder, and yellowtail flounder.

Entrainment from Seabed Preparation

Hydraulic dredging is generally used to modify a site to create a stable and level base in offshore seafloor habitats composed of large sand waves or megaripples. Hydraulic dredging moves the sediment to create a flat planar construction pad for the installation of WTGs, OSS, or Met Tower platforms and associated scour pad. The intake for the hydraulic pumps are typically located near the surface and withdraws large volumes of water along with the dredging head at the seafloor. If used, water intake poses an entrainment risk to pelagic and benthic eggs and larval life stages of both finfish and invertebrates in the various EFH species groups listed in Section 4.2. The dredge operations would be temporally short and most likely needed at only a few sites within a lease area. The limited volume of water during the temporally short dredging period would not produce a population-level impact on any EFH managed species, and therefore result in minor short-term but direct effects. As Reine and Clarke (1998) have demonstrated, the rate of egg and larval survival to adulthood for many species is naturally very low.

Underwater Noise from Seabed Preparation

Given the physical qualities of noise associated with dredging (see Draft EIS Appendix B [BOEM 2023a] for a description), injury and auditory impairment are unlikely, but all of the EFH species groups of both finfish and invertebrates could experience behavioral disturbance or masking close to the area where dredging may occur in relation to seabed preparation activities. No research has specifically looked at responses to these noise sources; however, the impacts are likely to be similar, but less intense, than those observed with vessel noise (Section 5.1.1.1.1.3) since these activities are not as widespread or frequent as vessel transits. Hydraulic dredging methods such as trailing suction hopper dredging and cutter suction dredging produce the loudest SPLs ranging from approximately 168 to 190 dB re 1 µPa at 3 feet (1 meter) while mechanical dredging techniques such as grab dredging and backhoe dredging produce generally lower SPL ranging from approximately 107 dB re 1 µPa at 154 meters to 179 dB re 1 µPa at 3 feet (1 meter) (McQueen et al. 2019). However, given the low risk of adverse effects related to noise from dredging noise on fish and invertebrates. Overall, the impacts would be limited to short-term behavioral responses which would have an adverse, negligible effect, as there would be no measurable impacts on species or habitat, or impacts would be so small that they would be extremely difficult to discern or measure.

Anchoring Activities associated with Seabed Preparation

Most vessels to be utilized during seabed preparation for the installation of the WTGs, OSSs, or the MET tower would utilize dynamic positions (DP) systems, but some in support of potential UXO removal, leveling and pre-trenching may require anchoring to support these activities. Offshore vessels such as jack-up barges utilize stabilization spuds. Jack- barges can be configured with three to four spuds which cause depressions or “footprints” in the seafloor that can persist over a long period of time depending on the sediment habitat and various factors related to the setting and removal of the spuds from the site. Impacts from anchoring relative to the seabed preparation would be limited, as construction is staggered from 2025 through 2028.

Habitat Loss/Conversion

Anchoring impacts could occur during anchor deployment, retrieval, and from anchor chain sweep. Contact and impact from anchoring activities could cause direct short-term (displacement), Long-term (habitat loss) or permanent impacts by crushing invertebrate infauna, immobile sessile or early life stage of organisms that utilize benthic resources as nursey habitats. US Wind is not currently expecting the need to perform any of these activities prior to installation. If new information concerning the need for these activities is discovered, US Wind would avoid impacts related to sensitive resources by following mitigation measures and BMPs when operating near or within any areas with sensitive benthic resources. As part of the mitigation measures US Wind would prepare and submit for review with cooperating agencies an anchoring plan. This plan would utilize HRG survey data to avoid sensitive habitats such as SAV and hard bottom and structurally complex benthic habitats to the maximum extent practicable. Since US Wind does not anticipate performing any seabed preparations in relation to WTG, OSS, or Met Tower installations, no direct or indirect adverse effects are predicted for the EFH of any managed benthic infauna, demersal finfish or invertebrate or pelagic species.

Sediment Suspension/Redeposition

Impacts resulting from anchoring or bottom contact would include increased turbidity levels and potential for contact causing mortality of demersal and infaunal invertebrate species and prey species such as benthic-demersal crustaceans (e.g., amphipods, shrimps, and crabs), and possibly, degradation of sensitive habitats. All impacts would be localized; turbidity would be temporary; impacts from anchor contact with soft bottom (or spud can or leg emplacement) would recover in the short-term. Degradation of sensitive habitats such as certain types of hardbottom or eelgrass, if it occurs, could cause long-term to permanent impacts. The response to suspended sediments would be species and life stage-specific. Adults as well as competently swimming juveniles or larvae of the Pelagic EFH species group (Section 4.2) will likely swim away from suspended sediment plumes produced during anchoring activities. Planktonic eggs and larvae of federally managed fishes and invertebrates will not be able to actively avoid sediment plumes. US Wind does not anticipate performing any seabed preparations no direct or indirect adverse effects are predicted for the EFH of any managed benthic infaunal, demersal finfish or invertebrate or pelagic species in relation to sediment suspension/redeposition.

Unexploded Ordinance Relocation and/or Removal

US Wind has not detected and does not expect to find unexploded ordnances (UXOs) within the boundaries of the proposed project area. Surveys within the Offshore Export Cable Route and Lease area have not detected the presence of any UXOs. If an UXO is found within the Lease area avoidance of any UXO through micrositing is the preferred approach where feasible. Avoidance entails micrositing of WTG, OSS or Met tower foundations away from any UXO hazards. UXO clearance involves relocation, removal, or detonation in place (Middleton et al. 2021). UXO detonations are not included under the Proposed Action and will not be discussed further (US Wind 2023).

Generally, the most common approach utilized to deal with UXOs within the footprint of a WTG, OSS, or Met Tower is avoidance. Avoidance entails micrositing of the foundations to avoid UXO hazards. UXO clearance involves relocation, removal, or detonation/incineration in place (Middleton et al. 2021). UXO detonations are not included under the Proposed Action and will not be discussed further (US Wind 2023). UXO clearance methodologies are not a common mitigation approach because of the high risk and cost (Middleton et al. 2021). The micrositing or relocation adjustments are usually limited to 50 to 100 feet (15 to 30 meters) from the UXO hazard (Middleton et al. 2021). The micrositing efforts result in the same type of short-term construction related and permanent operational effects as those described below in the construction methods for cable installation and WTG and OSS foundation installation.

The removal/relocation or onsite detonation/incineration of UXOs are generally the least utilized or desired approach because of the inherent risk and cost of operations (Middleton et al. 2021). If the UXO is within a sensitive biological or archeological resource area, removal and detonation or onsite incineration may be the only option. As part of the operation a thorough plan would be required, including protective measures for marine life, cultural resources, and human health and safety (GICHD 2016; Middleton et al. 2021). If all other removal or relocation methods are deemed ineffective for the UXO, detonation may be required and the resultant explosion creates both a shock wave and a rapid oscillation in pressure, which can adversely affect fishes and invertebrates through risk of barotrauma, hearing effects, or potential mortality.

Habitat Loss/Conversion from UXO Relocation and/or Removal

The main mechanism for habitat loss or conversion related to UXO relocation or removal would be the removal of seafloor sediments around the UXO. Removal of these seafloor sediments would be a direct but short-term effect. The excavation impression around the UXO would be miniscule in relation to other project related excavation/dredging operations and very localized resulting in a very small area and impacting potentially only a few individuals within the Mobile Benthic/Epibenthic – Soft bottom and Complex Habitat EFH species groups. These excavation activities effects are considered localized and short-term with benthic resources expected to recover completely without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006) and would most likely naturally refill.

Sediment Suspension/Redeposition from UXO Relocation and/or Removal

UXO removal would cause turbidity which would be temporally short (short-term) and very localized around the UXO removal site. The activity would result in short periods of elevated turbidity that would return to background levels within hours (1 to 2) if not minutes of the operations completion.

Entrainment from UXO Relocation and/or Removal

The excavation around the UXO would be very controlled and most likely completed through the use of a hydraulic dredge operated and manipulated by an ROV. This type of excavation/dredging would be very temporary and result in short periods of operations of the hydraulic pumps that pull small volumes of site water. US Wind does not anticipate performing any UXO removal operations and no direct or indirect adverse effects are predicted for the EFH of any managed benthic infaunal, demersal finfish or invertebrate or pelagic species in relation to entrainment related to UXO removal, but if it were to occur very limited volumes of site water intake would occur. This intake of water could potentially entrain the eggs and larvae of EFH managed species, however small withdrawals of water to support a very limited intake of this size would not result in a population level impact. As Reine and Clarke (1998) have demonstrated, the rate of egg and larval survival to adulthood for many finfish and invertebrate species is naturally very low.

Underwater Noise from UXO Relocation and/or Removal

If all other removal or relocation methods are deemed ineffective for the UXO, detonation may be required and the resultant explosion creates both a shock wave and a rapid oscillation in pressure, which can adversely affect fishes and invertebrates through risk of barotrauma, hearing effects, or potential mortality.

Barotrauma occurs when there is a rapid contraction and overextension of the swim bladder, which can occur when a fish is close to the site of the UXO detonation. The distance at which barotrauma may occur is generally expected to be smaller than that at which hearing effects could occur, although there is no data on temporary threshold shift (TTS) related to explosions. Jenkins et al. (2022) and Smith et al. (2022) exposed Pacific mackerel to explosives in situ at distances ranging 101 to 2,648 feet (31 to 807 meters) and examined potential damage to auditory tissues (Smith et al. 2022) and non-auditory tissues (Jenkins et al. 2022). Compared to controls, there were increases in mortality observed at distances up to 515 feet (157 meters) from the explosion, and other non-auditory injuries (e.g., damage to swim bladder and kidneys) occurred up to 1,093 feet (333 meters) from the source at received peak sound pressure levels (Lpk) of 226 dB re 1 μPa (Jenkins et al. 2022). At greater distances up to 1,312 feet (400 meters) and lower received Lpk (220 dB re 1 μPa), there was evidence of hair cell damage, suggesting that hearing would likely be impaired at this distance, although no hearing tests were conducted (Smith et al. 2022). Interestingly, a similarly designed study with sardines (Dahl et al. 2020) showed the greatest physiological effects (e.g., burst capillaries, swim bladder rupture, and kidney rupture) occurred at less than 164 feet (50 meters) from the explosion, but then a secondary increase in effects occurred 110 to 492 feet (125 to 150 meters) from the explosion. This secondary peak was thought to be the result of propagation pathways whereby the sound pressure reflections off the seafloor and sea surface may have converged at this distance and created a particularly rapid change in acoustic pressure. Larval forms of fishes with closed swim bladders are also likely to experience injury or mortality at close distances, as demonstrated in a field study by Govoni et al. (2008).

Fish and invertebrates that lack swim bladders are more resistant to underwater blasts (Goertner et al. 1994) because it is typically the rapid expansion and contraction of gas-filled spaces that results in the greatest physiological injury. Modeling work by Goertner (1978) predicted that the range at which effects could occur in a non-swim bladder fish was 100 times smaller than that of a fish with a swim bladder. Kevin and Hempen (1997) report on several studies in which various invertebrate species were exposed to charges of different sizes. Overall, despite some studies lacking adequate controls and sample sizes, they conclude that invertebrates are generally resilient to pressure-related damage from underwater explosions.

If UXO detonation is the only option, it will severely affect fish with and without swim bladders. The effects range will be within several hundred meters for fish with swim bladders and less than 328 feet (100 meters) for fish without swim bladders and invertebrates, but this would likely only affect a few individuals or a few fish schools. If detonation is demonstrated to be necessary, US Wind would be required to consult with all appropriate state and federal agencies to prepare a plan for safely detonating the UXO. Plans must follow all available guidance (GICHD. 2016; Carton et al. 2017; Middleton et al. 2021) and regulations regarding UXO interactions. US Wind would be required to submit mitigation and monitoring measures such as noise mitigation systems to reduce the area in which fish and invertebrates may experience more severe effects such as mortality or injury. Given the extremely short duration of explosions and the limited area over which potential effects may occur, impacts would be limited to behavioral effects that are expected to be short-term, making them of lesser concern than potential injury (Popper et al. 2014). Therefore, the impacts on EFH managed fishes and invertebrates and their habitat during potential detonations of UXOs would be direct and adverse but potentially short term. Most impacts such as mortality and serious injuries could be avoided with the implementation of mitigation measures but impacts that do occur could lead to a direct impact and loss of a few individuals that would not result in long-term impacts on EFH fish or invertebrate populations or their protected habitats.

5.1.1.2 Pile Driving

Background on Fish and Invertebrate Hearing

Many fishes and invertebrates produce sounds for basic biological functions like attracting a mate and defending territory. A recent study revealed that sound production in fishes has evolved at least 33 times throughout evolutionary time, and that most ray-finned fishes are likely capable of producing sounds (Rice et al. 2022). Fish may produce sounds through a variety of mechanisms, such as vibrating muscles near the swim bladder, rubbing parts of their skeleton together, or snapping their pectoral fin tendons (Ladich and Bass 2011; Rice et al. 2022). Marine invertebrates have been documented producing sounds ranging from the ubiquitous snapping shrimp "snaps" (Johnson et al. 1947) to spiny lobster "rasps" (Patek 2002) to mantis shrimp "rumbles" (Staaterman et al. 2011). Some sounds are also produced as a byproduct of other activities, such as the scraping sound of urchins feeding (Radford et al. 2008a) and even a "coughing" sound made when scallops open and close their shells (Di Iorio et al. 2012).

There are some species that do not appear to produce sounds, but still have acute hearing (e.g., goldfish), which has led scientists to surmise that animals glean a great deal of information about their environment through acoustic cues, a process called "auditory scene analysis" (Fay 2009). All the sounds in a given environment, both natural and human-made, comprise the "soundscape," or acoustic habitat for that species (Pijanowski et al. 2011). Acoustic habitats naturally vary over space and time, and there is increasing evidence that some fish and invertebrate species can distinguish between soundscapes of different habitats (Kaplan et al. 2015; McWilliam and Hawkins 2013; Radford et al. 2008b). In fact, some pelagic larvae may use soundscapes as a cue to orient towards suitable settlement habitat (Lillis et al. 2013, 2015; Montgomery 2006; Radford et al. 2007; Simpson et al. 2005; Vermeij et al. 2010) or to induce molting into their juvenile forms (Stanley et al. 2015).

All fishes and invertebrates are capable of sensing the particle motion component of underwater sound. The inner ear of fishes is similar to that of all vertebrates. Each ear has three otolithic end organs, which contain a sensory epithelium lined with hair cells, as well as a dense structure called an otolith (Popper et al. 2021). Particle motion is the displacement, or back and forth motion, of water molecules and as it moves the body of the fish (which has a density similar to seawater), the denser otoliths lag behind, creating a shearing force on the hair cells which sends a signal to the brain via the auditory nerve (Fay and Popper 2000). Many invertebrates have dense structures know as statoliths, which sit within a body of hair cells, and when the animal is moved by particle motion, it results in a shearing force on the hair cells, similar to that described for fish (Budelmann 1992; Mooney et al. 2010). Some invertebrates also have sensory hairs on the exterior of their bodies, allowing them to sense changes in the particle motion field around them (Budelmann 1992); the lateral line in fishes plays a similar role in fish hearing (McCormick 2011). Available research shows that the primary hearing range of most particle-motion sensitive organisms is below 1 kHz (Popper et al. 2021).

In addition to particle motion detection shared across all fishes, some species are also capable of detecting the pressure component of underwater sound (Fay and Popper 2000). Special adaptations of the swim bladder in these species (e.g., anterior projections, additional gas bubbles, or bony parts) bring it in close proximity to the ear, and as the swim bladder expands and contracts, pressure signals are radiated within the body of the fish making their way to the ear in the form of particle motion (Popper et al. 2021). These species can typically detect a broader range of acoustic frequencies (up to 3 to 4 kHz; Wiernicki et al. 2020) and are therefore considered to be more sensitive to underwater sound than those that can only detect particle motion. Hearing sensitivity in fishes is generally considered to fall along a spectrum: the least-sensitive (sometimes called "hearing generalists") are those that do not possess a swim bladder and only detect sound through particle motion, limiting their range to sounds below 1 kHz, while the most sensitive ("hearing specialists") possess specialized structures enabling pressure detection which expands their detection frequency range (Popper et al. 2021). A few species in the herring family can detect ultrasonic (>20 kHz) sounds (Mann et al. 2001), but this is considered very rare among the bony fishes. Another important distinction for species that do possess swim bladders is whether it is open or closed; species with open swim bladders can release pressure through a connection to the gut, while those with closed swim bladders can only release pressure very slowly, making them more prone to injury when experiencing rapid changes in pressure (Popper et al. 2019). It should also be noted that hearing sensitivity can change with age; in some species like black sea bass, the closer proximity between the ear and the swim bladder in smaller fish can mean that younger individuals are more sensitive to sound than older fish (Stanley et al. 2020). In other species, hearing sensitivity seems to improve with age (Kenyon 1996).

Compared to other fauna such as marine mammals, research has only scratched the surface in understanding the importance of sound to fish and invertebrate species, but there is sufficient data thus far to conclude that underwater sound is vitally important to their basic life functions, such as finding a mate, deterring a predator, or defending territory (Popper and Hawkins 2018; 2019). Therefore, these species must be able to detect components of marine soundscapes, and this detectability could be adversely affected by the addition of noise from Project activities.

Acoustic Habitats in the Project area

Acoustic habitats, including that of the Project area, can be represented by plotting the ratios of sound energy within selected frequency bandwidths for the habitat of interest. The acoustic habitat and changes within that habitat are demonstrated by shifts in the dominant frequency range and by increases or decreases in sound energy within selected bandwidths. Modeled soundscapes and sound maps, such as those provided in the NOAA's sound data mapping products (NOAA 2023), are generated by incorporating environmental (e.g., bathymetric, oceanographic), biological, and anthropogenic sound data, and then modeling the sound propagation over space and time. These models represent the basis for assessing acoustic habitats and are the baseline for a potential impact analysis to species due to the introduction of acoustic sources, such as those expected during offshore wind farm construction and operations, within that environment.

Additional data regarding acoustic habitats can also be obtained from in situ baseline sound data collected in or near the location of interest by underwater recorders. For waters offshore Delaware, which includes the Project area, in situ data were collected by Martin et al. (2014) for one year at two sites offshore Delaware with accompanying wind speed, wave height, and sea surface temperature data acquired from a nearby National Buoy Data Center (NBDC) buoy. Autonomous underwater sound recorders were deployed on four separate occasions to examine potential seasonal differences. From the data collected, the primary sources of ambient sound in this region were increased wave energy from passing storms (i.e., physical source), anthropogenic sound such as shipping, and biological sounds (Martin et al. 2014). Low frequency sound (<100 Hz) showed the highest sound levels for the entire recording period compared to sound in frequencies >100 Hz, ranging between approximately the 95^{th} percentile of 60 decibels (dB) referenced to (re) 1 micropascal (µPa) (which indicates that 95% of the recorded data was either at this sound levels or higher) and the 5^{th} percentile of 105 dB re 1 µPa (which indicates that only 5% of the recorded data was either at this sound level or higher). Contributing sound sources in this frequency band were primarily weather events and anthropogenic sound, largely shipping traffic. For the frequency band between 200 and 1,000 Hz, the root-mean-square sound pressure levels (SPLs) in the 5^{th} percentile reached about 95 dB re 1 µPa, but the 95^{th} percentile for this frequency band was lower, at approximately 50 dB re 1 µPa. The highest SPLs in this frequency band were correlated with increased fish vocalizations, specifically the striped cusk-eel (*Ophidion marginatum*), in the late summer and fall. This was the main deviation observed during the recording period; ambient sound levels were otherwise comparable throughout the year, and no discernable seasonal variation was documented (Martin et al. 2014).

Acoustic Threshold Criteria for Fish

For fish, NMFS has adopted injury criteria relative to impulsive sources using dual criteria developed by the Fisheries Hydroacoustic Working Group (FHWG 2008). These dual criteria were developed to account for the risk of exposure to high levels of accumulated energy for repeated impulsive sounds with the sound exposure level over 24 hours (SEL_{24h}) metric, and from exposure to rapid increase in sound pressure from single strikes with the peak sound pressure level (L_{pk}) metric (FHWG 2008; Popper et al. 2014). Currently, FHWG (2008) recommends a single SPL criterion for behavioral response of all fish and does not distinguish between impulsive and non-impulsive sources. Swim bladders, present in some fish, play a role in sound detection, and a fish's susceptibility to injury from sound exposure depends, in part, on the presence and function of a swim bladder. Threshold criteria have also been developed by Popper et al. (2014), although they have not been adopted by NMFS. These thresholds distinguish between different types of fish based on their hearing anatomy, as detailed further below:

- Fish with no swim bladder or other gas chamber. This group includes elasmobranchs (sharks and rays, such as the giant manta ray [*Mobula birostris*]), jawless fishes, flatfishes, and gobies (*Gobiidae*) that are expected to be only capable of detecting particle motion (Casper et al. 2012). These species are least susceptible to barotrauma, or tissue injury that results from rapid pressure changes (e.g., forced change in depth, explosions, intense sound) (Popper et al. 2014).
- Fish with swim bladders or other gas volumes not involved in hearing. This group includes some pelagic species such as Atlantic salmon (*Salmo salar*) and tuna, as well as Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*). These fishes are susceptible to barotrauma and are only capable of detecting particle motion.

- Fish with swim bladder or other gas volumes involved in hearing. This group includes Atlantic cod, herrings, shad (*A. sapidissima*), otophysans, mormyrids, and squirrelfish (*Holocentridae*). They detect both sound pressure and particle motion and are susceptible to barotrauma.
- Fish eggs and larvae (Popper et al. 2014).

The thresholds used in the modeling which formed the basis for assessing effects from underwater pile driving noise are provided in Table 5-4.

Table 5-4. Acoustic thresholds for various effects of impact pile driving

Group	Metric	Threshold
Injury[1]		
Fish Equal or greater than 2 g	SEL_{24h}	187
Fish Equal or greater than 2 g	L_{pk}	206
Fish less than 2 g	SEL_{24h}	183
Fish less than 2 g	L_{pk}	206
Recoverable Injury[2]		
Fish without swim bladder	SEL_{24h}	>216
Fish without swim bladder	L_{pk}	>213
Fish with swim bladder	SEL_{24h}	203
Fish with swim bladder	L_{pk}	>207
Temporary Threshold Shift[2]		
Fish without swim bladder	SEL_{24h}	>>186
Fish with swim bladder not involved in hearing	SEL_{24h}	>186
Fish with swim bladder involved in hearing	SEL_{24h}	186
Behavior[3]		
All fish	SPL	150

L_{pk} = zero-to-peak sound pressure level in units of dB re 1 µPa; SPL = root-mean-square sound pressure level in units of dB re 1 µPa; SEL_{24h} = sound exposure level over 24-hours in units of dB re 1 $µPa^2$ s

[1] From the Fisheries Hydroacoustic Working Group (2008)

[2] From Popper et al. (2014)

[3] From Andersson et al. (2007), Wysocki et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011)

Effects of Underwater Noise from Pile Driving on Fish and Invertebrates

An increase in underwater noise could affect the EFH of the listed finfish and invertebrates within the Lease Area during installation of the WTG, OSS, and Met Tower foundations. These activities have potential to produce noise above recommended fish acoustic thresholds (Table 5-4). Impact or vibratory pile driving used during construction of the Proposed Action to secure foundations into the seabed; for information on the physical characteristics of impact pile driving. Impact pile driving is characterized as an impulsive source and could cause injury and mortality of fishes and invertebrates in the vicinity of each pile, and could cause short-term stress, behavioral changes, and masking over greater distances. Overall, the effects of pile driving noise on fishes and invertebrates will vary based on the habitats they utilize and life history stage they encounter. An overview of available research of the effect of pile driving noise for each taxonomic group is provided below.

Fishes

Early observations of dead fish near a bridge construction project (Caltrans 2004) suggested that fish could be killed when very close to pile-driving operations (less than 33 feet [10 meters] from the pile). A field study since then measured potential mortality of fishes near pile-driving operations and found no increase in mortality of juvenile European seabass (a species with a closed swim bladder) at received L_{pk} of 210 to 211 dB re 1 µPa within 148 feet (45 meters) of the pile (Debusschere et al. 2014). Since little empirical work has examined the potential for non-recoverable injury (i.e., injuries that would lead to mortality), acoustic modeling is used to predict potential effects associated with the given acoustic thresholds (Table 5-4).

Ainslie et al. (2020) used a damped cylindrical spreading model informed by empirical measurements from the North Sea for pile diameters ranging from 11 to 23 feet (3.35 to 7.0 meters) to derive effect ranges based on the acoustic criteria provided in the Popper et al. (2014) Sound Exposure Guidelines. They estimated that using 7,000 strikes to drive a 19.7-feet (6-meters) diameter pile in water depths of 92 feet (28 meters) with 10 dB noise mitigation at the source, fish without a swim bladder could experience mortal injury up to 128 feet (39 meters) from the pile, and recoverable injuries up to 253 feet (77 meters) from the pile. These effect ranges were estimated to be larger for fish that have a swim bladder involved in hearing as mortal injury could occur up to 1,749 feet (533 meters) from the pile, and recoverable injury could occur up to 0.74 miles (1.2 kilometers) from the pile. In similar water depths of the Western North Atlantic, modeling predictions for installing a 36-foot (an 11-meter) diameter monopile assuming 2,202 strikes, a 4,000-kJ energy hammer, 10 dB of noise mitigation yielded similar exposure ranges. Fish without a swim bladder could experience recoverable injury out to 722 feet (220 meters), while fish with a swim bladder involved in hearing could experience recoverable injury out to 0.94 miles (1.52 kilometers) (Ocean Wind 2022). It is generally safe to assume that fishes without a swim bladder, as well as invertebrates, could experience recoverable injury on the order of tens to hundreds of meters, while fishes with swim bladders involved in hearing may experience effects on the order of 1 to 2 kilometers; these distances assume 10 dB of noise mitigation at the source.

The estimates above from available acoustic modeling analyses are described in terms of acoustic pressure, which is relevant for fishes with swim bladders, but for other species, particle motion is the more appropriate cue. Field work by Amaral et al. (2018) measured particle acceleration during impact pile-driving of jacket foundations with 4.3-foot (1.3-meter) diameter pin piles. At 1,640 feet (500 meters) from the pile, in water particle acceleration ranged from 30 to 65 dB re 1 μm/s^2 in the 10 to 1,000 Hz range, but closer to the seabed it was significantly higher, at 50 to 80 dB re 1 μm/s^2. When comparing these received levels to the published hearing capabilities of several fish species, it was surmised that in-water particle acceleration would be barely audible at this distance, while levels near the seabed would indeed be detectable (Amaral et al. 2018). These field measurements of particle motion are critical for putting other experimental research into context; most of the studies described below have focused on acoustic pressure, which is relevant for only a sub-set of fishes. It also underscores that species which lack hearing specializations are unlikely to experience significant effects from impact pile-driving beyond a few hundred meters from the source for similar-size piles and water depths.

A suite of empirical studies has examined other behavioral and physiological effects in fishes beyond non-recoverable and recoverable injuries previously described. Most of this work has focused on commercially important species like the European seabass, which lacks hearing specializations and has a closed swim bladder. Adult seabass generally dive deeper and increase swimming speed and group cohesion when exposed to intermittent and impulsive sources like pile driving (Neo et al. 2014, 2018), but juveniles become less cohesive (Herbert-Read et al. 2017) and generally seem to be more sensitive to pile-driving noise than adults (Kastelein et al. 2017). There is also some evidence that respiration rates may be affected by pile-driving noise (Spiga et al. 2017). Importantly, a number of studies have shown that European seabass are likely to habituate to pile driving noise over repeated exposure (Bruintjes et al. 2016; Neo et al. 2016; Radford et al. 2016). Together, this research suggests that European seabass, and probably other species with closed swim bladders, are likely to exhibit short-term startle or physiological responses, but would recover quickly once pile-driving is complete.

Results from field studies showed that free-swimming cod and sole both exhibited changes in swimming behavior in response to pile-driving noise (Mueller-Blenkle et al. 2010). Hawkins et al. (2014) found that schools of sprat were more likely to disperse, while mackerel were more likely to change water depth, and that both species, despite different hearing anatomy, responded at a similar received peak-to-peak sound pressure levels (L_{pk-pk}); 50% of the time they responded to L_{pk-pk} of 163 dB re 1 µPa which could be expected to occur up to tens of kilometers from the source. Lafrate et al. (2016) did not observe significant displacement in tagged grey snapper, a species with high site fidelity, residing within hundreds of meters of real pile driving operations, while Krebs et al. (2016) saw that Atlantic sturgeon seemed to avoid certain areas when pile-driving was taking place, suggesting that they would not remain in the area long enough to experience detrimental physiological effects. These field studies indicate that fishes may be startled, temporarily displaced, or change their schooling behaviors during pile-driving noise, but when pile driving is completed, they are likely to resume normal behaviors relatively quickly.

Overall, the research thus far indicates that fishes will exhibit short-term behavioral or physiological responses to pile-driving noise. Species that are considered hearing specialists would be more susceptible to physiological effects and behavioral disturbance and this risk would occur at greater distances than those considered hearing generalists. Aside from hearing anatomy, impacts are likely to differ between species based on other contextual factors, such as time of year or time of day. For example, impacts from pile-driving noise would be greater if they occur during spawning periods or within spawning habitat, particularly for species that are known to aggregate in specific locations to spawn, use sound to communicate, or spawn only once in their lifetime. However, fish that avoid an area during pile driving are likely to return following completion of pile driving activity so no long-term impacts on habitat availability are expected.

Invertebrates

Since marine invertebrates detect sound via particle motion and not sound pressure, they are not likely to experience barotrauma from pile driving. Very few studies have examined the effects of substrate vibrations from pile driving, yet many have recently acknowledged that this is a field of urgently needed research (Hawkins et al. 2021; Wale et al. 2021; Popper et al. 2022). Most of the currently available research has focused on water-borne particle motion, or even sound pressure, in relation to invertebrate sound detection.

Sessile marine invertebrates like bivalves are sensitive to substrate-borne vibrations and may be affected by pile-driving noise (Roberts et al. 2015; Spiga et al. 2016; Day et al. 2017). A recent study by Jézéquel et al. (2022) exposed scallops to a real pile-driving event at 26 and 164 feet (8 and 50 meters) from the pile. Measured peak particle acceleration was 110 dB re 1 $\mu m/s^2$ at 26 feet (8 meters) and 87 dB re 1 $\mu m/s^2$ at 164 feet (50 meters). None of the scallops exhibited swimming behavior, an energetically expensive escape response. At 26 feet (8 meters) from the pile, scallops increased valve closures during pile driving and did not show any habituation to repeated exposure to pile-driving noise. However, they returned to their pre-exposure behaviors within 15 minutes after exposure. Increased time spent with closed valves could reduce feeding opportunities and thus have energetic consequences, though the biological consequences of this effect have not been studied.

Cephalopods can detect low-frequency sounds by sensing particle motion with their statocysts and could therefore be injured from exposure to high-intensity noise. Damage to cephalopod statocysts has been observed in several tank-based studies (André et al. 2011; Sole et al. 2022). Jones et al. (2020) observed that exposure to pile-driving noise at median peak particle velocities of 40 dB re 1 m/s within a tank elicited alarm responses such as inking and jetting in longfin squid. While their initial responses diminished quickly, after 24 hours, the squid were re-sensitized to the pile-driving noise and showed no signs of habituation. A follow-up field study with small-scale pile driving looked at the behavior of the same species held in cages at different distances (26 and 164 ft [8 and 50 m]) and found similar results: alarm behaviors occurred with the first acoustic stimulus which diminished quickly (within approximately 4 seconds). Responses were only observed in squid located 26 feet (8 meters) from the pile, suggesting that at greater distances from pile-driving there is unlikely to be any alarm response (Cones et al. 2022). Another tank experiment examined predatory feeding behavior of longfin squid (Jones et al. 2021). Within the tank, peak particle acceleration during the playbacks were 130 to 150 dB re 1 $\mu m/s^2$ and L_{pk} was 160 to 180 dB re 1 µPa, which Jones et al. (2021) surmised was similar to field conditions within 1,640 feet (500 meters) of a 4.3-foot (1.3-meter) diameter steel pile. In the presence of pile-driving noise, there was a reduction in squid feeding success, and the introduction of pile-driving noise caused the squid to abandon predation attempts. Additional work showed that interactions between males and reproductive behaviors between males and females were unaffected by pile-driving noise, suggesting that the motivation to mate exceeds the potential stress that noise may introduce (BOEM-funded report, in press). This work underscores that squid (and likely all cephalopods) are sensitive to low frequency sound and may not habituate to pile-driving noise over repeated exposures. When pile-driving noise co-occurs with feeding periods, it could negatively affect feeding, but is unlikely to affect mating behaviors.

Like other marine invertebrates, crustaceans are capable of sensing low-frequency sound through particle motion in the water or in the substrate (Popper et al. 2001; Roberts and Breithaupt 2016). Research on seismic airguns and crustaceans has not demonstrated any widespread mortality or major physiological harm (Payne et al. 2007; Day et al. 2016a; Christian et al. 2003; Cote et al. 2020; Morris et al. 2020), though some sub-lethal effects on hemolymph biochemistry have been observed, and the biological consequences of these effects have not been well-studied. Pile-driving noise has also been shown to affect certain behaviors in crustaceans, such as reducing locomotor activity in Norway lobster (Solan et al. 2016), decreasing feeding activity in crabs (Corbett 2018), or inhibiting attraction to chemical cues in hermit crabs (Roberts and Laidre 2019). The available research indicates that marine crustaceans may alter their natural behaviors in response to pile-driving noise, but further work is required to understand the biological significance of these changes, and whether substrate-borne or water-borne particle motion has a greater influence on their behavior. Disentangling these effects is important for understanding the spatial scale at which they may be affected by pile-driving noise.

Eggs and Larvae

A handful of studies have directly investigated the effects of impulsive sources on eggs and larvae of marine fishes. Laboratory work by Bolle et al. (2012) and Bolle et al. (2014), which using a device similar to Halvorsen et al. (2012), showed that larvae of sole, seabass, and herring were relatively resilient to mortality even at received sound exposure levels exceeding 206 dB re 1 μPa^2 s, which the authors surmised was equivalent to the received sound exposure level (SEL) approximately 328 feet (100 meters) from a 13-foot (4-meter) diameter pile. This work suggests that fish larvae may be relatively resilient to pile-driving noise, which is generally consistent with the early literature on seismic airguns (Kostyuchenko 1973; Holliday et al. 1987; Booman et al. 1996; Saetre and Ona 1996). Research on invertebrate larvae is even more limited and has yielded mixed results. Two studies found little effect of exposure to seismic airguns on the embryonic or larval stages of spiny lobster in response to received SEL 185 dB re 1 μPa^2 s (Day et al. 2016b) or of crabs in response to received SPL of 231 dB re 1 µPa (Pearson et al. 1994). While Aguilar de Soto et al. (2013) did show that scallop larvae exposed to noise of seismic airguns showed body abnormalities and developmental delays, the larvae were held 2 to 4 inches (5 to 10 centimeters) away from the speaker for 90 hours of playbacks, which does not represent real-world conditions. Solé et al. (2022) examined hatching and survival of cuttlefish eggs and larvae after exposure to 16 hours of pile-driving noise in the same chamber used in Bolle et al. (2012). They found lower hatching success in exposed eggs, but the received particle motion levels at which this occurred were not reported. Without better understanding of the sound field, it is difficult to extrapolate these findings to real-world conditions.

The research suggests that fish larvae may be more resilient to pile-driving noise than invertebrate larvae. Impacts would be limited to areas in very close proximity to pile driving, and effects are likely to be species-specific. Given naturally high rates of mortality in marine larvae, it is unlikely to have significant population-level effects.

For the Proposed Action, underwater acoustic modeling was conducted for the Project's COP, and is available in the *Underwater Acoustic Assessment* (COP, Volume II, H-1; US Wind 2023) for all three proposed foundation types. For the modeling, a pile progression schedule (shown in Table 5-5) was used to account for the influence of hammer energies in the sound field produced, and noise mitigation was assumed to achieve a minimum of 10-dB noise mitigation during impact pile driving (COP, Volume I, Section 3.3.2; US Wind 2023). The installation of the WTGs, OSSs, and Met Tower will span a three-year period and the estimated number of each type of foundation installed in each year is summarized in Table 5-6.

Table 5-5. Pile progression of hammer energy used to model the sound fields produced during impact pile driving of the monopile foundations included under the Proposed Action

Pile Type	Number of Piles Installed Per day	Hammer Energy (kJ)	Duration at Hammer Energy (min)	Blows per Minute	Blows per Pile	Total Duration for Pile Installation per Day (min)	Total Number of Blows per Day
11-meter WTG Monopile	1	1,100[1]	30	20	600	120	4,800
		2,200[1]	60	40	2,400		
		3,300[1]	30	60	1,800		
3-meter OSS Skirt Pile	4	1,500	480	40	19,200	480	19,200
1.8-meter Met Tower Caisson Piles	3	500	360	8	3,000	360	3,000

Source: COP, Volume II, Appendix H-1, Table 10; US Wind 2023

kJ = kilojoules

[1] These hammer energies (1,100 to 3,300) are the hammer energies expected during the installation of the monopile but the maximum energy of 4,400 kJ was used in the monopile modeling; these hammer energies represent 25%, 50%, and 75% of the maximum hammer energy.

Table 5-6. Estimated annual installation schedule of the Proposed Action for the three-year period over which the WTG, OSS, and Met Tower foundations will be installed

Month	WTG 11-m Monopile	OSS 3-m Jacket Skirt Pile	Met Tower 1.8-m Caisson Pile
Year 1			
May			
June	8		
July		1	
August			
September	13		
Year 2			
May	16		
June	16		1
July	16	2	
August	7		
September			
Year 3			
May			
June	15		
July	10	1	
August	13		

Source: COP, Volume II, Appendix H-1, Table 11; US Wind 2023
OSS = offshore substation; WTG = wind turbine generator

As discussed previously, potential for injury is characterized using two metrics, L_{pk} and SEL_{24h}. The L_{pk} metric characterizes the potential for injury resulting from the rapid increase in sound pressure that occurs within the immediate vicinity of the pile when it is struck by the hammer, whereas the SEL_{24h} metric characterizes the potential for injury resulting from cumulative exposure to sound energy above a given threshold (Table 5-4) within a 24-hour period. The ranges for potential mortal injury, recoverable injury, TTS, and behavioral disturbances for each applicable fish group are provided in Tables 5-7 through 5-9 for the WTG foundations, OSS foundations, and Met Tower foundations, respectively.

Table 5-7. Ranges (in meters) to acoustic thresholds in meters during impact pile driving activities for installation of the 11-meter WTG foundations under the Proposed Action

Foundation Type	Potential Mortal Injury		Recoverable Injury		TTS		Behavioral
	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	SPL
Fish with no swim bladder	50	0	50	0	-	4,500	13,650
Fish with swim bladder not involved in hearing	100	150	100	450	-	4,500	13,650
Fish with swim bladder involved in hearing	100	200	100	450	-	4,500	13,650
Fish <2 g	-	-	150	6,150	-	-	13,650
Fish ≥2 g	-	-	150	4,000	-	-	13,650

Source: COP, Volume II, Appendix H-1, US Wind 2023
- = not applicable for this category; L_{pk} = zero-to-peak sound pressure level in units of decibels referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal; WTG = wind turbine generator

Table 5-8. Ranges to acoustic thresholds in meters during impact pile driving activities for installation of the 3-meter OSS foundations under the Proposed Action

Foundation Type	Potential Mortal Injury		Recoverable Injury		TTS		Behavioral
	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	SPL
Fish with no swim bladder	0	0	0	0	-	0	2,650
Fish with swim bladder not involved in hearing	0	0	0	50	-	1,750	2,650
Fish with swim bladder involved in hearing	0	50	0	50	-	1,750	2,650
Fish <2 g	-	-	0	2,600	-	-	2,650
Fish ≥2 g	-	-	0	1,500	-	-	2,650

Source: COP, Volume II, Appendix H-1, US Wind 2023
- = not applicable for this category; L_{pk} = zero-to-peak sound pressure level in units of decibels referenced to 1 micropascal; OSS = offshore substation; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal

Table 5-9. Ranges to acoustic thresholds in meters during impact pile driving activities for installation of the 1.8-meter Met Tower foundations under the Proposed Action

Foundation Type	Potential Mortal Injury		Recoverable Injury		TTS		Behavioral
	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	L_{pk}	SEL_{24h}	SPL
Fish with no swim bladder	0	0	0	0	-	0	750
Fish with swim bladder not involved in hearing	0	0	0	0	-	50	750
Fish with swim bladder involved in hearing	0	0	0	0	-	50	750
Fish <2 g	-	-	0	150	-	-	750
Fish ≥2 g	-	-	0	50	-	-	750

Source: COP, Volume II, Appendix H-1, US Wind 2023
- = not applicable for this category; L_{pk} = zero-to-peak sound pressure level in units of decibels referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal

Potential mortal injury from impact pile driving activities under the Proposed Action is unlikely to occur for any of the foundations, as the maximum range to these thresholds during impact pile driving activities 10-dB noise mitigation is 656 feet (200 meters) during installation of the WTG monopiles (Table 5-7), which could be avoided by mobile fish and invertebrate species during construction, particularly when considering the physical space that will be occupied around the pile by the noise mitigation system implemented during impact pile driving (COP, Volume I, Section 3.3.2; US Wind 2023). All other modeled foundation types result in ranges of 0 feet (0 meter) to 164 feet (50 meters) to the potential mortal injury threshold (Table 5-8 and 5-9).

The ranges to the recoverable injury SEL_{24h} thresholds were generally large, as this threshold is based on sound energy accumulating over the entire pile installation period (Table 5-7), and the maximum modeled range to these thresholds is 20,177 feet (6,150 meters) for recoverable injury in fish <2 g during installation of the WTG monopile foundations (Table 5-7). The range to the TTS threshold was similarly large modeled up to 14,764 feet (4,500 meters) for all fish (Table 5-7). The ranges to the L_{pk} thresholds were all smaller in comparison (<492 feet [150 meters] for all fish groups), as this metric is based on the peak sound pressure reached during a single pile strike. However, it is worth noting that the maximum SEL_{24h} threshold range for fish <2 g does not apply to all fish species likely to be present in the Project area. For fish ≥2 g the range to the threshold is reduce to 13,123 feet (4,000 meters), and the largest range to the SEL_{24h} threshold from Popper et al. (2014) is 1,476 feet (450 meters) for recoverable injury in fish with swim bladders that are both involved and not involved in hearing. Therefore, while some individuals may face a risk of being exposed to sound energy above the threshold criteria for a sufficient duration to elicit injury out to 20,177 feet (6,150 meters), other individuals would only face this risk within 1,476 feet (450 meters) depending on their physiology (Popper et al. 2014) which may be more easily managed with mitigation measures (Section 6). Furthermore, the range to the threshold for fish with no swim bladder from Popper et al. (2014) was 0 feet (0 meters) for the SEL_{24h} metric and 164 feet (50 meters) for the Lpk metric (Table 5-7), indicating species without a swim bladder would likely face a substantially lower risk of injury compared to those with a swim bladder. The ranges to the SEL_{24h} injury thresholds for all other foundation types were substantially smaller and therefore pose a lower risk of injury (Tables 5-8 and 5-9).

Though there is a risk of injury, it is expected these would be recoverable injuries and would not result in mortalities of individuals, further evidenced by the available literature discussed previously in this section. Additionally, the implementation of mitigation measures such as soft-start procedures, though geared towards marine mammals and sea turtles (COP, Volume II, Section 1.5; US Wind 2023) could reduce the potential for serious injury resulting from exposure to noise above the SEL threshold. Soft-start procedures would facilitate a gradual increase of hammer blow energy allowing time for fish to potentially leave the area prior to the start of operations at full energy that could result in injury. Soft-start procedures could be effective in deterring fish from foundation installation activities prior to exposure resulting in a serious injury. This reduces the risk of exposure and injury to prey species within EFH during pile driving under the Proposed Action and is, therefore, unlikely to occur.

The primary effect that may occur during impact pile driving would be behavioral disturbances. The modeled ranges to the behavioral disturbance thresholds for all fish were estimated at 2,460 feet (750 meters) for the Met Tower Caisson pile foundations, 8,694 feet (2,650 meters) for the OSS jacket foundations, and 44,783 feet (13,650 meters) for the WTG monopile foundations (Tables 5-7 through 5-9). As discussed previously, available studies suggest potential behavioral responses for fish and invertebrates to impact pile-driving noise could include changes in dive behavior, swim speed, and group cohesion, though the extent and severity of the response will vary based on the species and circumstances.

Overall, the duration of impact pile-driving activities under the Proposed Action would be relatively short-term (up to 2 hours per day for the WTG monopiles; 8 hours per day for the OSS jacket piles; and up to 6 hours per day for the Met Tower Caisson) and once construction is complete and pile driving has ceased impacts would dissipate. Due to the temporary, localized nature of noise produced by impact pile driving under the Proposed Action construction scenario and the implementation of mitigation measures (Section 6), which would minimize the risk of exposure to above-threshold noise levels, moderate direct adverse impacts on the EFH of all of the finfish and invertebrates listed in the EFH species groups (Section 4.2) would be expected. BOEM would ensure that US Wind prepare and submit a Pile Driving Monitoring Plan to BOEM, BSEE, and NMFS for review and concurrence at least 90 days before start of pile driving. An operational sound field verification plan to determine the operational noises emitted from the Offshore Project area would also be created by US Wind. The plan would be reviewed and approved by BOEM and NMFS.

5.1.1.3 Installation of Foundations and Scour Protection

Habitat Loss/Conversion from Installation of Foundations Scour Protection

The permanent area displaced by WTG foundations (PDE of up to 121) under the Proposed Action is expected to be 2.84 acres. Four OSSs would be installed, and though the foundation has not yet been decided the total area of seafloor disturbance is up to 1.7 acres (0.7 hectares), assuming they are also monopile foundations, creating the maximum footprint. The Met Tower would displace an additional 435 square feet (40.41 square meters). In total, about 27.21 acres (10.61 hectares) of seafloor habitat would be permanently affected by the construction and installation of the WTGs, OSSs, and Met Tower foundations for the Proposed Action.

US Wind intends to include scour protection in the form of rock around the base of the WTG and OSS monopile foundations, an area of approximately three times the diameter of the piles which translates in approximately 0.19 acres (0.08 hectares) per WTG and 0.13 acres (0.05 hectares) per OSS large-pile jacket (COP, Volume II, Section 1.3, US Wind 2023). No scour protection is anticipated at the Met Tower foundation. The first layer of scour protection rocks will be deployed in a circle around the pile location. This layer of small rocks, the filter layer, will stabilize the sandy seafloor, avoiding the development of scour holes. The rocks will be placed by a specialized rock dumping vessel with a layer thickness of up to 2 feet (0.7 meters). Once the inter-array cables have been pulled into the monopile, a 2 to 7 feet (1 to 2 meters) thick second layer of larger rocks, the armor layer, will be placed to stabilize the filter layer around the monopile.

The Lease Area consists of 84.4% soft-bottom habitat (sand and silt-sized sediments [Table 3-2]). The soft bottom habitat at each WTG may be permanently changed into hard substrate through the installation of scour protection (rocks and rubble) around monopiles. Estimates for permanent conversion of the benthic habitat at the WTG and OSS foundations is estimated at 23.15 acres (9.31 hectares) (see Appendix G, Table G-1). There is no scour protection anticipated associated with the Met Tower. Most of the permanent impact from the installation of scour protection (20.05 acres [8.11 hectares]) is associated with soft bottom habitats.

Installing the foundations and scour protection pad could crush or bury the EFH of benthic or epibenthic managed species. Scour protection materials have the potential to turn soft bottom areas into hardbottom ecosystems preferred by members of the Mobile and Sessile Complex Bottom EFH species groups (Section 4.2 [Langhamer 2012, Degraer et al. 2018, Causon and Gill. 2018, Glarou et al. 2020]). This will conversely eliminate habitats designated as EFH for members of the Sessile and Mobile Soft bottom EFH species groups (Section 4.2) including Atlantic surfclam, ocean quahog, summer flounder, witch flounder, windowpane, little skate, clearnose skate, red hake, and white hake. The foundations and scour protection features will attract certain shelter-seeking fishes and invertebrates from the Mobile/Epibenthic Complex Bottom EFH species group (e.g., black sea bass, tautog, monkfish, striped bass). Some epibiota from the region such as sea whips, sponges, and encrusting bivalves that colonize artificial substrates will increase structural complexity and enhance habitat quality for EFH species and life stages (Steimle and Figley 1996; Schweitzer and Stevens 2019).

Although added complex substrate may increase diversity and abundance of some species, novel fouling communities can alter local trophic pathways in various ways (e.g., Degraer et al. 2020; Mavraki et al. 2021). The structures may also attract invasive species and in some situations create potential ecological traps (e.g., resident predators eating newly settled larvae). The alteration of habitat and additional structures may provide stepping stones for invasive species already present within the region. BOEM is currently conducting research to evaluate various options that will improve the quality of construction-derived complex habitats. Given that 84.4% of the Lease Area is soft bottom habitat (see Table 5-2) the development of communities supporting EFH managed species of the Sessile and Mobile Complex Bottom EFH species group could off-set the adverse long-term effects aspects of the Soft bottom EFH species groups displaced.

Sediment Suspension/Redeposition from Installation of Scour Protection

Sediment suspension and redeposition generated by the placement of the scour protection surrounding the WTG, OSS, and Met Tower installation would result in increased turbidity within the footprint of the scour pad and down current of the installation site. The construction of the scour protection would be completed before the installation of the monopiles. The first layer of scour protection (2 ft [0.7 m]) will consist of smaller pea rocks as a sediment-stabilizing layer. This initial layer deployment will result in sediment suspension with elevated turbidity and decreased water quality. These conditions will occur during the placement of the rock layer and should subside immediately once the deployment of this layer is complete. Once this initial sediment stabilizing layer is in place the sediment suspension from the placement of subsequent layers of rock (2 to 7 ft [0.7 to 2.13 m]) should be alleviated and greatly reduced. The adverse effects of suspension and redeposition of sediments from the initial deployment should be short-term and predominantly an indirect effect on the Sessile/Epibenthic and Mobile/Epibenthic Soft bottom EFH species and early life stages which include the eggs and larvae of Atlantic herring, Atlantic sea scallops, Ocean quahogs, red hake, winter flounder, and yellowtail flounder.

5.1.1.4 Offshore Vessel Activity associated with Installation of Foundations

Habitat Loss/Conversion from Anchoring associated with Installation of Foundations

For monopile foundation installation in the WTG, US Wind assumes that up to four feeder vessels could be needed. The feeder vessels may be jack-up vessels or tug and barge units, and they may employ anchors for positioning, utilizing mid-line anchor buoys (COP, Volume I, US Wind 2023).

As stated in Section 2.2.1.4, anchoring activities (conventional anchors or jack up barge with spuds) by vessels involved with installation of WTGs OSSs and the single Met Tower are expected to impact 15.57 acres (6.3 hectares) of the seafloor (COP, Volume II, Section 1.3, US Wind 2023). These impacts are expected to temporarily alter the infauna assemblages within the anchor -spud can footprints and potentially any area exposed to anchor chain sweep. Infauna assemblages may include individuals of federally managed species such as Atlantic surfclam, Atlantic sea scallop, and ocean quahog as well as annelids, mollusks, crustaceans, and other invertebrates. These later invertebrates comprise an important foraging base for Mobile Benthic/Epibenthic Soft bottom or Heterogeneous EFH species including little skate, clearnose skate, red hake, white hake, scup, summer flounder, witch flounder, and others (Garrison and Link, 2000). Anchor placement would temporarily displace some demersal feeding fishes with EFH in the area as the infauna recolonize the impact scars from the anchors. Vessel activity associated with construction is expected to last for about 10 months (Table 5-6). Recolonization of impacted areas will depend on the size of the impact scar and the nature of the supply of settling larvae or motile individuals capable of settling. The impacts on managed species within the Action Area from seabed habitat loss or conversion during the installation of the WTGs, OSSs, and the Met Tower would be an initial direct impact to the infauna within the anchor fall footprint. Once the anchor is removed the adverse effects from the anchor scar would be short-term based on the assessment that the soft bottom habitats would recover after disturbance and without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006). The adverse effects of anchor impacts could be reduced by following mitigation measures and BMPs when operating near or within any areas with sensitive benthic resources. As part of the mitigation measures US Wind would prepare and submit for review with cooperating agencies an anchoring plan. This plan would utilize HRG survey data to avoid sensitive habitats such as SAV and hard bottom and structurally complex benthic habitats to the maximum extent practicable.

Sediment Suspension/Redeposition from Anchoring associated with Installation of Foundations

Sediment suspension and redeposition in relation to the utilizations of anchors related to WTG, OSS and Met Tower installation would be very similar to thar described previously in Section 5.1.1.1. The area of seafloor temporarily disturbed during vessel anchoring during installation of the WTG, OSS and Met Tower foundations is anticipated to be approximately 15.57 acres (6 hectares) (COP, Volume II, Section 1.3, US Wind 2023). The response to suspended sediments would be species and life stage-specific. Adults as well as competently swimming juveniles or larvae of the Pelagic EFH species group (Section 4.2) will likely swim away from suspended sediment plumes produced during anchoring activities. Planktonic eggs and larvae of federally managed fishes and invertebrates will not be able to actively avoid sediment plumes. The adverse effects of the sediment plumes would be a direct impact to these early life stages, but the effects would be temporary with the initial elevated turbidity returning to background levels once the anchor is statically in place or removed from the seafloor.

Potential Introduction of Exotic/Invasive Species via Ballast of Offshore Foundation Installation Vessels

Marine invasive species have been accidentally introduced into habitats along the U.S. Atlantic seaboard in multiple instances. Pederson et al. (2005) lists the numerous vectors that transport invasive organisms and inoculate new areas. Some of the dominant vectors are shipping and hull fouling, aquaculture, marine recreational activities, commercial and recreational fishing, and ornamental trades. Additionally offshore drilling, hull cleaning activities, habitat restoration, research, and floating marine debris (particularly plastics) may also facilitate the transfer of invasive organisms (Pederson et al. 2005). Ballast water exchange/discharge and biofouling are the two main vectors for invasive species introduction (Carlton et al. 1995; Drake 2015). The offshore wind industry would increase the risk of accidental releases of invasive species due to increased maritime traffic to support installation and potentially conceptual decommissioning operations. The impacts related to the release and establishment of invasive species on finfish, invertebrates, and EFH are multifaceted. Invasive species such as the Asian shore crab (*Hemigrapsus sanguineus*) have spread throughout most of the Mid-Atlantic Bight and northern areas of the South Atlantic Bight. The Asian shore crab was first collected in the Delaware Bay area in 1988 and extended north to Maine and south to North Carolina (Epifanio 2013). There is a potential for invasive species being introduced and established as a result of offshore wind activities. Vessels required for the importation of components of the WTGs, OSSs, and submarine power cables and the specialized construction vessels from international ports could potentially represent transport vectors. The impacts of invasive species on EFH could be strongly adverse, widespread, and permanent. The introduction and impact of the Asian shore crab in the geographical analysis areas is a prime example of a species that became established and has out-competed native fauna and adversely modified the coastal habitat. The potential for introducing an invasive species through ballast water releases or biofouling from installation activities related to US Wind construction activities is quite small and only related to the vessels utilized to import components of some of the WTG systems (monopiles and generators). These vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025) and EPA NPDES Vessel General Permit standards, both of which aim to prevent the release of ballast waters contaminated with an invasive species. As such, accidental releases from the construction activities related to the Lease Area would not be expected to contribute appreciably to overall impacts on EFH; impacts related to the release of invasive species on the EFH resources are considered negligible within the Lease Area.

Accidental Fuel Spills from Offshore Vessels

Vessels used for WTG operations may generate waste, including bilge and ballast water, sanitary and domestic wastes, and trash and debris. All vessels associated with the Proposed Action would comply with USCG requirements for the prevention and control of oil and fuel spills. Small spills would rapidly dissipate, and fish kills rarely occur. For the duration of a spill species and life stages residing in the upper water column (Pelagic EFH species group) are most at risk for contact with the spilled oil. Pelagic species that, as adults, forage at water's surface would be most likely to encounter a surface spill. Tunas, mackerels, and herrings known to feed at the surface would likely avoid small spills. Planktonic early life stages (eggs and larvae) of many fish species would be less able to avoid a spill and therefore most vulnerable to toxic properties of the oil. Numerous federally managed species described above in Table 4-1 have pelagic eggs and larvae that would be at risk if they encountered a spill. Vessel activity including limited anchoring and accidental spills/discharges are expected to have a short-term adverse effect on the Pelagic EFH species group if a spill were to occur.

Vessels associated with the construction activities of the Proposed Action may potentially generate operational waste, including bilge and ballast water, sanitary and domestic wastes, and trash and debris. All vessels associated with the Project would comply with USCG requirements for the prevention and control of oil and fuel spills. Proper vessel regulations and operating procedures would minimize effects on the EFH of the federally managed species discussed in Section 4 (Table 4-1), resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012). Additionally, training and awareness of BMPs proposed for waste management and mitigation of marine debris would be required of Project personnel, reducing the likelihood of occurrence to a very low risk. Likewise, utilizing BMPs for ballast or bilge water releases specifically from vessels transiting from foreign ports would reduce the likelihood of accidental release. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time; as such, BOEM expects localized and temporary negligible impacts on EFH resulting from these accidental releases.

Underwater Noise from Offshore Vessel Activity

During installation of the WTG, OSS, and Met Tower foundations, several types of vessels will be used to transport crew and supplies, and during construction, dynamic positioning systems may be used to keep the pile-driving vessel in place (Section 2.2.1.4). The cavitation of vessel propellors produces low-frequency, nearly continuous noise that is audible by most fishes and invertebrates and could result in physiological stress, auditory masking, and behavioral responses. Further details of the physical qualities of vessel noise can be found in Draft EIS Appendix B (BOEM 2023a). Effects of vessel noise on EFH within the Project area would likely result from effects on prey species.

Avoidance of vessels and vessel noise has been observed in several pelagic, schooling fishes, including Atlantic herring (Vabø et al. 2002), Atlantic cod (Handegard 2003) and others (De Robertis and Handegard 2013). Fish may dive toward the seafloor, move horizontally out of the vessel's path, or disperse from their school (De Robertis and Handegard 2013). These types of changes in schooling behavior could render individual fish more vulnerable to predation but are unlikely to have population-level effects. A body of recent work has documented other, more subtle behaviors in response to vessel noise, but has focused solely on tropical reef-dwelling fish. For example, damselfish antipredator responses (Ferrari et al. 2018; Simpson et al. 2016) and boldness (Holmes et al. 2017) seem to decrease in the presence of vessel noise, while nest-guarding behaviors seem to increase (Nedelec et al. 2017). There is some evidence of habituation, though: Nedelec et al. (2016) found that domino damselfish increased hiding and ventilation rates after two days of vessel noise playbacks, but responses diminished after one to two weeks, indicating habituation over longer durations.

It is possible that vessel noise could induce physiological stress or lead to acoustic masking in fishes. Several studies have shown an increase in cortisol, a stress hormone, after playbacks of vessel noise (Celi et al. 2016; Nichols et al. 2015; Wysocki et al. 2006), but other work has shown that the handling stress of the experiment itself may induce a greater stress response than an acoustic stimulus (Harding et al. 2020; Staaterman et al. 2020). The cavitation of vessel propellors produces low-frequency, nearly continuous noise that is audible by most fishes and invertebrates and could mask important auditory cues, including conspecific communication (Haver et al. 2021; Parsons et al. 2021). Stanley et al. (2017) demonstrated that the communication range of both haddock and cod (species with swim bladders but lacking connections to the ear) would be significantly reduced in the presence of vessel noise, which is frequent in their habitat in Cape Cod Bay. Generally speaking, species that are sensitive to acoustic pressure would experience masking at greater distances than those that are only sensitive to particle motion. Rogers et al. (2021) and Stanley et al. (2017) theorize that fish may be able to use the directional nature of particle motion to extract meaning from short range cues (e.g., other fish vocalizations) even in the presence of distant noise from vessels.

The limited research on invertebrates' response to vessel noise has yielded inconsistent findings thus far. Some crustaceans seem to increase oxygen consumption (Wale et al. 2013) or show increases in some hemolymph (an invertebrate analog to blood) biomarkers like glucose and heat-shock proteins, which are indicators of stress (Filiciotto et al. 2014). Other species (American lobsters and blue crabs) showed no difference in hemolymph parameters but spent less time handling food, defending food, and initiating fights with competitors (Hudson et al. 2022). While there does seem to be some evidence that certain behaviors and stress biomarkers in invertebrates could be negatively affected by vessel noise, it is difficult to draw conclusions from this work since it is limited to the laboratory, and in most cases, particle motion was not measured as the relevant cue.

The planktonic larvae of fishes and invertebrates may experience acoustic masking from continuous sources like vessels. Several studies have shown that larvae are sensitive to acoustic cues and may use these signals to navigate towards suitable settlement habitat (Montgomery 2006; Simpson et al. 2005), metamorphosize into their juvenile forms (Stanley et al. 2012), or even to maintain group cohesion during their pelagic journey (Staaterman et al. 2014). However, given the short range of such biologically relevant signals for particle motion-sensitive animals (Kaplan and Mooney 2016), the spatial scale at which these cues are relevant is rather small. If vessel transit areas overlap with settlement habitat, it is possible that vessel noise could mask some biologically relevant sounds (Holles et al. 2013), but these effects are expected to be short-term and would occur over a small spatial area.

Simply due to the physical nature of vessel noise (see Draft EIS Appendix B [BOEM 2023a]), it is unlikely to cause barotrauma or auditory damage in fishes, but could lead to behavioral changes, increased stress, or masking. Overall, impacts of vessel noise on fish prey species within EFH are expected to be minor, as they will be transient and localized in nature. Only a few individuals would be affected at any given time, and they are likely to return to normal behaviors after the noise is over.

5.1.2 Inter-array and Offshore Export Cable Installation

5.1.2.1 Seabed Preparation (Including Boulder Relocation/Dredging/Grading/Grapnel Runs)

Habitat Loss/Conversion from Seabed Preparation

Pre-installation seabed preparation, such as levelling, pre-trenching or boulder removal, is not currently expected for Offshore Export Cable Route deployment (COP, Volume I, US Wind 2023). Section 5.1.1.1 discusses effects of seafloor preparation using grading and boulder removal for WTGs, OSS, and Met Tower installations. The principal seabed preparatory procedure for cable installation is referred to as grapnel run as described in Section 2.2.2.1. The main objective for grapnel runs is to remove debris that could hinder, damage, or ensnare the installation equipment utilized during cable installation. The disturbance of the cable installation is expected to disturb approximately the same spatial area of benthic habitat. Any debris recovered during the grapnel run would be stored on the vessel and properly disposed of onshore. The impacts related to grapnel runs would be very localized and temporally short and would recover completely without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006). The grapnel runs would impact the sensitive life stages of demersal eggs, larvae, and adult life stages of Mobile and Sessile/Epibenthic Soft bottom finfish and invertebrates. Life stages of invertebrate managed species such as longfin inshore squid, Atlantic surfclam, and Atlantic sea scallop. Managed finfish species that could be impacted are neonates for the dusky shark, blacktip sharks, clearnose skates and juvenile and adult of scup, Atlantic sharpnose shark, and Atlantic angel shark. There would be no habitat loss or conversion in relation to the grapnel runs.

The sand tiger shark HAPC is situated just to the north and almost contiguous with the northern boundary of the proposed offshore export cable route. The adverse impacts on managed species within the Action Area from seabed habitat loss or conversion during the installation of the inter-array (83.95% soft bottom; 12.7% heterogeneous complex [see Appendix G, Table G-1]) and offshore export cable (66.3% soft bottom; 31.7% heterogeneous complex [see Appendix G, Table G-1]), would be direct although short-term based on the assessment that the soft bottom habitats would recover shortly after disturbance and without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

Sediment Suspension/Redeposition from Seabed Preparation (Grapnel Run)

The primary technologies that would have the largest spatial impact on the seafloor habitat would be grapnel runs to be completed prior to the inter-array and offshore export cable installation. The Sessile and Mobile Benthic/Epibenthic – Soft bottom and Heterogeneous Complex EFH species group and their eggs, larvae, and adult life stages would be the predominant EFH species group to be impacted by sediment suspension and redeposition from grapnel run operations. The impacts related to the grapnel runs would be very localized and temporary. If the seafloor habitat is composed of soft or heterogenous complex sediments, the benthic infauna would recover completely without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

Underwater Noise from Seabed Preparation

A detailed analysis of underwater noise related to Vessel Activity was presented in Section 5.1.1.3. Due to the physical nature of vessel noise (see Draft EIS Appendix B [BOEM 2023a]), it is unlikely to cause barotrauma or auditory damage in fishes, but could lead to behavioral changes, increased stress, or masking. Overall, impacts of vessel noise on fish prey species within EFH are expected to be indirect and short-term, as the noise and resultant impacts will be transient and localized in nature. Only a few individuals would be affected at any given time, and they are likely to return to normal behavior after the source of the noise has moved out of range to be detected by a finfish or invertebrate EFH species.

UXO Relocation and/or Removal along Offshore Export and Inter-array Cable Routes

Habitat Loss/Conversion from UXO Relocation and/or Removal

Habitat loss in relation to UXO removal along the inter-array cable and offshore export cable will be much the same as activities and mechanisms described in Section 5.1.1 (Seabed Preparation for WTG, OSS and Met Tower installation). US Wind has not detected and does not expect to find unexploded ordnances (UXOs) within the boundaries of the proposed offshore cable routes. Surveys within the inter-array cable route have not detected the presence of any UXOs. If an UXO is identified during any subsequent future surveys, US Wind would most likely utilize avoidance measures such as micrositing adjustments of the cable route to reduce any risk for the cable laying operations. The micrositing efforts would result in the same type of short-term construction related and long-term operational effects as those described in the construction methods for cable installation provided in Section 5.1.2.2.

Sediment Suspension/Redeposition from UXO Relocation and/or Removal

Impacts related to sediment suspension and redeposition will be very similar to those described in Section 5.1.1 (Seabed Preparation for WTG, OSS and Met Tower installation). As stated previously if a UXO is detected within the proposed inter-array cable route US Wind would most likely utilize avoidance measures and uses micrositing adjustments of the cable route to reduce any risk for the cable laying operations. The micrositing efforts would result in the same type of short-term construction related and long-term operational effects as those described in the construction methods for inter-array cable installation provided in Section 5.1.2.2.

Entrainment from UXO Relocation and/or Removal

Impacts related to entrainment from UXO removal will be very similar to impacts described in Section 5.1.1. (Seabed Preparation for WTG, OSS and Met Tower installation). As stated previously if a UXO is detected within the proposed inter-array cable route US Wind would most likely utilize avoidance measures and use micrositing adjustments of the cable route to reduce any risk for the cable laying operations. The micrositing efforts would result in the same type of short-term construction related and long-term operational effects as those described in the construction methods for inter-array cable installation provided in Section 5.1.2.2.

Underwater Noise from UXO Relocation and/or Removal

Impacts related to UXO disposal from the installation of inter-array, offshore and inshore export cables would be identical to the process described in seabed preparation for WTG and OSS platform installation, scour protection installation, and are discussed in detail in Sections 5.1.1.1.1.

5.1.2.2 Trenching/Cable Installation (Offshore)

Habitat Loss/Conversion from Offshore Cable Installation

During installation of the inter-array cables, and offshore export cables multiple vessels would be used for the installation of US Wind cable networks. US Wind is planning to use multiple construction vessels with various configurations (COP, Volume I, US Wind 2022). Most of the proposed vessels would be equipped with dynamic positioning systems, but some would require anchoring and spudding. As these vessels move along the cable routes, they will disturb the seafloor during the cable trenching and laying process. For cable installation, the cable barge will lay and bury the cable between the two end points maneuvering along the cable route using its six-point anchoring system (assisted by an anchor handling tug) and positioned using spuds as required.

Overall, installation of the 125.6 miles (202.2 kilometers) inter-array cables would temporarily disturb a maximum of 29.9 acres (12.1 hectares) of seafloor during cable installation, including vessel anchoring, jack-up vessels and seabed preparation. (see Appendix G, Table G-1). Installation of up to 142.5 miles (229.3 kilometers) offshore export cable is expected to temporarily disturb 27.6 acres (11.17 hectares) of seafloor. Anchors and spuds will contact the seafloor damaging or eliminating infauna assemblages that may affect feeding of Mobile-Soft bottom and Heterogenous Complex species (Section 4.2). Along the Offshore Export Cable Route, Sessile and Mobile Soft bottom and Heterogeneous Complex EFH species groups would be the most likely to be affected by the cable installation jetting operations through direct seafloor disturbance and displacement from potential feeding areas. The estimated impact to the entire offshore project area is comprised of approximately 80.6% soft bottom benthic habitat resulting in a short-term impact (Table 5-2).

These impacts are expected to temporarily alter the benthic infauna and epibenthic assemblages within the anchor footprints and the jet plow track as described in previous sections (5.1.1 and 5.1.2. Seabed Preparation). Infauna assemblages may include individuals of federally managed species such as Atlantic surfclam, Atlantic sea scallop, and ocean quahog as well as annelids, mollusks, crustaceans, and other invertebrates. These later invertebrates comprise an important foraging base for EFH species including little skate, clearnose skate, red hake, white hake, scup, summer flounder, witch flounder, and others (Garrison and Link, 2000). Anchor placement and jet plow cable installation would be a direct short-term impact by displacing some demersal feeding fishes with EFH in the area as the infauna recolonize the impact scars from anchoring and cable installation. Cable installation activities are expected to last for about 10 months (Table 5-6). Recolonization of impacted areas will depend on the size of the impact scar and the nature of the supply of settling larvae or motile individuals capable of settling. Once the jet plow has passed through and successfully buried the cable and all anchoring activities have ceased, soft bottom and heterogeneous complex seafloor habitats would recover within a few months with no mitigation (Dernie et al. 2003).

Seafloor disturbance resulting from cable installation will directly impact and displace infaunal, epibenthic, and demersal Mobile/Epibenthic Soft bottom and Sessile/Epibenthic and Mobile Benthic/Epibenthic Heterogeneous Complex habitat organisms and their consumers from the cable routes. This direct impact is expected to result in short-term adverse effects on managed species and EFH.

Sediment Suspension from Offshore Cable Installation

As described in Section 2.2.2.2, transmission cables (export or inter-array) will be installed using a jet plow capable of digging a trench 3.3 to 13.1 feet (1 to 4 meters) into the sedimentary seafloor (e.g., Elliot et al. 2017). Jet plows use a pressurized water stream to fluidize bottom sediments along the route where the cable is being installed. The process suspends sediments into the water column where they are transported laterally away from the trench for varying distances depending on grain size as well as currents, winds, and tides. Suspended sediments will settle back to the seafloor within 24 hours. Typical jet plowing operations move about 300 feet (94 meters) per hour. Thus, suspended sediment plumes will be most pronounced in the vicinity of the jet plow as it moves along the cable route. Trenching the offshore export cable is expected to take about 5 months and an additional 5 months for the inter-array cables.

Sediments suspended by the jet plow may temporarily impact feeding, movement, or reproductive activity in federally managed species and their EFH. Suspended sediments during construction in the WTG area and offshore export cable would temporarily affect water column EFH limiting abilities of visually oriented feeders as well as important visual communication among individuals of certain species (e.g., courtship signaling among inshore long fin squid [Mooney et al. 2016]). Elevated suspended sediment may also affect habitat selection by settling larval stages of some fishes and invertebrates and may result in increased susceptibility to predation for many species (Wilbur and Clarke, 2001; Wenger et al. 2017). In the Lease area and Offshore Export Cable Route members of the Pelagic EFH species group (Section 4.2) such as Atlantic mackerel, Atlantic butterfish, bluefish, Atlantic herring, dusky sharks, mako sharks, and others would be expected to actively avoid suspended sediment plumes. Members of the Mobile Soft bottom and Mobile Complex Habitat EFH species groups (Section 4.2) would also avoid suspended sediment plumes but members of this group (e.g., little skate, clearnose skate, windowpane, summer flounder, red hake, and monkfish) would likely have a higher tolerance for suspended sediment levels than would species in the Pelagic group. Sessile Soft bottom and Complex Habitat EFH species groups would be unable to avoid sediment plumes.

Modeling of sediment suspension and transport for the offshore export cable indicated that most sediment suspended by the jet plow will stay within 91 meters (300 feet) of the active trench (Appendix A, *Offshore Sediment Transport Modeling Report*). Suspended sediment concentrations would be less than 200 mg/L at 450 feet (137 meters) from the Offshore Export Cable Route and the inter-array cables. Concentrations of suspended sediments of 10 mg/L would settle to the seafloor within hours. All suspended sediments would disappear within hours and would extend up to 1.2 nautical miles (2.24 kilometers) from the inter-array cable and Offshore Export Cable Route centerline and be suspended at any given location for less than 4 hours (Appendix A).

Sediments settling back to the seafloor can produce layers of varying thickness that decrease with increasing distance from the plow. This sedimentation will affect soft bottom and complex benthic habitats and would affect demersal spawning species with benthic eggs and temporarily exclude benthic feeding fishes from some areas. Organisms with nominal mobility will be most susceptible to sedimentation, for example individual Atlantic surfclams, and ocean quahogs which are essentially sessile as adults and juveniles could potentially be smothered. Sea scallops may be able to unbury after sediment deposition and not be as vulnerable to sedimentation effects. Inshore longfin squid eggs are demersal usually attached as a cluster (mop) to emergent rock or macroalgae frond (Jacobson, 2005). Laboratory studies have shown fish eggs (winter flounder) rarely hatch if covered by a sediment layer >0.8 inches (>2.5 millimeters) (Berry et al. 2011). Also, a diversity of infauna (worms, crustaceans, bivalves, and gastropods) which comprise the prey base for many demersal foraging fishes from the Mobile Soft bottom and Mobile Complex Habitat EFH species groups could be smothered.

Sediment dispersion modeling showed that deposition thicker than 0.01 inches (0.2 millimeters) will mostly occur within 300 feet (91 meters) of the Offshore Export Cable Route. Most of the fluidized sediments lost to the water column are predicted to quickly settle back to the seafloor. Suspended sediment concentrations are predicted to be less than 200 mg/L at distances greater than 450 feet (137 meters) from the Offshore Export Cable Route and inter-array cables (Appendix A, *Offshore Sediment Transport Modeling Report*). The adverse effects of the cable installation are predicted to be direct in relation to displacement and potential burial of Sessile infauna/Epibenthic and Motile Soft bottom and Heterogenous Complex species. The effects of sediment redeposition are expected to be short-term with benthic habitats recovering within a few months with no mitigation (Dernie et al. 2003). Indirect adverse effects are predicted for the pelagic and demersal EFH species and their prey. The adverse effect on the Pelagic EFH species group is expected to be short term with sediment suspension and the concomitant turbidity levels returning to background levels within 4 hours after jetting activities are completed.

Entrainment from Offshore Cable Installation

Water withdrawals are necessary for jet-plow cable installation which is the primary method of installing the offshore export cable, as well as the inter-array and inter-link cables (Section 2.2.2). Due to the surface-oriented intake for the jet plow, water withdrawal has the potential to entrain pelagic eggs and larvae from fishes and invertebrates. All entrained organisms will die due to the physical stress associated with the pump system (USDOI and MMS 2009). Jet plowing will occur throughout the year and will likely overlap spawning periods for most federally managed species that broadcast eggs into the water column when spawning. Species with pelagic eggs or larvae include Atlantic surfclam, Atlantic sea scallop, inshore longfin squid, windowpane, witch flounder, summer flounder silver hake, monkfish, Atlantic mackerel, silver hake, and butterfish. Vulnerability to entrainment would depend on spawning times for individual species with pelagic eggs and larvae. These life stages are listed as members of the Pelagic EFH species group (Section 4.2) and include soft bottom species such as Atlantic surfclam, Atlantic sea scallop, summer flounder, windowpane, monkfish; complex bottom species (black sea bass, tautog, and scup); and pelagic species (Atlantic mackerel, bluefish, inshore longfin squid).

Along the inter-array and Offshore Export Cable Route, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawals from the jet plow. Actual water withdrawal volumes associated with jet plowing were not provided in the COP (US Wind 2023), but Cape Wind estimated a standard jet plow withdraws of 4,500 gallons (17,034.4 liters) of water per minute and moves on average 300 ft/ (USDOI and MMS, 2009, Table 5.3.2-6). This would result in average daily (24 hours) water withdrawals of 6,480,000 gallons (24,529,468 liters) for conventional jet plowing.

The relatively small area in which the jet plowing would occur (in relation to the Mid-Atlantic Bight region) and the short period of time in which jet plowing would be employed indicates that only a fraction of the potential habitat for most vulnerable pelagic organisms would be impacted (e.g., Saila et al. 1997). The EFH assessment for Cape Wind indicated the potential for entraining 48.5 million eggs and larvae through water withdrawal for jet plowing would have a minimal impact on the managed species of finfish and invertebrates due to the high fecundity of species and the relatively small proportion of eggs and larvae that survive to adulthood (USDOI and MMS 2009). Reine and Clarke (1998) have demonstrated, the rate of egg and larval survival to adulthood for many species is naturally very low. Similarly, project-related entrainment of eggs and larvae from regional fish and invertebrate populations are expected to be a direct short-term effect but one that is not expected to have a population level effect on the EFH finfish or invertebrate species.

Underwater Noise from Offshore Cable Installation

Given the physical qualities of noise associated with dredging, trenching, and cable-laying (BOEM 2023a Appendix B), injury and auditory impairment are unlikely, but fishes and invertebrates could experience behavioral disturbance or masking close to the dredging activity. No research has specifically looked at responses to these noise sources, but the impacts are likely to be similar, but less intense, than those observed with vessel noise (Section 5.1.1.2), since these activities are not as widespread or frequent as vessel transits. Therefore, the effects of noise during potential jet plowing are expected to be so small as to be very indirect and short-term.

5.1.2.3 Cable Protection Installation (Concrete Mattresses, etc.)

Habitat Loss/Conversion from Offshore Cable Protection

US Wind has proposed concrete mattresses as the materials to be used for cable protection along the inter-array cables and along the Offshore Export Cable Route. A maximum of 10% of the Inter-array cable and Offshore Export Cable Route will require cable protection, likely to be significantly less. The installation of cable protection along the Offshore Export Cable Route will result in loss of approximately 27.6 acres (11.12 hectares) of seafloor most of which is characterized as soft bottom benthic habitat (18.3 acres [7.4 hectares]) (see Appendix G, Table G-1). The installation of cable protection along the inter-array cable will result in loss of approximately 29.9 acres (12.1 hectares) of seafloor most of which is characterized as soft bottom benthic habitat (26.1 acres [10.56 hectares]).

Permanent habitat conversion impacts on EFH species and habitats resulting from the presence of cable protection are considered an operational effect of the Proposed Action and are described in Section 5.1.2.2. Placement of the mattresses would crush and bury EFH species and habitats within the affected areas where cable protection is needed. These effects would be similar to those described in Section 5.1.1.2 scour pad installation and Section 5.1.2.2. for cable installation. As mentioned in Section 5.1.1.2, members of Mobile Complex bottom EFH species group (black sea bass, tautog, monkfish, striped bass) prefer structured habitats and will be attracted to such habitat by immigration and larval settlement (Steimle and Figley 1996; Schweitzer and Stevens 2019). Conversion of the fine, unstructured sediments into complex, hard habitats through the addition of cable protection (if required) would likely create additional EFH for species that depend on hard and complex structure. Areas where soft bottom habitats are converted would remove EFH for species that prefer fine, unconsolidated substrate (Mobile and Sessile Soft bottom groups). The presence of these introduced hard surfaces (cable protection structures) may result in new habitats for hard-bottom species (Sessile Benthic/Epibenthic – Complex Habitat and Mobile Benthic/Epibenthic – Complex Habitat) and result in increases in biomass for benthic fish and invertebrates (Kerckhof et al. 2019; Raoux et al. 2017). The addition of new hard-bottom substrate in a predominantly soft-bottom environment will enhance local biodiversity; enhanced biodiversity associated with hard-bottom habitat is well documented (Pohle and Thomas 2001; Fautin et al. 2010). This indicates that marine structures would generate beneficial impacts to the hardbottom benthic community. However, some impacts such as the loss of soft-bottom habitat may be adverse. Since soft bottom is the dominant habitat type in the Lease Area (84.4%) and

Offshore Export Cable Route (68%) (see Tables 3-2), the species that rely on this habitat are not likely to experience population-level impacts (Guida et al. 2017; Greene et al. 2010). A successional sequence of impacts on benthic resources by the presence of artificial hard substrates is likely but might not be foreseeably defined due to our current lack of knowledge, particularly on long-term changes and large-scale effects (Dannheim et al. 2020).

As previously outlined in section 5.1.1.2, added hardbottom substrate may increase diversity and abundance of some species, novel fouling communities can alter local trophic pathways in various ways (e.g., Degraer et al. 2020; Mavraki et al. 2021). The structures may also attract invasive species and in some situations create potential ecological traps (e.g., resident predators eating newly settled larvae). The alteration of habitat and additional structures may provide stepping stones for invasive species already present within the region. BOEM is currently conducting research to evaluate various options that will improve the quality of construction-derived hardbottom habitats. Given that 84.4% of the Lease Area is soft bottom habitat (see Table 3-2) and 68% of the Offshore Export Cable Route, the development of communities supporting EFH managed species of the Sessile and Mobile Complex bottom EFH species group could off balance the adverse long-term effects aspects of the soft bottom EFH species groups displaced.

Sediment Suspension and Redisposition from Offshore Cable Protection

Installing cable protection will suspend sediments temporarily but no specific sediment transport modeling was done for this particular project activity. See Section 5.1.1.2. for a discussion of sediment suspension and redeposition effects on federally managed species from various soft bottom, Complex bottom, and Pelagic EFH species groups related to the placement of materials onto soft bottom seafloor habitat. Unlike the scour pad installation, concrete mattresses will be placed using controlled and precise placement of the mattresses reducing the sediment suspension to very low if not unmeasurable levels. The adverse effect related to sediment dispersion would be short-term and indirect.

5.1.2.4 Vessel Activity associated with Installation of Offshore Cables

Habitat Loss/Conversion from Anchoring of Offshore Cable Installation Vessels

Installing cable protection will require vessel support to place the proposed concrete mattresses. US Wind has proposed to use dynamic position (DP) vessels as much as possible but in the event that a DP vessel is not available the general industry utilized vessel would be a Jack-up barge utilizing spud cans. No specific estimate for the spatial impacts has been provided for this particular project activity, but the resultant adverse effects would be similar as those described in Section 5.1.1.1. A discussion of the seafloor impacts and adverse effects on federally managed species from various soft bottom, Complex bottom, and Pelagic EFH species groups related to the placement of materials onto soft bottom seafloor habitat is provided. Unlike the scour pad installation, concrete mattresses placement will require a much smaller footprint and require only a single anchoring site per cable protection feature installation effort. The adverse effects related to anchoring activity and resulting habitat loss/conversion during cable protection installation would be permanent and direct for the Sessile and Mobile Soft bottom EFH species groups (Section 4.2) within the anchor or spud can footprint. Once the anchor is removed the adverse effects from the anchor scar would be short-term based on the assessment that the soft bottom habitats would recover after disturbance and without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006). The adverse effects of anchor impacts could be reduced by following mitigation measures and BMPs when operating near or within any areas with sensitive benthic resources. As part of the mitigation measures US Wind would prepare and submit for review with cooperating agencies an anchoring plan. This plan would utilize HRG survey data to avoid sensitive habitats such as SAV and hard bottom and structurally complex benthic habitats to the maximum extent practicable.

Sediment Suspension/Redisposition from Anchoring of Offshore Cable Installation Vessels

Sediment suspension and redeposition in relation to the utilizations of anchors related to cable protection installation would be very similar to thar described previously in Section 5.1.1.1. and 5.1.1.3. The response to suspended sediments would be species and life stage-specific. Adults as well as competently swimming juveniles or larvae of the Pelagic EFH species group (Section 4.2) will likely swim away from suspended sediment plumes produced during anchoring activities. Planktonic eggs and larvae of federally managed fishes and invertebrates will not be able to actively avoid sediment plumes. The adverse effects of the sediment plumes would be a direct impact to these early life stages, but the effects would be temporary with the initial elevated turbidity returning to background levels once the anchor is statically in place or removed from the seafloor.

Potential Introduction of Exotic/Invasive Species via Ballast of Offshore Cable Installation Vessels

There is a potential for invasive species being introduced and established as a result of offshore wind activities. Vessels required for the importation of components of the export cables and the specialized construction vessels from international ports could potentially represent transport vectors. The impacts of invasive species on EFH could be strongly adverse, widespread, and permanent. The introduction and impact of the Asian shore crab in the geographical analysis areas is a prime example of a species that became established and has outcompeted native fauna and adversely modified the coastal habitat. The potential for introducing an invasive species through ballast water releases or biofouling from installation activities related to US Wind construction activities is quite small and only related to the vessels utilized to import components of some of the WTG systems (monopiles and generators). These vessels are required- to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025) and EPA NPDES Vessel General Permit standards, both of which aim to prevent the release of ballast waters contaminated with an invasive species. As such, accidental releases from cable installation activities related to the inter-array and offshore export cable installation would not be expected to contribute appreciably to overall impacts on EFH; impacts related to the release of invasive species on the EFH resources are considered to be very unlikely.

Accidental Fuel Spills from Offshore Cable Installation Vessels

Vessels used for cable installation operations may generate waste, including bilge and ballast water, sanitary and domestic wastes, and trash and debris. All vessels associated with the Proposed Action would comply with USCG requirements for the prevention and control of oil and fuel spills. Small spills would rapidly dissipate, without major adverse effects occurring. For the duration of a spill species and life stages residing in the upper water column (Pelagic EFH species group) are most at risk for contact with the spilled oil. Pelagic species that, as adults, forage at water's surface would be most likely to encounter a surface spill. Tunas, mackerels, and herrings known to feed at the surface would likely avoid small spills. Planktonic early life stages (eggs and larvae) of many fish species would be less able to avoid a spill and therefore most vulnerable to toxic properties of the oil. Numerous federally managed species described above in Table 4-1 have pelagic eggs and larvae that would be at risk if they encountered a spill. Vessel accidental spills/discharges are expected to have a short-term adverse effect on the Pelagic EFH species group if a spill were to occur.

Underwater Noise from Offshore Cable Installation Vessels

Vessels used during installation of the inter-array and export cables would be similar to those used during installation of the WTG, OSS, and Met Tower foundations (Section 2.2.1.4), but would be expected to generally be smaller in both size of the cable-laying vessels compared to the foundation installation vessels, as well as quantity of vessels needed during cable installation. Effects of the noise produced by vessels during cable installation would be similar to those described in Section 5.1.1.2. Overall, impacts of vessel noise on fish prey species within EFH are expected to be minor, as they will be transient and localized in nature. Only a few individuals would be affected at any given time, and they are likely to return to normal behavior after the noise ceases.

5.1.2.5 Horizontal Directional Drilling – Offshore Export Cable

HDD Entry/Exit – Offshore Export Cable

US Wind states (COP, Volume II, US Wind 2023) that HDD technologies will be utilized as the offshore export cable landfall site east of 3Rs Beach, Maryland (Figure 5-1). The HDD exit hole will be approximately 1,600 to 5,300 feet in length (488 to 1,600 meters). Final HDD lengths will depend on factors such as soil conductivity, cable design, and available installation methods to minimize disturbance in the shallow areas between the beach front and the offshore exit hole.

Figure 5-1. 3R's Beach landfall: HDD with offshore/onshore transition vault connection

HDD gravity cells would be needed for each of the four offshore export cables on the Atlantic Ocean side of the barrier beach landfall to transition the offshore export cables to shore. A gravity cell is a temporary metal containment with an open bottom and top structure that is lowered to the seafloor. The gravity cell is typically lowered from a barge and does not require the walls of the cell to be driven into the seabed. This would disturb approximately 0.59 acres (0.24 hectares) (COP, Volume II, US Wind 2023). An additional eight gravity cells and two HDD locations will be needed to transition the inshore export cable from the barrier beach landfall into Indian River Bay (Old Basin Cove) and out of Indian River (Deep Hole) to the onshore substation.

It is expected that the gravity cells for in-water operations would be up to 60 meters long and 10 meters wide (197 feet long and 33 feet wide). The gravity cells will be designed to minimize the release of drilling cuttings and fluids and would be open on the seaward (outbound) side to facilitate the installation of the export cables. The presence of the gravity cells would be temporary and preclude any demersal and pelagic feeding fishes from the soft bottom acreage usurped by the HDD activity. These species at the beach would include adult summer flounder, Atlantic croaker (*Micropogonias undulatus*), and northern kingfish (*Menticirrhus saxatilis*). The HDD work may be conducted simultaneously or in stages depending on the final design of the Project. See Section 2.2.2.5 for further details on HDD.

HDD fluid release from Inshore Export Cable

The HDD process uses lubricating fluids and muds composed mostly of bentonite clay. For the possibility of fluid spill on site, a drilling fluid fracture contingency plan will be in place prior to HDD activity. Disposal of drilling fluids and cuttings will follow Best Management Practices (BMPs) for the disposal of solid waste or inert fill materials related to the drilling operations and will follow State and Federal regulations. These HDD activities are expected to have direct and short-term adverse effects on the Pelagic EFH species group and potentially a short to long-term effect on the Sessile/Epibenthic and Mobile Soft bottom EFH species groups. Once the gravity cell is removed, the dynamic nearshore environment should naturally backfill the HDD pit and the soft bottom benthic habitat should recover within 12-24 months with no mitigation (Dernie et al. 2003).

5.1.3 Inshore Export Cable Installation

5.1.3.1 Seabed Preparation (Including Boulder Relocation/Dredging/Grading/Grapnel Runs)

Habitat Loss/Conversion from Dredging and Dredge Material Disposal associated with Barge Access

Refer to section 2.2.3.1 for a complete description of Habitat Loss/Conversion from Dredging and Dredge Material Disposal associated with Barge Access and section 2.2.3.2 for proposed Seabed Preparation activities.

Dredging and disposal operations associated with barge access within the Indian River Bay would result in disturbance and modification of the benthic softbottom habitat. These installation activities will directly impact and displace infaunal, epibenthic, and demersal Mobile/Epibenthic soft bottom habitat organisms and their consumers from the areas of dredging and areas where thin layer deposition reuse will occur in tidal wetland areas. This direct impact (burial, smothering, elevated turbidity) is expected to result in short-term adverse effects on managed species and their EFH. The direct adverse effects for infauna within the Indian River Bay will result in mortality as well as displacement of EFH managed demersal species, their prey, and NOAA Trust resources (American shad, blue crabs, and Striped bass). EFH managed demersal species that could potentially be impacted include scup, black sea bass, summer flounder, windowpane flounder, winter flounder, and Atlantic butterfish. Each of these EFH species utilize the estuarine habitats seasonally or during a particular lifestage that could be impacted during the proposed dredging activities. The proposed dredging timeframe (October – March) will reduce the negative effects of the dredging activities based on the premise that most of the mentioned EFH species will not be utilizing the inshore estuarine habitats of the Indian River Bay during the proposed timeframe. Recolonization of impacted areas (dredge and thin layer deposition reuse areas) will depend on the size of the impact of these areas and the supply of settling larvae or motile individuals available to recolonizing the disturbed habitats. Once dredging has ceased soft bottom habitats would be expected to recover within a few months to a year with no mitigation (Dernie et al. 2003). Sand borrow projects near Indian River Bay inlet support recovery times for infauna of a few months to a few years in relation to dredged areas and benthic habitats disturbed though dredging and sediment placement and burial (USACE 2016).

Habitat Loss/Conversion from Seabed Preparation

Pre-installation seabed preparation, such as levelling, pre-trenching or boulder removal, is not currently expected for Inshore Export Cable Route installation (COP, Volume I, US Wind 2023). The main type of seabed preparation will include a pre-installation HRG survey and grapnel run as described in Section 5.1.2.1. Grapnel runs would be conducted to remove marine debris such as lost fishing nets, pots, or other objects from the construction path that could impact cable lay and burial. Typically, three passes of pre-lay grapnel runs would occur, one along the centerline and parallel lines to the centerline on either side, to ensure routes are clear. The grapnel will penetrate approximately 15.7 inches (40 centimeters) into the seafloor snagging and removing debris within the cable route. The sediment habitat within the Indian River Bay consists of a 100% soft bottom (Table 5-3) and the surface area to be temporarily impacted along the Inshore Export Cable Route seabed preparation is estimated to be 168.3 acres (68.1 hectares) of benthic habitat (Appendix G, Table G-1). The impacts related to grapnel runs would be very localized and temporally short and would recover completely without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006). The grapnel runs would impact Pelagic (Atlantic herring, Atlantic butterfish juvenile/adults, longfin inshore squid, juvenile/adults, Red hake) and Sessile Benthic/Epibenthic – soft bottom EFH species group and their eggs, larvae, and adult life stages of invertebrate managed species such as summer flounder, windowpane flounder juvenile/adult, scup, skates, juvenile/adults, smooth dogfish juvenile, Spiny dogfish juvenile, within the Indian River Bay. Along with ecologically important prey species (Bay Anchovy, Striped Anchovy, River herring, hard clams, and softshell clams).

Sediment Suspension/Redeposition from Seabed Preparation

Sediment suspension related to grapnel runs within the Indian River Bay will be very similar to the conditions generated within the Offshore Export Cable Route described in section 5.1.2.2. The adverse effects related to sediment suspension for the grapnel runs will be very short-term and should return to background conditions within hours. The disturbance of the cable installation is expected to disturb approximately the same spatial area of benthic habitat as the grapnel footprint. The impacts related to the grapnel runs would be direct and adversely affect mainly the sessile/epibenthic infauna, however the effects would be very localized and temporary. The seafloor habitat within the Indian Rive Bay is composed of soft bottom habitat and with the transient passes of the grapnel equipment the benthic infauna are expected to recover completely without mitigation in short-term time frame (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

Entrainment from Seabed Preparation

The impacts of entrainment from seabed preparation along the Inshore Export Cable Route would be similar in nature that those described for seabed preparation activities along the Offshore Export Cable Route (Section 5.1.1.1). To achieve the target burial depth US Wind and its contractors have determined dredging would necessarily precede cable installation in locations along the cable routes for barge access. Hydraulic dredging would be used to provide access for the barges used for cable installation. The intake for the hydraulic pumps are typically located near the surface and withdraws large volumes of water along with the dredging head at the seafloor. If used, water intake poses an entrainment risk to pelagic and benthic eggs and larval life stages of both finfish and invertebrates in the various EFH species groups listed in Section 4.2. The limited volume of water during the temporally short dredging period would not produce a population-level impact on any EFH managed species, and therefore would have minor short-term but direct effect.

Underwater Noise from Seabed Preparation

Vessels used during grapnel runs will include a vessel equipped with a large winch and A-frame cable management system. Effects of the noise produced by the vessel utilized to grapnel runs installation would be similar to or potentially smaller those described in Section 5.1.1.2, since they would be operating in the Indian River Bay. Overall, impacts of vessel noise on EFH species and their prey within the Indian River Bay are expected to be direct but short-term, as they will be transient and localized in within the immediate area during grapnel run operations. Only a few EFH species individuals would be affected at any given time, and they are likely to return to normal behaviors after the vessel passes and the noise ceases.

UXO Relocation and/or Removal along Inshore Export Cable Route

Impacts associated with unexploded ordnances (UXO) relocation and removal are described in Section 5.1.1.1.1, and 5.1.2.1 above. As stated previously, US Wind has not detected and does not expect to find UXOs within the boundaries of the Inshore Export Cable Route. Surveys within the Inshore export cable route have not detected the presence of any UXOs. If an UXO is found within the Inshore export cable route avoidance of an UXO through micrositing is the preferred approach where feasible. Avoidance entails micrositing of cable route away from any UXO hazards. UXO clearance involves relocation, removal, or detonation in place (Middleton et al. 2021). UXO detonations are not included under the Proposed Action and will not be discussed further (US Wind 2023).

5.1.3.2 Trenching/Cable Installation of Inshore Export Cable Route.

Habitat Loss/Conversion from Inshore Export Cable Installation

Overall, installation of up to 43.5 miles (68.1 kilometers) inshore export cable is expected to temporarily disturb 168.3 acres (68.1 hectares) of seafloor. It should be noted approximately 39 acres (15.8 hectares) of seafloor would be temporarily disturbed during dredging for barge access along the western portion of the cable route. This disturbance would occur within the same footprint as the cable installation. US Wind proposes to install the cables along the southern Inshore Export Cable Route through Indian River Bay. The Inshore Export Cable Route is 131 feet (40 meters) wide, with a potential temporary construction disturbance area (anchoring) of an additional 250 feet (76 meter) extending from either side of the route.

Jet plow cable installation with concomitant anchor placement from supporting installation vessels would result in seafloor disturbance and modification. These installation activities will directly impact and displace infaunal, epibenthic, and demersal Mobile/Epibenthic soft bottom and heterogeneous complex habitat organisms and their consumers from the cable routes. This direct impact is expected to result in short-term adverse effects on managed species and EFH. The direct adverse effects for Infauna within the Indian River Bay will result in mortality as well as displacement of EFH managed demersal and pelagic finfishes. Once the cable is in place and buried invertebrate infauna will recolonize the impact scars from dredging, anchoring, and cable installation. Recolonization of impacted areas will depend on the size of the impact scar and the nature of the supply of settling larvae or motile individuals capable of settling. Once the jet plow has passed through and successfully buried the cable, and all anchoring activities have ceased soft bottom and heterogeneous complex seafloor habitats would recover within a few months with no mitigation (Dernie et al. 2003).

Sediment Suspension from Inshore Export Cable Installation

Jet plowing the 42.3 miles (68.1 kilometers) of inshore export cable through Indian River Bay is expected cause a temporary increase in suspended sediment concentrations and the re-deposition of sediments. US Wind prepared the results of a suspended sediment and deposition transport model associated with jet plowing of the inshore export cables through Indian River Bay. These analyses indicated, given the predominantly fine sediments along the Inshore Export Cable Route (100% soft bottom habitat, Table 5-3), that the suspended sediment plume is likely to last between 5 and 24 hours. The results of the sediment transport assessment indicated that most of the fluidized sediments lost to the water column are predicted to quickly settle back to the bay floor and deposition thicknesses greater than 0.2 inches (5 millimeters) will typically occur within 95 feet (30 meters) of the cables regardless of route (Appendix H, *Indian River Bay Sediment Transport Modeling*). Suspended sediment concentrations are predicted to be less than 200 mg/L at distances greater than 4,600 feet (1,400 meters) from the cables

(Appendix H). Model results indicate that the suspended sediment plume resulting from jet plowing will have a limited duration. All suspended sediment concentrations greater than 50 mg/L above ambient conditions are predicted to dissipate in less than 12 hours after the passage of the jet plow. Suspended sediment plumes greater than 10 mg/L are predicted to disappear within 24 hours after the completion of jetting operations.

The timing of the jet plowing with respect to the tidal cycle will play a large role in determining the direction of the sediment plume. Flushing rates within Indian River Bay are long (approximately 3 days) relative to the anticipated sediment suspension duration (less than 12 hours), making it unlikely the suspended sediment would flush out through the inlet. The sediment transport modeling results concluded that the proposed jet plowing for cable installation would result in short-term and localized effects (Appendix H, *Indian River Bay Sediment Transport Modeling*). Due to silting in Indian River Bay, it would continue to be dredged, so burying cables in the area would not cause greater impacts than dredging. US Wind would conduct turbidity monitoring while performing dredging in Indian River Bay, in accordance with the requirements contained in the USACE and DNREC permits.

The increased turbidity and sediment deposition may kill filter feeding Sessile Benthic Soft bottom EFH species groups, or sensitive larval life stages of both finfish and invertebrate EFH and prey species. The ability to tolerate increased turbidity and sedimentation varies by life stage. For example, eggs of hard clams suffered increasing abnormal development with increasing silt concentrations from 0.75 g/L to 3.0 g/L, while growth of larvae was inhibited above 0.75 g/L although were able to survive at 4 g/L (Roegner and Mann 1990). Growth of juvenile and adult hard clams was inhibited at .044 g/L (Roegner and Mann 1990).

Many organisms that inhabit these soft sediment habitats are regularly exposed to natural disturbances that create spatial heterogeneity and resource patchiness. These communities are composed of opportunistic species which have high reproductive rates to recolonize disturbed areas. Impacts related to jet plowing would be localized and short-term, and communities are expected to recover relatively quickly (Dernie et al. 2003; Boyd et al. 2005). Sediment suspension and redeposition from cable installation (jet plowing) would impact the Sessile/Epibenthic Soft bottom species and EFH species with a benthic life stage (e.g., juvenile butterfish, juvenile Red hake, and juvenile Sand tiger sharks, Common thresher shark and skates). These adverse effects would be direct but short-term relative to displacement during cable installation operations. Although benthic community recovery rates specific to cable emplacement for offshore wind projects are not yet known, nearby sediment dredging, and sand borrow projects including near Indian River Bay inlet support recovery times of a few months to a few years (USACE 2016).

US Wind completed an evaluation to characterize constituent levels in the surface water and sediments from areas within Indian River and Indian River Bay proposed for potential dredging, and to evaluate potential impacts on ecological and/or human health (Environmental Risk Solutions. 2024). Analytical surface water data were compared to DNREC HSCA Screening Levels for Marine Surface Water. Analytical sediment data from three composite samples were compared to appropriate screening levels to determine the potential for adverse effects on human health and ecological receptors. The evaluation of risks to terrestrial ecological receptors was completed through a comparison of sediment data to

HSCA ecological surface soil screening levels and additional benchmarks specific to terrestrial receptor groups (plants, invertebrates, mammals and birds). The conclusion of the evaluation is that for all chemical groups analyzed in the Indian River surface water and sediments, as well as all potential human and ecological exposure scenarios, there is negligible potential for adverse effects associated with potential dredging activities.

Entrainment from Inshore Export Cable Installation

In Indian River Bay the most common broadcast spawners would be members of the Pelagic Prey EFH species group (Section 4.2) as well as NOAA Trust Resources (Section 4.3). Based on inland ichthyoplankton surveys in the region (e.g., Morson et al. 2019) early life stages expected for Indian River Bay would include bay anchovy, alewife, Atlantic menhaden, and Atlantic silversides (*Menidia menidia*). Eggs and larvae of these species would be most likely to be entrained along the Indian River Bay trenching route. As discussed previously in Section 5.1.2.1, the relatively small area in which the jet plowing would occur (in relation to the Mid-Atlantic Bight region) and the short period of time in which jet plowing would be employed indicates that only a fraction of the potential habitat for most vulnerable pelagic organisms would be impacted (e.g., Saila et al. 1997). The EFH assessment for Cape Wind indicated the potential for entraining 48.5 million eggs and larvae through water withdrawal for jet plowing would have a minimal impact on the managed species of finfish and invertebrates due to the high fecundity of species and the relatively small proportion of eggs and larvae that survive to adulthood (USDOI and MMS 2009, Reine and Clarke, 1998). Similarly, project related entrainment of eggs and larvae from regional fish and invertebrate populations are expected to be a direct short-term effect but one that is not expected to have a population level effect on the EFH finfish or invertebrate species.

Underwater Noise from Inshore Export Cable Installation

Given the physical qualities of noise associated with dredging, trenching, and cable-laying (BOEM 2023a Appendix B), injury and auditory impairment are unlikely, but fishes and invertebrates could experience behavioral disturbance or masking close to the dredging activity. No research has specifically looked at responses to these noise sources, but the impacts are likely to be similar, but less intense, than those observed with vessel noise (Section 5.1.1.2), since these activities are not as widespread or frequent as vessel transits. Therefore, the effects of noise during potential jet plowing are expected to be so small as to be indirect and very short-term.

5.1.3.3 Cable Protection Installation (Concrete Mattresses, etc.)

Habitat Loss/Conversion from Cable Protection of Inshore Export Cables

As previously stated, US wind does not anticipate the need for cable protection structures (e.g., mattresses, rock placement, cable protection systems [CPSs]) along the Inshore Export Cable Route.

Sediment Suspension and Redisposition from Cable Protection of Inshore Cables

As previously stated, US wind does not anticipate the need for cable protection structures (e.g., mattresses, rock placement, cable protection systems [CPSs]) along the Inshore Export Cable Route.

5.1.3.4 Vessel Activity associated with Installation of Inshore Export Cables

Habitat Loss/Conversion from Inshore Vessel Activity

No specific estimates for the spatial impacts have been provided for anchoring impacts related to dredging or jetting operations within the Indian River Bay for the installation of cables, but the resultant adverse effects would be similar as those described in Section 5.1.3.2. A discussion of the seafloor impacts and adverse related to habitat loss and conversion is provided in Sections 5.1.2.4. and 5.1.3.2. As Outlined previously, once the anchor is removed the adverse effects from the anchor scar would be short-term based on the assessment that the 100% soft bottom habitat in the Indian Rive Bay (Table 5-3) would recover after disturbance and without mitigation (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006). The adverse effects of anchor impacts could be reduced by following mitigation measures and BMPs when operating near or within any areas with sensitive benthic resources. As part of the mitigation measures US Wind would prepare and submit for review with cooperating agencies an anchoring plan for operations within the Indian River Bay. This plan would utilize HRG survey data to avoid sensitive habitats such as SAV and hard bottom and structurally complex benthic habitats to the maximum extent practicable.

Sediment Suspension/Redisposition from Inshore Vessel Activity

Sediment suspension and redeposition in relation to the anchoring activities would be very similar to that described previously in in Section 5.1.2.4. and 5.1.3.2. The response to suspended sediments would be species and life stage specific. Adults as well as competently swimming juveniles or larvae of the Pelagic EFH species group (Section 4.2) will likely swim away from suspended sediment plumes produced during anchoring activities. Planktonic eggs and larvae of federally managed fishes and invertebrates will not be able to actively avoid sediment plumes. The adverse effects of the sediment plumes would be a direct impact to these early life stages, but the effects would be temporary with the initial elevated turbidity returning to background levels once the anchor is statically in place or removed from the seafloor.

Potential Introduction of Exotic/Invasive Species from Inshore Vessel Activity

The likelihood of the introduction of exotic/invasive species brought into the Indian River Bay by the vessels supporting installation activities is very low. Overall, the vessel to be utilized will most likely be from a pool of construction vessels within the US. The introduction of invasive species could occur during ballast water and bilge water discharges. The size of the vessels and their point of origin within the US would greatly limit the probability of these vessels functioning as a vector for releasing a viable egg or larval/juvenile densities that could establish a self-sustaining invasive species within the Indian

River Bay. As such, accidental releases from future offshore wind development would not be expected to contribute appreciably to overall adverse impacts on the EFH managed species or their habitat in the Indian River Bay.

Accidental Fuel Spills from Inshore Vessel Activity

As outlined in section 5.1.1.3 and 5.1.2.4 accidental fuel spills as related to cable installation activities is predicted to be unlikely and small in scale. All vessels associated with the Proposed Action would comply with USCG requirements for the prevention and control of oil and fuel spills. Small spills would rapidly dissipate, without major adverse effects occurring. For the duration of a spill species and life stages residing in the upper water column (Pelagic EFH species group) are most at risk for contact with the spilled oil. Pelagic species that, as adults, forage at water's surface would be most likely to encounter a surface spill. Tunas, mackerels, and herrings known to feed at the surface would likely avoid small spills. Planktonic early life stages (eggs and larvae) of many fish species would be less able to avoid a spill and therefore most vulnerable to toxic properties of the oil. Numerous federally managed species described above in Table 4-2 have pelagic eggs and larvae that would be at risk if they encountered a spill. Vessel accidental spills/discharges are expected to have a short-term adverse effect on the Pelagic EFH species group if a spill were to occur.

Underwater Noise from Inshore Vessel Activity

Underwater noise related to Project vessel activity within the Indian River Bay during cable installation activities is expected to cause the same level of minor short-term adverse effects as those described in the preceding sections (5.1.1.3, and 5.1.2.4). Overall, adverse effects from vessel noise on EFH species and their prey species within the Indian River Bay EFH are expected to be direct but very short-term as they will be transient and localized in nature. Only a few individuals would be affected at any given time, and they are likely to return to normal behavior after the vessel passes or the noise ceases.

5.1.3.5 Horizontal Directional Drilling – Inshore Export Cable

HDD Entry/Exit – Inshore Export Cable

HDD gravity cells would be needed for each of the four inshore export cables within Indian River Bay and Indian River landward of the barrier beach landfall. A gravity cell is a temporary metal containment with an open bottom and top structure that is lowered to the seafloor. The gravity cell is typically lowered from a barge and does not require the walls of the cell to be driven into the seabed. Eight gravity cells at two HDD locations will be needed to transition the inshore export cable from the barrier beach landfall into Indian River Bay (Old Basin Cove) and out of Indian River (Deep Hole) to the onshore substation. This would disturb approximately 1.19 acres (0.48 hectares) (COP, Volume II, US Wind 2023). An additional four gravity cells may be needed on the Atlantic Ocean side of the barrier beach landfall and is considered part of the Offshore Export Cable Route.

It is expected that the gravity cells for in-water operations would be up to 60 meters long and 10 meters wide (197 feet long and 33 feet wide). The gravity cells will be designed to minimize the release of drilling cuttings and fluids and would be open on the seaward (outbound) side to facilitate the installation of the export cables. These impacts would temporarily preclude any demersal feeding fishes from the soft bottom acreage usurped by the HDD activity. These species would bottom feeding juvenile summer flounder, spot (*Leiostomus xanthurus*), Atlantic croaker as well as pelagic prey species bay anchovy, and Atlantic silversides, and Atlantic menhaden would be temporarily displaced by the gravity cells. The HDD work may be conducted simultaneously or in stages depending on the final design of the Project. See Section 2.2.2.5 for further details on HDD. As outlined in Section 5.1.2.5, HDD systems use lubricating fluids and mud composed mostly of inert bentonite clay. For the possibility of drilling muds spills on either end of the drilling sites (entry or exit) or along the HDD route, a drilling fluid fracture contingency plan will be in place prior to HDD activity. The operational HDD activities are expected to have minor direct short-term adverse effects on EFH managed species. These adverse effects will cease once the HDD sites (entry or exit) are restored to prior conditions. The disturbed soft bottom benthic habitat is expected to recover completely without mitigation in a short-term time frame (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

HDD fluid release from Inshore Export Cable

If in the event an HDD fluid release were to occur, US Wind would immediately take corrective steps and follow the drilling fluid fracture contingency plan. The HDD operation will include monitoring of the downhole water/bentonite slurry to minimize the potential of drilling fluid fracture. The level of adverse effects to the Indian River Bay habitat would be limited to impacts on the soft bottom benthic habitat and localized turbidity around the fracture site. If while monitoring the drilling operations, an immediate drop in pressure is detected, operations will cease and an immediate inspection to detect a mud fracture will be conducted to limit the amount turbidity and seafloor impacts. As part to the corrective actions, all bentonite will be recovered from the seafloor. As stated previously and once removed from the fracture site there will be no remanent contamination. The adverse impacts to soft bottom benthic and Pelagic EFH species groups will be short-term and will recover without mitigation once the bentonite is removed.

5.1.4 Construction of O&M Facility

5.1.4.1 Bulkhead Repairs and Fixed Pier

Construction at the O&M Facility will include repairs to the existing concrete wharf (bulkhead repair and timber fender systems). Bulkhead repairs including steel sheet pile and an attached timber fender system will occur along the existing concrete wharf 175 feet (53.3 meters). The bulkhead repairs will be performed by placing sheet piling a maximum of 18 inches (45.7 centimeters) beyond the existing wharf face and filling the void between the two before being capped. The existing floating dock which is 75 feet (22.9 3 meters) long and the existing pier which is 550 feet (167.6 meters) long by 12-foot (3.7 meters) wide will be replaced by a fixed pier which will be 625 feet (190.5 meters) long and range from 28 to 32 feet (8.5 to 9.7 meters) wide. The length of the proposed pier will not extend any further into Ocean City Harbor any further than the current dock and pier structures. Additional bulkhead repairs will occur within the same footprint of a segment (235 feet [71.6 meters]) of the proposed fixed pier.

New construction at the O&M Facility would occur from a barge mounted crane which is anticipated to include pile driving for the pier and installation of concrete pile caps, deck and curbs. Equipment such as jib cranes are anticipated to be installed on the pier deck and mooring hardware mounted along the curb as required for the CTVs. Up to 170 steel pipe pier piles- 12-to-18-inch (30.5 to 45.7 centimeters) diameter, 100 to 125 feet (30.5 to 38.1 meters) in length would be driven by impact hammer. A 2-foot-(0.6 meter) wide timber fender system along the north side of the pier and along the steel sheet pile bulkhead will be installed. Also, a 2-foot-(0.6 meter) wide timber fender system and wave screen on the south side of the pier would be installed. Up to 240 timber fender system piles 12-to-18-inch (30.5 to 45.7 centimeters) diameter, 40 to 45 feet (12.2 to 13.7 meter) in length would be driven by impact hammer. The piling duration for the steel pipe pier piles and timber fender system piles would occur over a period of up to 6-months.

The sheet pile bulkhead would include up to 120 sheets that would be driven by impact hammer over a period of up 3 months.

The means and methods of pile installation would be consistent with similar scale projects in the area. The specific hammer energy would be further refined as the project progresses, however US Wind does not anticipate any exceptional or non-traditional methods of installation that vary from similar work.

There is no proposed dredging for the construction or operations of the pier, although if facilities are found to be insufficient and additional dredging is required, additional EFH consultation and permitting may be required.

Habitat Loss/Conversion from Waterfront Construction

The footprint of the proposed bulkhead repairs and fixed pier would permanently impact approximately 19,700 square feet (1,830.2 square meters) of seafloor. The existing O&M site includes waterfront facilities, the seafloor has been previously disturbed and no sensitive habitats (oyster reef or eelgrass) are known to be present. As such the proposed in-water structures are not expected to affect any sensitive habitats within the Ocean City Inlet and Sinepuxent Bay confluence.

Based on the uniformity of benthic habitats within Sinepuxent Bay, the proposed construction will impact soft bottom infaunal organisms through crushing and burial that would result in injury or mortality in the area if the sheet piles and pier pilings. Motile soft bottom organisms would be directly impacted but would avoid the area during construction activities. The absence of these organisms would result in loss of foraging within the construction footprint. Once construction is completed the softbottom habitats would recover within a few months with no mitigation (Dernie et al. 2003). As outlined in previous sections, the addition of hard structures (bulkhead and pilings) may increase diversity and abundance of some estuarine species. The new structures may also attract invasive species. The alteration of habitat and additional structures may provide stepping stones for invasive species within the Sinepuxent Bay that are already present within the region. The pier pilings may provide habitat for Benthic and Epibenthic Complex Habitat Prey Species such as blue mussels and eastern oysters. The pier structure would also cause minor adverse effects through shading of the benthic habitats located under the fixed pier and the immediate area.

All impacts from the construction of the O&M facility would be permanent and persist as long as the structures are present.

Effects of Underwater Noise from Pile Driving on Fish and Invertebrates

Impact pile driving activities may occur inshore during construction to support the development and retrofitting of the proposed O&M facility (Section 2.3.1). Construction at the O&M facility will include pile driving associated with the proposed sheet steel bulkhead and pile supported fixed pier. The bulkhead repairs will be performed by placing sheet piling a maximum of 18 inches (45.7 inches) beyond the existing wharf face and filling the void between the two before being capped. The proposed fixed pier will be 625 feet (190.5 meters) long and range from 28 to 32 feet (8.5 to 9.7 meters) wide. The length of the proposed pier will not extend any further into Ocean City Harbor any further than the current dock and pier structures.

It is anticipated up to 170, 12-to-18-inch (30.5 to 45.7 centimeters) diameter steel pipe piles will be installed using impact pile driving over an approximate 6-month period; up to 240, 12-to-18-inch (30.5 to 45.7 centimeters) diameter timber fender system piles will be installed using impact pile driving over an approximate 6-month period; and up to 120 sheet piles will be installed using impact pile driving for the bulkhead over an approximate 3-month period. While no specific timeline for acquisition and retrofitting of the O&M facility is provided in the COP (US Wind 2023), it is anticipated that any inshore impact pile driving required to develop the O&M facility will be completed before the targeted commercial operations date for phase 1 in December 2025.

No acoustic modeling is available for this activity from US Wind, so the NMFS Multi-Species Pile Driving Calculator Tool (NMFS 2023) was used to estimate ranges to the thresholds for fish ≥2 g. Source levels for this activity were obtained from the “impact proxy sound levels” tab of this calculator tool based on the data that used the most comparable pile size, material, and water depth to use as a proxy for the Proposed Action. The estimated strike rates and expected number of piles installed per day were identified based on available incidental take authorization applications on NMFS website (Naval Facilities Engineering Command Mid-Atlantic 2020; Weston Solutions, Inc. 2023). A summary of the parameters used in the Multi-Species Pile Driving Calculator tool are summarized for each proposed pile type below and PDFs of the calculator tool tabs used for this assessment are provided in Appendix K. All calculations assumed use of a noise mitigation system which would achieve at least 5 dB noise attenuation.

- The proxy source levels for impact piling of the proposed 12- to 18-inch steel (30.5 to 45.7 centimeters) piles were based on measurements of 20-inch steel piles installed in 10 feet (3 meters) water depth conducted by Caltrans (2015). It was assumed that up to five piles would be installed per day each requiring up to 100 strikes per pile based on the information provided in Weston Solutions, Inc. (2023).
- The proxy source levels for impact piling of the proposed 12- to 18-inch (30.5 to 45.7 centimeters) timber piles were based on measurements of 14-inch (35.6 centimeter) steel piles installed in 16 feet (5 meters) water depth conducted by Caltrans (2020). It was assumed that up to five piles would be installed per day each requiring up to 100 strikes per pile based on the information provided in Weston Solutions, Inc. (2023).

- The proxy source levels for impact piling of the proposed sheet piles were based on measurements of 24-inch sheet (61 centimeter) piles in 7 to 20 feet (2 to 6 meters) water depth conducted by Caltrans (2020). It was assumed that up to three piles would be installed per day based on the information provided by Naval Facilities Engineering Command Mid-Atlantic (2020). A strike rate for impact piling of the sheet piles was not provided in this report, just the duration of the installation for each sheet pile. Therefore, using information available in Caltrans (2020) which indicates sheet piles could be installed using an APE 7.5, and the maximum blow rate of 75 blows per minute for this hammer based on manufacturer specifications (American Pile Driving Equipment, Inc. 2023), it was assumed for the purposes of this assessment that 975 blows would be required for each sheet pile installation assuming a total installation duration of 13 minutes (Naval Facilities Engineering Command Mid-Atlantic 2020).

Results from the calculator tool indicate physical injury ranges for fish ≥2 g may be met or exceeded within 11 feet (3 meters) from the source for the 12- to 18-inch (30.5 to 45.7 centimeters) steel piles based on the Lpk metric; within 1.5 feet (0.5 meters) from the source for the 12- to 18-inch (30.5 to 45.7 centimeters) timber piles based on the SEL_{24h} metric; and within 124 feet (38 meters) from the source for the sheet piles based on the SEL_{24h} metric (Appendix K). Noise levels may exceed the SPL 150 dB re 1 µPa behavioral disturbance threshold for all fish within 82 feet (25 meters) from the 12- to 18-inch (30.5 to 45.7 centimeters) steel piles; 45 feet (14 meters) from the 12- to 18-inch (30.5 to 45.7 centimeters) timber piles; and 707 feet (215 meters) from the sheet piles (Appendix K).

The location where the proposed O&M facility would occur overlaps with EFH for black sea bass, scup, clearnose skate, windowpane flounder, spiny dogfish, little skate, summer flounder, Atlantic butterfish, Atlantic herring, longfin inshore squid, winter skate, bluefish, red hake, monkfish, sand tiger shark, albacore tuna, bluefin tuna, sandbar shark, skipjack tuna, and yellowfin tuna (NOAA Fisheries 2023). The location of the O&M facility also overlaps with the HAPC for summer flounder (Figure 4-2). Of these species, only Atlantic herring fall under the hearing specialist category (Section 5.1.1.2) meaning they have a swim bladder that is involved in hearing and enables greater capabilities for detecting the sound pressure component of underwater sound compared to species with no swim bladder (i.e., elasmobranch species, flatfish, spiny dogfish, Atlantic butterfish, longfin inshore squid) which would only detect the particle motion component of underwater sound (Section 5.1.1.2). The remaining species have a swim bladder that is not involved in hearing, so they have some capacity to detect changes in sound pressure, but they are predominantly sensitive to particle motion (Section 5.1.1.2). Available data indicate particle motion levels sufficient to affect fish tissues is expected to be dominant only within short ranges around the source (Amaral et al. 2018; Mickle and Higgs 2022; Harding and Cousins 2022), beyond which sound pressure physiological injury effects would dominate.

Based on the results from the Multi-Species Pile Driving Calculator Tool (Appendix K), recoverable physiological injury for fish ≥2 grams (which is applicable for Atlantic herring) would only be expected to occur out to a maximum of 11 feet (3 meters) from the source for the 12- to 18-inch (30.5 to 45.7 centimeters) steel piles based on the Lpk metric; within 1.5 feet (0.5 meters) from the source for the 12- to 18-inch (30.5 to 45.7 centimeters) timber piles based on the SEL_{24h} metric; and within 124 feet (38 meters) from the source for the sheet piles based on the SEL_{24h} metric. Given these small ranges to the sound pressure thresholds, and because particle motion levels sufficient to result in physiological injury would be expected to occur over a smaller range for all other fish species, it is unlikely that injury would occur for any fish species within the EFH and HAPC that overlaps with the proposed O&M facility location.

Behavioral disturbances for all fish species may occur out to a maximum of 82 feet (25 meters) from the 12- to 18-inch (30.5 to 45.7 centimeters) steel piles; 45 feet (14 meters) from the 12- to 18-inch (30.5 to 45.7 centimeters) timber piles; and 707 feet (215 meters) from the sheet piles (Appendix K). However, this is based on the sound pressure component of underwater sound and would therefore predominantly be applicable to Atlantic herring, the only hearing specialist species with EFH near the proposed O&M facility location. For all other fish and invertebrate species, the dominant method of underwater sound detection is through particle motion. Measurements of particle motion during installation of foundations for 6-megawatt WTG in approximately 98 feet (30 meters) water depth indicated particle motion during pile driving may result in behavioral disturbances for fish species, but mitigated particle acceleration levels for pile driving were only 10 dB re 1 $\mu m/s^2$ higher than ambient particle acceleration levels at 1,903 feet (580 meters) from the pile (Sigray et al. 2022). This suggests particle motion levels produced by pile-driving noise during installation of the O&M facility are unlikely to be significantly higher than ambient particle motion levels in the Project area. Additionally, pile driving activities during development of the O&M Facility would only occur over an approximate 6-month period for the steel piles, a 6-month period for the timber piles, and a 4-month period for the sheet piles. Given the relatively low ranges to the sound pressure threshold of 150 dB re 1 µPa the limited distance over particle acceleration levels would exceed baseline conditions, and the limited duration of this activity will occur, any behavioral effects experience by fish and invertebrates in the area would be limited to short-term and relatively minor changes such as startle responses that would only be expected when active piling of the O&M facility infrastructure was occurring.

5.1.5 Operation/Presence of Structures

5.1.5.1 Artificial Substrate (WTG/OSS/Met Tower/Turbine Scour Protection)

Community Structure Changes from Artificial Substrate

The Lease Area is generally characterized by mobile sandy substrates on gentle slopes, with shell hash frequently accompanying mineral substrates (Guida et al. 2017). A total of 93% of the slopes within the Lease area do not exceed 1 degree and additionally 99% of the slopes do not exceed 2 degrees. Hard bottom benthic habitats are rare in the Lease Area and primarily occur as gravel or cobble dominated substrates (Guida et al. 2017; NOS 2015). In summary, 56,090 acres (22,699 hectares) of the Lease Area is characterized as soft bottom (84.4%), with the remaining 10,336 acres (4,183 hectares) 15.6%, characterized as complex, heterogenous and large-grained combined) (see Table 3-2).

Habitat complexity is an important contributor to diversity and abundance of a large number of EFH finfish and ecologically important fish and invertebrate prey species utilized by EFH species (e.g., through facilitating refuge from prey during early life stages, providing areas of post-larval settlement; Loren et al. 2007; Malatesta and Auster 1999). Wind energy structures, including WTGs, OSSs scour protection pads, and cable protections systems, create uncommon areas of relief within habitats that are predominately characterized as areas with low-relief sand-waves and sand ripple seascapes. Structure-oriented EFH finfish are attracted to these hard substrate installations. Impacts on the soft bottom sediment habitats from structure presence are localized and can be short term to permanent for the life of each wind energy project, potentially for as long as each structure remains in place. Fish aggregations found in association with seafloor structures can provide localized, short term to permanent, beneficial impacts on some fish species due to increased prey species availability. Initial recruitment to these hard substrates may result in the increased abundance of EFH species fish and epifaunal invertebrate species (Claisse et al. 2014; Smith et al. 2016; BOEM 2021); such recruitment may result in the development of diverse demersal fish and invertebrate assemblages. However, such high initial diversity levels may decline over time as early colonizers are replaced by successional communities (Degraer et al. 2018). Further, colonization by non-native biota (e.g., invasive or nuisance species) may alter localized benthic or epipelagic communities (Glasby et al. 2007).

Considering the above information, BOEM anticipates that the impacts of the presence of structures on EFH species of finfish and invertebrates would be a minor adverse effect within the lease area and may include minor beneficial impacts on the community structure within the Project area. All impacts would be permanent as long as the hardbottom complex artificial structures remain.

Invasive Species from Artificial Substrate

The offshore wind industry would increase the risk of accidental releases of invasive species due to increased maritime traffic. The impacts of invasive species that might settle the introduced hard structure on managed species and their EFH depend on many factors but could be widespread and permanent. Releases of invasive species may or may not lead to the establishment and persistence of invasive species. The alteration of habitat and additional structures may provide stepping-stones for invasive species already present within the region. As documented in observations of colonial sea squirt (*Didemnum vexillum*) at the Block Island Wind Farm (HDR 2020), the impacts of invasive species could be strongly adverse, widespread, and permanent if the species were to become established and outcompete native fauna or modify habitat. For example, colonial sea squirt is already an established species in New England with documented occurrence in subtidal areas, including on Georges Bank, where numerous sites within a 56,834-acre (23,000-hectare) area are 50 to 90% covered by colonial sea squirt (Bullard et al. 2007). The structures may also provide habitat for the invasive red lionfish (*Pterois volitans/miles*). Red lionfish, native to the Indo-Pacific, are established from North Carolina to the Caribbean Sea and Gulf of Mexico (Schofield 2010). Red lionfish have an affinity for natural and artificial hardbottom and feed opportunistically on fishes and to a lesser extent motile invertebrates (Munoz et al. 2011). Although young individuals have been recorded from as far north as Massachusetts, the established northern range limit ends at Cape Hatteras, North Carolina (Scofield 2010; Whitfield et al. 2014; Hunter et al. 2021). Water temperature is an important determinant in lionfish distribution. Most observations as well as projections of species distribution models indicate a preference for water temperatures over 16°C (Greive et al. 2016; Kimball et al. 2004). In the near future, the US Wind structures may be colonized by lionfish during summer months, but these individuals would not likely survive the winters within the project area. Over time and with climate change, the spread of and survival of adults may eventually extend the present range northward into the offshore

Maryland/Delaware area. If this happens, control measures such as lionfish spearfishing derbies or dedicated eradication programs could be developed (e.g., de Leon et al. 2013; Harris et al. 2020).

The potential for introducing an invasive species through ballast water releases or biofouling from US Wind operational activities is quite low and only related to the vessels utilized to import components of some of the WTG systems (monopiles and generators) during installation. The vessel to be utilized during the operational and maintenance phase of US Wind will most likely be built within the US following Jones Act requirements. As outline in Section 5.1.1.2 vessels to be utilized during the operation and maintenance phases will be 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 to prevent the release of ballast waters contaminated with an invasive species. As such, accidental releases from the operational and maintenance phase of US Wind Lease Area would not be expected to contribute appreciably to overall impacts on EFH; impacts related to the release of invasive species on the EFH resources are considered to not be of very low risk. If in the unlikely chance that an invasive species were to become established within the US Wind Lease area the impacts to managed species and their EFH could be permanent as long as the WTGs, OSSs, and Met Towers remain in place and the invasive species is able to establish within the project area and adversely affect the EFH species that utilize the same ecological niche and habitat.

5.1.5.2 Underwater Noise during Operations

Acoustic Effects to Species and Species Behaviors

The operation of Project WTG may introduce low-level, continuous noise into the marine environment of EFH within the Project area. The primary effects of this noise on EFH would result from behavioral effects on prey species as no injury is likely to occur for any species due to the non-impulsive characteristics of this source. Additional details of the physical qualities of WTG operational noise can be found in Appendix B of the Draft EIS (BOEM 2023a).

Elliot et al. (2019) compared field measurements during offshore wind operations from the Block Island Wind Farm to the published audiograms of a few fish species. They found that, even at 164 feet (50 meters) distance from an operating WTG, particle acceleration levels were below the hearing thresholds of several fish species, meaning that it would not be audible at this distance. Pressure-sensitive species (such as those with a swim bladder) may be able to detect operational noise at greater distances, though this will depend on other characteristics of the acoustic environment (e.g., sea state). Nonetheless, it is unlikely that operational noise will be audible to animals beyond those that live in close vicinity to the pile (i.e., those that have settled there due to the structure it provides), and even if it is audible, it may not be bothersome. Therefore, while the noise from operational turbines under the Proposed Action will be present or permanent throughout the life of the Project, impacts from operational noise to EFH managed species and their fish prey species re expected to be non-measurable for some species (e.g., those without swim bladders) or so such a slight impairment that it may not be meaningfully measured for other species (e.g., those with swim bladders).

5.1.5.3 Hydrodynamic Effects during Operations

Human-made structures, especially tall vertical structures such as foundations, alter local water flow (hydrodynamics) at a fine scale, and increase seafloor scour, which may alter sediment grain sizes and benthic community structure (Lefaible et al. 2019). These structures may modify upwelling process and the patterns of vertical stratification in the upper ocean layers (Mostafa 2015). Water flow typically returns to background levels within a relatively short distance from a structure and impacts on the EFH of managed species of finfish and invertebrates are typically undetectable (BOEM 2021). The cumulative effects of the presence of multiple structures on local or regional-scale hydrodynamic processes are not currently well understood, though the consequences for benthic resources of such hydrodynamic disturbances are anticipated to be localized. These marine structures, (e.g., tower foundations, scour protection, cable protection) create uncommon vertical relief in a predominantly soft-bottom seascape. The marine structures create turbulence that transports nutrients upward toward the surface, increasing primary productivity at localized scales (Danheim et al. 2020). These changes have been reported to increase food availability for filter-feeders on and near the structures creating a beneficial impact (Degraer et al. 2020). The consequences for benthic resources from such hydrodynamic disturbances are anticipated to be localized, to vary seasonally, and have minor impacts.

A recent study completed by BOEM assessed the mesoscale effects of offshore wind energy facilities on coastal and oceanic environmental conditions and habitat by examining how oceanic responses would change after turbines are installed, particularly with regards to turbulent mixing, bed shear stress, and larval transport (Johnson et al. 2021). This study focused on the Massachusetts-Rhode Island marine areas where proposed wind energy lease areas are in the licensing review process. Due to the integration of localized turbulence and wind wake effects of individual turbines, the study was able to more accurately simulate hydrographic changes and associated impacts from offshore wind farms. This modeling study assessed four post-installation scenarios. Two species of finfish (silver hake and summer flounder) and one invertebrate (Atlantic sea scallop) were selected as focal species for the assessment of the impact on larval transport. The results of this modeling effort indicate that, at a regional fisheries management level, these shifts are not considered overly relevant with regards to larval settlement. Indirect impacts of structures influencing primary productivity and higher trophic levels are possible but are also not well understood. Overall, BOEM anticipates that the hydrodynamic impacts associated with the presence of the WTGs and OSSs would be negligible on EFH fish and invertebrate species based on currently available information.

Depending on local atmospheric conditions, wind wakes may develop as result of the WTG structures. Hydrodynamic models developed for North Sea scenarios indicate that wind wakes can develop in the lee of WTG fields. Most research on effects of wind wake indicates that WTG presence could lead to changes in water column stratification and potentially benthic productivity (Daewal et al. 2022; Dorell et al. 2022). Empirical investigations in the North Sea showed destratification of the water column and changes in the plankton density downstream of the structures but no change in fish abundance as measured with echosounders (Floeter et al 2017). It is not yet clear how these results can be applied to similar structures on the NE U.S. continental shelf.

If the PDE includes up to 121 WTG foundations and four OSSs are installed within the Lease Area, these added structures may attract finfish and invertebrates that approach the structures during routine movement or during migration. Such attraction could alter or slow migratory movements. However, temperature is expected to be a bigger driver for habitat occupation and species movement (Moser and Shepherd 2009; Fabrizio et al. 2014; Secor et al. 2018). Migratory fish and invertebrates have exhibited an ability to move away from structures unimpeded. The potential for the presence of many distinct structures within the Lease Area could affect the natural feeding behaviors of pelagic species that utilize the offshore Delaware/Maryland shelf waters and potentially increase the time required for migration behaviors. Managed species that may be impacted the most are the 25 pelagic species listed in Section 4.2, EFH Species Groups, and the highly migratory species along with their prey and foraging resources. Until more data can be gathered, BOEM anticipates that temperature would be the overriding factor that could impact the Pelagic EFH species group, resulting in a minor but indirect permanent impacts.

5.1.6 Operation/Presence of Inter-array and Offshore Cables

5.1.6.1 Power Transmission (EMF, Heat)

Migration and Movement from Presence of Offshore Cables

Impacts of EMF on benthic habitats is an emerging field of study; as a result, there is a high degree of uncertainty regarding the nature and magnitude of effects on all potential receptors (Hogan et al. 2023). Biologically notable impacts on finfish and invertebrates have not been documented for AC cables (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015), but behavioral impacts have been documented for benthic species (skates and lobster) near operating DC cables (Hutchison et al. 2018). The impacts from EMF are localized and affect the animals only while they are within relatively proximity to the EMF source (Bochert and Zettler 2004). Currently, there are no published studies within the U.S. on potential effects of EMF on commercial scallops, clams, or squid (Hogan et al. 2023). There is no evidence to indicate that EMFs from undersea AC power cables negatively affect commercially and recreationally important fish species (CSA Ocean Sciences Inc. and Exponent 2019). Sensitivity ranges, likely encounter rates and the varying potential effects based on life stages remain gaps in our knowledge (Hogan et al. 2023). Cables buried to proper depths and protective shielding would minimize EMF intensity and extent (Normandeau et al. 2011). Although the EMFs would exist as long as a cable was in operation, previous studies indicate that the EMFs from AC cables within the Action Area are not expected to affect soft bottom Mobile or Sessile/Epibenthic managed species or degrade their EFH (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015).

Because of the presence of shortnose sturgeon, Atlantic sturgeon and horseshoe crabs and the close vicinity of the sandbar and sand tiger shark HAPCs within and near the Project area, US Wind has conducted a site-specific study of potential EMF impacts and found that electric field produced to be below the reported detection thresholds for electrosensitive marine organisms (Appendix I, *Offshore*

Electric and Magnetic-Field Assessment). When operating at peak loading, the maximum level of the magnetic field produced from the offshore export cables was calculated as 148 mG (14.8 μT) at the seabed, and quickly decreased to 12 mG (1.2 μT) just 3 feet (1 meter) above the seafloor (Appendix I). These values are 3.4 and 42 times lower respectively than EMF levels which have shown no impact (Appendix I). In the case of sturgeon species, the maximum EMF levels calculated of the induced electric field sensed by sturgeon is approximately 1.8 mV/m at the seabed over the buried Offshore Export Cable during periods of peak loading. Studies utilizing Russian sturgeon as a test subject found that the threshold for behavioral changes is approximately 11 times lower than the 20 mV/m electric field reported (Appendix I). The maximum EMF levels produced by the inter-array cables at the target burial depth of 3.3 feet (1 meter) was calculated as 49 mG (4.9 μT). At a distance of 10 feet (3 meters) horizontally from all cable types, the EMF decreased to less than 1 mG (0.1 μT) (Appendix I).

Community Structure Changes/Effect from Presence of Offshore Cables

Electromagnetic forces (EMF) emanate continuously from installed electrical power transmission cables. Biologically notable impacts on the structure of marine communities, and EFH have not been documented for AC cables (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015), and as previously mentioned but behavioral impacts have been documented for benthic species (skates and lobster [Nephropidae or Astacidea]) present near operating DC cables (Hutchison et al. 2018). These impacts are localized and affect the animals only while they are within the EMF field. There is no evidence to indicate that EMFs from undersea AC power cables negatively affect managed finfish or invertebrate species (CSA Ocean Sciences Inc. and Exponent 2019, Hogan et. al. 2023). EMFs would emanate from AC cables during operation. US Wind would use power cable shielding and target burial depths to minimize EMF intensity and extent. Although the EMFs would exist as long as a cable was in operation, previous studies indicate that the EMFs from AC cables within the Project area are not expected to affect EFH species (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015, Hogan et. al. 2023). Therefore, the EMF produced by the Project's cables would not be detectable by resident magneto-sensitive fish or invertebrates. As part of the operation phase US Wind would be monitoring the inter-array and offshore export cables. The monitoring effort may identify areas where HVAC cables are unburied on the seabed and corrective measures be employed. Therefore, the adverse effects on Sessile Benthic/Epibenthic and Mobile Complex Habitat bottom-dwelling finfish and invertebrate managed species would be direct and permanent as long as the cable network is transmitting electrical power but the impact levels have not been detected or document. As such, operating cables are not projected to have any adverse effects on the populations or distributions or migration of managed species in the Offshore Project area. The operation of the installed cables would include inspections and maintenance when needed.

5.1.6.2 Cable Protection

Community Structure Changes/Invasive Species from Protection of Offshore Cables

The placement of cable protection would result in long-term conversion of soft bottom habitat to complex hardbottom benthic habitat. This conversion would make it unsuitable for EFH-designated species associated with soft bottom habitats much in the same process that scour protection systems would change demersal habitats in the Lease Area during one or more life stages. The new hard surfaces in the soft bottom habitat would convert benthic habitat to more complex hardbottom benthic habitat and would provide similar artificial reef benefits as previously discussed in Section 5.1.2.3. The installation of cable protection systems would therefore result in long-term effects on EFH lasting for the life of the Project. If removal of the cables is required, the cable protection would likely be removed, restoring the affected area to soft bottom sand habitat (effects of cable protection removal would be addressed under a separate future EFH consultation for Project conceptual decommissioning). EFH for demersal organisms and life stages that utilize soft bottom sand habitats would be adversely affected in the intermediate term to long term by alteration of natural habitat and the placement of protective structures. The positive effects (artificial reef effect) on species with hard bottom addition even when weighed against concomitant loss of soft bottom habitat, suggests a minor beneficial effect of added cable protection.

5.1.6.3 Power Conversion

US Wind is not utilizing HVDC offshore cables or technologies; therefore, power conversion is not further discussed.

5.1.6.4 Operational Water Quality (Vessel and Facility Operations)

Water Quality from Offshore Vessel Activity during O&M

Vessel anchoring and discharges could occur during O&M and impacts would be the same as discussed under the construction and installation phase. Short-term impacts in the immediate area where anchors and chains meet the seafloor would be expected for anchoring. Benthic organisms that contact anchoring devices and gear would experience mortality, and nearby organisms could be injured or killed due to high turbidity, and deposition. Discharge of bilge water and treated liquid wastes in the volumes expected would be negligible during the operation phase.

Water Quality from O&M of WTG Scour and Cable Protection

Offshore O&M includes regular inspections with cable surveys anticipated in year 1, year 3, and then every 5 years after. Underwater ROV surveys will be used to inspect cable protection and cable entry, and cathodic protection, therefore benthic communities will not be disturbed. The offshore export cables and inter-array cables would be monitored through distributed temperature sensing equipment. The distributed temperature sensing system would be able to provide a real time monitoring of temperature along the Offshore Export Cable Route, alerting US Wind should the temperature change, which could be the result of scouring of material and cable exposure. Only cable repairs, if required, would temporarily affect benthic communities, and only in a localized area immediately adjacent to the repair. Assuming repairs would be infrequent and affecting only small sections of the cables, impacts are expected to have no detectable effects on EFH species and would be negligible.

Though the seafloor sediments within the Project area have been noted to be prone to scour (COP, Volume II, Appendix A1, Section 10.4; US Wind 2023), the addition of WTG scour protection would minimize the potential for local sediment transport and subsequent impacts to EFH species.

Water Quality from Power Conversion during Offshore O&M

US Wind is not utilizing HVDC offshore cables or technologies; therefore, power conversion is not further discussed.

Releases of Marine Debris during Offshore O&M

Accidental releases of trash and debris may occur from vessels during any phase of the Project. Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness elimination as described in BSEE NTL No. 2015-G03 (Marine Trash and Debris Awareness and Elimination), per BOEM guidelines for marine trash and debris prevention. BOEM assumes all vessels would comply with these laws and regulations to minimize releases.

Accidental Spills during Offshore O&M

Vessels associated with the Proposed Action may potentially generate waste, including bilge and ballast water, sanitary and domestic wastes, and trash and debris. All vessels associated with the Proposed Action would comply with USCG requirements for the prevention and control of oil and fuel spills. Proper vessel regulations and operating procedures would minimize effects on EFH species resulting from the release of debris, fuel, hazardous materials, or waste (BOEM 2012). US Wind will prepare a project specific Spill Prevention, Control, and Countermeasure Plan and Oil Spill Response Plan prior to construction that will carry throughout the O&M. However, US Wind will still monitor for and report any environmental releases or fish kills to the appropriate authorities (e.g., in Delaware state waters, reports will be made via DNREC 24-hour hotline). Likewise, utilizing BMPs for ballast or bilge water releases specifically from vessels transiting from foreign ports would reduce the likelihood of accidental release. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time; as such, impacts on EFH species resulting from these accidental releases are expected to be localized, temporary, and negligible.

5.1.7 Operation/Presence of Inshore Cables

5.1.7.1 Power Transmission (EMF, Heat)

Migration and Movement from Presence of Inshore Export Cables

As summarized in Section 5.1.5.1 the presence of properly buried AC current cables within the Indian River Bay are not expected to adversely affect finfish or invertebrate EFH managed species, their prey species or NOAA Trust species. No biologically notable impacts on finfish and invertebrates have been documented for AC cables (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015). There is no evidence to indicate that EMFs from undersea AC power cables negatively affect commercially and recreationally important fish species (CSA Ocean Sciences Inc. and Exponent 2019). Sensitivity ranges, likely encounter rates and the varying potential effects based on life stages remain gaps in our knowledge (Hogan et al. 2023). Cables buried to proper depths and protective shielding would minimize EMF intensity and extent (Normandeau et al. 2011). Although the EMFs would exist as long as a cable was in operation, previous studies indicate that the EMFs from AC cables within the Action Area are not expected to affect soft bottom Mobile or Sessile/Epibenthic managed species or degrade their EFH (CSA Ocean Sciences Inc. and Exponent 2019; Thomsen et al. 2015).

Because of the presence of shortnose sturgeon, Atlantic sturgeon and horseshoe crabs and the close vicinity of the sandbar and sand tiger shark HAPCs within and near the Project area, US Wind has conducted a site-specific study of potential EMF impacts and found that electric field produced to be below the reported detection thresholds for electrosensitive marine organisms (Appendix J, *Onshore Magnetic-Field Assessment*). When operating at peak loading, the maximum level of the magnetic field produced from the inshore cable route cables through Indian River Bay was calculated as 148 mG (14.8 µT) at the seabed, and quickly decreased to 12 mG (1.2 µT) just 3 feet (1 meter) above the seafloor (Appendix J). These values are 3.4 and 42 times lower respectively than EMF levels which have shown no impact (Appendix J). In the case of sturgeon species, the maximum EMF levels calculated of the induced electric field sensed by sturgeon is approximately 1.8 mV/m at the seabed over the buried Inshore Export Cable during periods of peak loading. Studies utilizing Russian sturgeon as a test subject found that the threshold for behavioral changes is approximately 11 times lower than the 20 mV/m electric field reported (Appendix J). The maximum EMF levels produced by the inshore cables at the target burial depth of 3.3 feet (1 meter) was calculated as 49 mG (4.9 µT). At a distance of 10 feet (3 meters) horizontally from all cable types, the EMF decreased to less than 1 mG (0.1 µT) (Appendix J).

Community Structure Changes/Effect from Presence of Inshore Export Cables

As addressed in Section 5.1.5.1, the presence of properly buried AC current cables within the Indian River Bay are not expected to adversely affect or change the community structure of finfish or invertebrate EFH managed species, their prey species, or NOAA Trust species.

5.1.7.2 Cable Protection

Community Structure Changes/Invasive Species from Protection of Inshore Export Cables

As previously stated, US Wind does not anticipate the need for cable protection structures (e.g., mattresses, rock placement, cable protection systems [CPSs]) along the Inshore Export Cable Route.

5.1.7.3 Operational Water Quality (Vessel and Facility Operations)

Water Quality from Inshore Vessel Activity during O&M

Vessel activity with the primary level of potential adverse effects would be anchoring during operations and maintenance activities will be similar to the effects levels as discussed in Section 5.1.1, 5.1.2, 5.1.3. Anchoring activities could create short-term impacts in the immediate area where anchors and chains meet the seafloor. US Wind will continuously complete extensive physical, geotechnical, and biological surveys to characterize the benthic habitat to be utilized and modified for their project's operation and potential decommissioning. With these activities in mind, US Wind will avoid any sensitive or critical habitats if anchoring activities are required. The best method for mitigation for this impact-producing factor is avoidance and micrositing of project components away from sensitive habitats. Once the anchor is removed the adverse effects from the anchor scar would be short-term based on the assessment that the benthic habitat is expected to recover within a few months to a year after disturbance and without mitigation depending on the benthic resource conditions (Boyd et al. 2005; Dernie et al. 2003; Hobbs 2002, 2006).

Releases of Marine Debris during Inshore O&M

Accidental releases of trash and debris may occur from vessels during any phase of the proposed US Wind project. Vessel operators, employees and contractors will be briefed on marine trash and debris awareness elimination as described in BSEE NTL No. 2015-G03 (Marine Trash and Debris Awareness and Elimination), per BOEM guidelines for marine trash and debris prevention. BOEM assumes all vessels would comply with these laws and regulations to minimize releases. Additional requirements will be put in place to monitor and adaptively mitigate for lost fishing gear that may accumulate at WTG, OSSs, and Met Tower foundations to reduce the amount of marine debris lost from commercial and recreational fisheries activities. The adverse effects from potential releases of marine debris are expected to be direct but mostly short-term and minor due to the implementation of the listed BMPs, USEPA National Pollutant Discharge Elimination System (NPDES) permits and U.S. Coast Guard (USCG) regulations.

Accidental Spills during Inshore O&M

From 2000 to 2009, the average spill size for vessels other than tanker ships and tanker barges was 88 gallons (333 liters) (USCG 2011). Should a spill from a vessel associated with the inshore operations and maintenance phase of the Project to occur, BOEM anticipates that the volume would be similar. According to BOEM modeling (Bejarano et al. 2013), a release of 128,000 gallons (484,533 liters) is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons (7,571 liters) or less is likely to occur every 5 to 20 years. The probability of an accidental discharge or spill occurring simultaneously from multiple WTGs is extremely low. An oil weathering model used by NOAA predicted that a spill of 105,000 gallons (397,468 liters) would dissipate rapidly, and depending on the ambient conditions, would reach a concentration of 0.05% between 0.5 and 2.5 days (Tetra Tech Inc. 2015). The volume tested was 1,931 times the average volume recorded by the USCG, suggesting that 88 gallons (333 liters) would dissipate much faster and affect a much smaller area. Therefore, along with the low likelihood of a large release and the rapid dissipation, impacts on the EFH of managed species are extremely unlikely.

5.2 Project Monitoring Activities

As discussed in Chapter 6, US Wind has proposed to conduct surveys and/or review existing data to identify important, sensitive, and unique marine habitats to be avoided, monitor fish through nanotag antennas, conduct comprehensive wildlife surveys, build an observation information database to include surveys, protective species observer data, and other wildlife monitoring records, and conduct a site-specific study of potential EMF impacts, if applicable, on species such as horseshoe crabs, conch, and finfish.

5.2.1 Marine Mammal Monitoring

US Wind is providing funding over ten years to the University of Maryland Center for Environmental Science (UMCES) for research projects aimed at understanding the potential effects of offshore wind development on marine mammals. The Marine Mammal Monitoring program is part of the UMCES overall monitoring program TailWinds. The Marine Mammal Monitoring program will the deployment of a near real-time whale detection system to provide timely alerts on the presence of baleen whales (North Atlantic right whales, and humpback, fin, and sei whales) for a 12-month period from 2022 to 2023. The project is a unique partnership between UMCES and Woods Hole Oceanographic Institution that utilizes specialized quiet mooring technology, whale vocalization detection algorithms, and telecommunications to transmit frequent alerts on the presence of baleen whales. The initiative enables continued and real-time data collection through the buoy system that was initially funded by the Maryland Energy Administration and deployed by the Maryland Department of Natural Resources.

5.2.2 Acoustics Monitoring

Passive acoustics monitoring is part of the UMCES overall monitoring program TailWinds funded by US Wind. The passive acoustic monitoring array is part of a long-term research project will support passive acoustic monitoring to detect large whales, such as North Atlantic right whales and dolphins to understand their presence and migration patterns in and around the Lease area and the potential effects of construction. Working with Cornell University's Center for Conservation Bioacoustics, two types of listening devices will be deployed to determine the occurrence and position of large whales and dolphins, and to detect the tonal echolocation clicks of small cetaceans including porpoises. Additionally, this project will deploy equipment to listen for passing fish, sharks, rays, and turtles that have been implanted with transponders for broader scientific research.

5.2.3 Fisheries Monitoring

The Fishery Resource Monitoring program is part of the UMCES overall monitoring program TailWinds. The goal of the Commercial and Recreational Fisheries Monitoring program is to evaluate the extent that black sea bass (BSB) change their aggregation behaviors before, during, and after construction. Black sea bass are structure-oriented with large aggregations occurring on artificial reefs and wrecks. Turbine foundations will add three-dimensional structure within US Wind's Lease where very little currently exists. This research project will assess the benefits and potential fish aggregation effects. It will also test black sea bass fishing with ropeless gear, an important technology to reduce whale entanglement.

A commercial pot survey will consist of rigs of 15 commercial pots each, with pots spaced proximate and distant to turbine structures to capture both turbine- and project-scaled changes in BSB catch rates. Monthly pot surveys (Mar-Nov) of six rigs, four in the project area and two in an adjacent control area, deploy ropeless EdgeTech devices to avoid whale and turtle entanglements. Impacts related to the fisheries monitoring plan presented implementation would likely be short-term in duration. While the effects from the monitoring effort would result in impacts on EFH managed species through the intentional or incidental take of individual organisms, the number affected would be small in comparison to commercial and recreational fisheries activities within the project area and would not measurably affect the EFH of managed finfish or invertebrate species or their prey organisms.

5.2.4 Benthic Habitat Monitoring

US Wind has not presented a benthic monitoring plan at this time. As part of the regulatory review process, US Wind will be engaging and negotiating with the appropriate federal and state regulatory agencies throughout the life of the Project that may lead to the requirement to develop an adaptive benthic monitoring program.

5.3 Conceptual Decommissioning

The planned life of the Project is 25 to 30 years, though US Winds intends to request an extension of commercial operations period up to 30 or 35 years. Impacts resulting from decommissioning of the Project are expected to be similar to or less than those experienced during construction. The technologies to support the decommissioning operations are expected to advance during the lifetime of the Project, which may reduce impacts. A full decommissioning plan will be provided to the appropriate regulatory agencies for approval prior to decommissioning activities and will detail potential impacts. As part of the regulatory process and resources agency negotiations for decommissioning activities, a new EFH assessment evaluating the impacts on EFH species and resources would be prepared and evaluated prior to decommissioning operations.

5.3.1 Anticipated Vessel Activity Associated with Decommissioning

Accidental releases, anchoring, discharges, noise, and port utilization would all have similar risks or impacts as the construction phase. Vessel traffic will increase from the O&M phase as the deconstruction and or removal of structures occurs. The increase in vessel traffic increases the risk of accidental releases, and discharges. Anchoring will be required to stabilize vessels, and deconstruction noises may temporarily impact managed species and their EFH locally and short term. The elevated noise levels may make the habitat temporarily less suitable and may cause fish and motile invertebrate EFH-designated species to temporarily vacate the Project area during decommissioning activities. The impacts will directly affect the soft bottom, heterogenous complex, complex and pelagic species, in the short-term but will return to close to background conditions within the project area.

5.3.2 Anticipated Treatment of Foundation Types, Scour Protection and Cables

All foundations and Project components would be removed to 15 feet (4.6 meters) below the mudline (30 CFR 585.910(a)), unless other methods are deemed suitable through consultation with the regulatory authorities, including BOEM. The conceptual decommissioning process for the WTGs and OSS is anticipated to be generally the reverse of construction and installation, with Project components transported to an appropriate disposal or recycling facility. WTGs, OSS, and the Met Tower would all be removed, with their foundations removed potentially to 15 feet (4.6 meters) below the seafloor. Based on the approval of the appropriate regulatory agencies, scour protection systems may be left in place to provide seafloor habitat. The inter-array and offshore export cables will be disconnected and either retired in place or removed from the seafloor based on the preferred approach to minimize environmental impacts, based on agency approval.

These impacts to fish and EFH-designated species are anticipated to be short term and localized due to the disturbance of a relatively small area and would not cause long-term impacts once decommissioning activities are completed. Benthic and pelagic fish species are anticipated to avoid the area during Project decommissioning activities and are anticipated to move back into the area upon completion. However, benthic habitat that serves as forage area for bottom-dwelling species may take longer to recover to pre-impact conditions.

There would be short-term increases in sediment suspension and deposition during bottom disturbance activities. These increases in sediment suspension and deposition may cause short-term adverse impacts to mobile fish and EFH-designated species because of decrease in habitat quality for benthic species. Less mobile egg and larval life stages may experience injury or loss of individuals similar to what was described for construction. Juveniles and adults are anticipated to vacate the habitat due to suspended sediment levels in the water column and avoid impact. Pelagic habitat quality and EFH is expected to quickly return to pre-disturbance levels. The adverse effects of decommissioning on EFH and managed species are expected to be direct but would have a short-term effect and return to close to background conditions.

5.3.3 Anticipated Effects from Proposed Treatment of EFH

The adverse Impacts resulting from decommissioning of the proposed US Wind project s are expected to be similar to or less than those experienced during the original installation and commissioning phases or the project. The technologies to support the decommissioning operations are expected to advance during the lifetime of the project, which may reduce impacts. A full decommissioning plan will be required and provided to the appropriate regulatory agencies for approval prior to decommissioning activities and will detail potential impacts. As part of the regulatory process and resource agency negotiations for decommissioning activities, a new EFH assessment will evaluate the adverse effects on EFH species and resources prior to decommissioning operations. It is anticipated that the removal of the monopiles from the Lease Area would shift these habitats that were converted to complex habitat back to pre-construction conditions (soft bottom) and likely result in a reversion of local finfish and invertebrate species assemblages to soft bottom communities. Cable removal, if required, would result in direct disturbance of EFH along the path of the cables and would resuspend bottom sediments and adversely affect the soft bottom and heterogenous complex organisms temporarily (very short-term). The impacts from suspended sediments would be at levels much less than what occurred during installation. Overall, the impact levels related to decommissioning would be similar if not reduced as to those that occurred during installation with the exception that the impacts related to pile driving generated noise would not occur.

5.4 Cumulative and Synergistic Effects to EFH

The PDE includes up to 121 WTGs, 4 OSSs, and one Met Tower would permanently impact approximately 68.61 acres (27.76 hectares) of benthic habitat within the Project area (see Appendix G, Table G-1). These permanent impacts would include WTG and OSS foundations, scour protection, and the cable protection required along the cable routes. Within the Lease Area alone, approximately 55.90 acres (22.62 hectares) of the total 80,000 acres (32,374 hectares), or 0.06% would be permanently altered by the offshore structures and associated scour protection. This is in addition to the estimated total OCS (4,771 acres [1,931 hectares] for WTG seabed disturbance and 152,509 acres [61,718 hectares] for offshore export cable seabed disturbance) per the Draft EIS Appendix D, Table D2-2 (BOEM 2023a). The presence of these foundations would cause localized hydrodynamic effects lasting over the life of the projects, potentially including changes in water flow, changes in vertical mixing and associated primary production, and changes in larval distribution patterns.

New structures could also affect the migration of species that prefer complex habitat by providing unique hardbottom features (relative to the primarily sandy seafloor) within this area of the Mid-Atlantic Bight. This could lead to retention of those species and possibly impact spawning opportunities for some EFH species and the prey species they utilize. However, it is also possible that the new structures would provide additional habitat resources, rather than substituting for previously occupied habitat. A potential positive impact could occur due to the development of complex habitat and the expansion of complex habitat species within the Lease Area in the greater Mid-Atlantic Bight. The new structures could create an "artificial reef effect", whereby more sessile and benthic structure-oriented organisms (e.g., sponges, algae, mussels, barnacles, shellfish, sea anemones) would colonize these structures (Coates et al. 2014; Danheim et al. 2020; English et al. 2017; Degraer et al. 2020). This sessile invertebrate assemblage may provide a food source and habitat to other motile EFH invertebrates and finfish. Though these new developing habitats would be at the expense of the soft bottom EFH species that utilize the infaunal, epifaunal, and demersal habitats (e.g., clams, flounders, skates).

Climate change will also play a role in the effects on EFH and the ambient waters and seabed morphology (De Stewart and Yuan 2019). Climate change is known to increase temperatures, alter ocean acidity, raise sea levels, and increase numbers and intensity of storms. These changes in mean sea level, tides, and wave heights impact the morphology of the sand ridges (De Stewart and Yuan 2019). Modeling of the Mid-Atlantic Bight Cold Pool from 1968 to 2019 showed rapid warming and a limiting in the spatial extent (Friedland et al. 2022). Increased temperatures can alter habitat, modify species' use of existing habitats, change precipitation patterns, and increase storm intensity (EPA 2016; NASA 2019). As temperatures rise, the oceans absorb the majority of the excess heat, with 60% of the upper ocean (0 to 2,297 ft [0 to 700 m] depth) experiencing increased temperatures (NOAA 2018). The warmer waters expand and create sea level rise, which greatly impacts coastal communities. Simultaneously, ocean acidity has increased by roughly 30% since the Industrial Revolution (EPA 2016). Increase of the ocean's acidity has numerous effects on ecosystems including reducing available calcium carbonate that organisms use to build shells, which can result in feeding shifts within food webs (EPA 2016; Friedland et al. 2022; NASA 2019) and interannual abundance fluctuations (Kane 2011). For example, between 1982 and 2018 the average center of biomass for 140 marine fish and invertebrate species along U.S. coasts shifted approximately 20 miles (32 kilometers) north. These species also migrated an average of 21 feet (6.4 meters) deeper (EPA 2016).

6 Avoidance, Minimization, and Mitigation

6.1 Avoidance and Minimization Measures

BOEM anticipates that US Wind would coordinate with the required resource agencies and non-governmental resource stakeholders to design and implement a monitoring program.

6.2 Mitigation and Environmental Monitoring

A summary of lessee-proposed mitigation and monitoring measures proposed by US Wind are listed in Table 6-1. This table is adapted from DEIS (BOEM 2023a). Continued discussion and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides the most flexible and protective mitigation measures should be conducted by US Wind. Other potential mitigation and monitoring measures analyzed are provided in Table 6-2.

Table 6-1. Summary of lessee-proposed mitigation and monitoring measures

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Benthic Resources	C	Anchoring	Potential impacts from anchoring will be minimized by avoiding locations with sensitive habitats and utilizing mid-line anchor buoys.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	C	Cable emplacement and maintenance	Based on feedback from DNREC, US Wind will implement the following time of year restrictions to minimize impacts of sediment disturbance: • No in-water work (e.g.; cable installation, HDDs, dredging) within Indian River Bay between March 1 and September 30, and • No HDD activities at the beach landfall from April 15 through September 15 to avoid impacts to spawning horseshoe crabs.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, DNREC
Benthic Resources	C	Cable emplacement and maintenance	Minimize sediment disturbance by utilizing the best available technologies to achieve deep burial of submarine cable into a stable sediment layer (i.e., jet plow technology, HDD, gravity cells, etc.).	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	C	Cable emplacement and maintenance	To the greatest extent practicable, select areas with suitable seabed conditions for cable installation during cable route planning.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	O&M	Cable emplacement and maintenance	To the greatest extent practicable, select areas with suitable seabed conditions for cable installation during cable route planning.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	C	Electric and magnetic fields (EMFs) and cable heat	Use submarine cables that have proper electrical shielding and bury the cables in the seafloor, when practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	O&M	Electric and magnetic fields (EMFs) and cable heat	Conduct a site-specific study of potential EMF impacts on electrosensitive marine organisms.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Benthic Resources	C	Presence of structures	Minimize the amount of scour protection required.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	O&M	Presence of structures	Minimize the amount of scour protection required.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	C	Presence of structures	Select suitable geological locations for the installation of the WTG, OSS and Met Tower foundations and design foundations appropriate to geological conditions.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Benthic Resources	O&M	Presence of structures	Select suitable geological locations for the installation of the WTG, OSS and Met Tower foundations and design foundations appropriate to geological conditions.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Coastal Habitat and Fauna	C	Accidental releases	Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan will be prepared prior to construction and for operations activities.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	O&M	Accidental releases	Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan will be prepared prior to construction and for operations activities.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	C	Accidental releases	US Wind will develop a Stormwater Pollution Prevention Plan (SWPPP) for onshore construction activities, as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	USEPA, DNREC
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	Cables will be installed using a jet plow to the greatest extent possible. Any dredging needed is expected to be limited to the gravity cells.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	Horizontal Directional Drilling (HDD) will be used at landfall locations.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	Shellfish relocation/restoration along Inshore Export Cable Corridor 1 ("Inshore Export Cable Route") will be evaluated pre- and post- installation if warranted.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE, DNREC
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	The Project has been sited to avoid sensitive or rare habitats (such as high-density clam beds) where feasible, and habitat disturbance will be minimized to the extent practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE, DNREC
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	US Wind will install cables using HDD to avoid impacts to coastal dunes and interdunal wetlands and to minimize bottom disturbance.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE, DNREC
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	US Wind will locate cable landfalls and onshore facilities so as to avoid impacts to known nesting beaches, where feasible. The use of HDD for cable installation under the Barrier Beach Landfalls will avoid impacts on beaches.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE< DNREC
Coastal Habitat and Fauna	C	Cable emplacement and maintenance	US Wind will minimize impacts on submerged aquatic vegetation where practicable. No submerged aquatic vegetation has been identified in areas proposed for permanent or temporary disturbance.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USACE, DNREC
Coastal Habitat and Fauna	C	Cable emplacement, Presence of structures	US Wind would prioritize beneficial reuse of dredge material (i.e., wetland restoration), based on the material characteristics and opportunities as they present themselves, over placement in offshore or onshore disposal areas.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USACE, DNREC
Coastal Habitat and Fauna	C	Cable emplacement, Presence of structures	US Wind will compile a comprehensive wildlife survey and observation information database to include surveys, PSO data, and other wildlife monitoring records. Data will be made available to government, research, and environmental groups, among others. Information is provided on the following website: https://remote.normandeau.com/uswind_home.php.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE, DNREC

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Coastal Habitat and Fauna	O&M	Electric and magnetic fields (EMFs) and cable heat	Conduct a site-specific study of potential EMF impacts on electrosensitive marine organisms.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	O&M	Electric and magnetic fields (EMFs) and cable heat	Use submarine cables that have proper electrical shielding and bury the cables in the seafloor, when practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Coastal Habitat and Fauna	C	Land disturbance	Agency consultation and monitoring regarding coastal habitats and species will be conducted as needed to mitigate disturbances, as practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	USFWS, DNREC
Coastal Habitat and Fauna	C	Land disturbance	US Wind will develop a Stormwater Pollution Prevention Plan (SWPPP) for onshore construction activities, as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	USACE, DNREC
Commercial Fisheries and For-hire Recreational Fishing	C	Cable emplacement and maintenance and Presence of structures	US Wind will conduct pre- and post-construction monitoring for regionally important species, in a partnership with the University of Maryland Center for Environmental Science to study black sea bass, to identify commercial and recreational fishing impact.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Commercial Fisheries and For-hire Recreational Fishing	O&M	Cable emplacement and maintenance and Presence of structures	US Wind will conduct pre- and post-construction monitoring for regionally important species, in a partnership with the University of Maryland Center for Environmental Science to study black sea bass, to identify commercial and recreational fishing impact.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Commercial Fisheries and For-hire Recreational Fishing	O&M	Electric and magnetic fields (EMFs) and cable heat	Conduct a site-specific study of potential EMF impacts on electrosensitive marine organisms.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Commercial Fisheries and For-hire Recreational Fishing	C	Gear utilization	US Wind established a process for gear loss compensation for commercial fishermen.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Commercial Fisheries and For-hire Recreational Fishing	O&M	Gear utilization	US Wind established a process for gear loss compensation for commercial fishermen.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Commercial Fisheries and For-hire Recreational Fishing	C	Traffic	US Wind developed a Fisheries Communication Plan, in conjunction with the designated Fisheries Liaison Officer and will work with fisheries stakeholders to update it as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Commercial Fisheries and For-hire Recreational Fishing	O&M	Traffic	US Wind developed a Fisheries Communication Plan, in conjunction with the designated Fisheries Liaison Officer and will work with fisheries stakeholders to update it as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Commercial Fisheries and For-hire Recreational Fishing	C	Traffic	US Wind will work cooperatively with commercial/recreational fishing entities and interests to review planned activities and ensure that the construction and operation activities will minimize potential conflicts.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Commercial Fisheries and For-hire Recreational Fishing	O&M	Traffic	US Wind will work cooperatively with commercial/recreational fishing entities and interests to review planned activities and ensure that the construction and operation activities will minimize potential conflicts.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Finfish, Invertebrates, and EFH	C	Accidental releases	Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan and Oil Spill Response Plan (OSRP) will be prepared prior to construction and for operations activities.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Finfish, Invertebrates, and EFH	C	Accidental releases	Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness elimination as described in BSEE NTL No. 2015-G03 (“Marine Trash and Debris Awareness and Elimination”), per BOEM guidelines for marine trash and debris prevention.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Anchoring	Impacts to summer flounder HAPC will be minimized by using dynamic positioning where feasible to minimize the need for construction vessels to anchor to the seafloor and using midline buoys to reduce seafloor scarring when construction vessels need to anchor.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Cable emplacement and maintenance	Based on feedback from DNREC, US Wind will implement the following time of year restrictions to minimize impacts of sediment disturbance: • No in-water work (e.g.; cable installation, HDDs, dredging) within Indian River Bay between March 1 and September 30, and • No HDD activities at the beach landfall from April 15 through September 15 to avoid impacts to spawning horseshoe crabs.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, DNREC
Finfish, Invertebrates, and EFH	C	Cable emplacement and maintenance	Conduct surveys and review existing data to identify important, sensitive, and unique marine habitats to be avoided.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Cable emplacement and maintenance	Minimize construction activities as practicable in areas containing anadromous fish during migration periods.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Cable emplacement and maintenance	Seafloor disturbance during construction will be minimized as practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Cable emplacement and maintenance	Sediment disturbance associated with submarine cable laying will be minimized by jet plowing, HDD techniques and the use of gravity cells where feasible.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Cable emplacement, Presence of structures	US Wind will compile a comprehensive wildlife survey and observation information database to include surveys, PSO data, and other wildlife monitoring records. Data will be made available to government, research, and environmental groups, among others. Information is provided on the following website: https://remote.normandeau.com/uswind_home.php.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Discharges/intakes	Vessels will adhere to United States Coast Guard (USCG) guidelines; follow applicable regulations related to the discharge of bilge water, gray water, and sanitary waste; maintain discharge permits, as appropriate; follow good maintenance and housekeeping procedures to prevent releases of oil and other chemicals to the sea; maintain up-to-date Oil Spill Response Plans (OSRPs) to prevent, contain, and clean up any accidental spills.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	O&M	Electric and magnetic fields (EMFs) and cable heat	Conduct a site-specific study of potential EMF impacts on electrosensitive marine organisms.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Finfish, Invertebrates, and EFH	O&M	Electric and magnetic fields (EMFs) and cable heat	Use submarine cables that have proper electrical shielding and bury the cables in the seafloor, when practicable.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Lighting	Work lighting will be limited to the extent practicable to areas of active construction in coordination with USCG and other agencies as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Noise	Soft-start procedures and noise mitigation will be used during foundation pile driving.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Finfish, Invertebrates, and EFH	C	Presence of structures	Fish monitoring equipment including nanotag antennas has been installed on the Metocean Buoy.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, NMFS
Water Quality	C	Accidental releases	Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan and Oil Spill Response Plan (OSRP) will be prepared prior to construction and for operations activities.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Water Quality	O&M	Accidental releases	Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan and Oil Spill Response Plan (OSRP) will be prepared prior to construction and for operations activities.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Water Quality	C	Accidental releases	US Wind will develop a Stormwater Pollution Prevention Plan (SWPPP) for onshore construction activities, as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USEPA
Water Quality	O&M	Accidental releases	US Wind will develop a Stormwater Pollution Prevention Plan (SWPPP) for onshore construction activities, as appropriate.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USEPA
Water Quality	C	Accidental releases	US Wind will monitor for and report any environmental release or fish kill to the appropriate authorities, e.g., in Delaware state waters, reports will be made via DNREC 24-hour hotline.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USEPA, DNREC
Water Quality	O&M	Accidental releases	US Wind will monitor for and report any environmental release or fish kill to the appropriate authorities, e.g., in Delaware state waters, reports will be made via DNREC 24-hour hotline.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USEPA, DNREC
Water Quality	C	Accidental releases	Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness elimination as described in BSEE NTL No. 2015-G03 ("Marine Trash and Debris Awareness and Elimination"), per BOEM guidelines for marine trash and debris prevention.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE
Water Quality	O&M	Accidental releases	Vessel operators, employees, and contractors will be briefed on marine trash and debris awareness elimination as described in BSEE NTL No. 2015-G03 ("Marine Trash and Debris Awareness and Elimination"), per BOEM guidelines for marine trash and debris prevention.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE

Resource Area Mitigated	Project Stage*	Impact-Producing Factor (IPF)	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Water Quality	C	Cable emplacement and maintenance	Based on feedback from DNREC, US Wind will implement the following time of year restrictions to minimize impacts of sediment disturbance: • No in-water work (e.g.; cable installation, HDDs, dredging) within Indian River Bay between March 1 and September 30, and • No HDD activities at the beach landfall from April 15 through September 15 to avoid impacts.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, DNREC
Water Quality	C	Cable emplacement and maintenance	Sediment disturbance associated with submarine cable laying will be minimized by jet plowing, HDD techniques and the use of gravity cells where feasible.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USACE
Water Quality	C	Cable emplacement and maintenance	Turbidity monitoring will be conducted during construction as required by the permitting authorities. Conduct TSS and water quality monitoring during cable installation activities and post installation as needed.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USACE
Water Quality	C	Discharges/intakes	A drilling fluid fracture contingency plan will be in place prior to the start of HDD activities. Operations will be shut down immediately in the event a frac-out occurs.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USACE
Water Quality	C	Discharges/intakes	Vessels will adhere to United States Coast Guard (USCG) guidelines; follow applicable regulations related to the discharge of bilge water, gray water, and sanitary waste; maintain discharge permits, as appropriate; follow good maintenance and housekeeping procedures to prevent releases of oil and other chemicals to the sea; maintain up-to-date Oil Spill Response Plans (OSRPs) to prevent, contain, and clean up any accidental spills.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USCG
Water Quality	O&M	Discharges/intakes	Vessels will adhere to United States Coast Guard (USCG) guidelines; follow applicable regulations related to the discharge of bilge water, gray water, and sanitary waste; maintain discharge permits, as appropriate; follow good maintenance and housekeeping procedures to prevent releases of oil and other chemicals to the sea; maintain up-to-date Oil Spill Response Plans (OSRPs) to prevent, contain, and clean up any accidental spills.	COP, Volume II, Section 1.5 (US Wind 2023)	BSEE, USCG

*C = Construction; O&M = Operations and Maintenance

BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; COP = Construction and Operations Plan; DNREC = Department of Natural Resources and Environmental Control; EFH= essential fish habitat; EMF= electromagnetic field; EPA = Environmental Protection Agency; HAPC = habitat area of particular concern; HDD = horizontal directional drilling; IPF = impact producing factor; NMFS = National Marine Fisheries Service; NTL = Notice to Lessees; OSS = Offshore Substation; PSO = Protected species observer; TSS = Total suspended solids; USCG = U.S. Coast Guard; WTG = wind turbine generator

Table 6-2. Summary of other potential mitigation and monitoring measures analyzed

Resource Area Mitigated	Project Stage*	Impact Producing Factor	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Commercial Fisheries and For-hire Recreational Fishing	C, O&M, D	Presence of structures	BOEM would require that US Wind implement a compensation program for lost income for commercial and recreational fishermen and other eligible fishing interests for construction and operations consistent with BOEM's draft guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 or as modified in response to public comment. This measure, if adopted, would reduce impacts from the impact- producing factor (IPF) presence of structures by compensating commercial and recreational fishing interests for lost income during construction and a minimum of 5 years post-construction. If adopted, this measure would reduce the negligible to major impact level from the presence of structures to negligible to moderate. This is because a compensation scheme will mitigate "indefinite" impacts to a level where the fishing community would have to adjust somewhat to account for disruptions due to impacts but income losses would be mitigated.	BOEM COP approval	BSEE
Finfish, Invertebrates, and EFH	C, O&M	Presence of structures	BOEM would require US Wind to develop a Lionfish Monitoring and Adaptive Management Plan.	BOEM COP approval; NMFS EFH Consultation	BSEE, NMFS
Finfish, Invertebrates, and EFH	C, O&M, D	Multiple IPFs	The measures required by the final Essential Fish Habitat consultation would be incorporated into COP approval, and BOEM and/or NMFS would monitor compliance with these measures.	BOEM COP approval; NMFS EFH Consultation	BSEE, NMFS
Marine Mammals; Sea Turtles; Finfish, Invertebrates, and EFH; Benthic Resources	C, O&M	Noise, Traffic, Accidental Releases	BOEM will require US Wind comply with all the Project Design Criteria and Best Management Practices for Protected Species at https://www.boem.gov/sites/default/files/documents//PDCs%20and%20BMPs%20for%20Atlantic%20Data%20Collection%2011222021.pdf, that implement the integrated requirements for threatened and endangered species resulting from the June 29, 2021, programmatic consultation under the ESA, revised September 1, 2021. This requirement also applies to non-ESA-listed marine mammals that are found in that document. Consultation conditions occurring in State waters outside of BOEM jurisdiction may apply to co-action agencies issuing permits and authorizations under this consultation	BOEM COP approval; NMFS MMPA IHA/LOA; NMFS ESA consultation	BSEE, NMFS
Marine Mammals; Sea Turtles; Finfish, Invertebrates, and EFH; Benthic Resources	C, O&M, D	Accidental releases	US Wind would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities would continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Record keeping and the availability of records for inspection by BSEE. By February 1 of each year, US Wind would submit to BSEE an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. US Wind would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov).	BOEM COP approval	BSEE

Resource Area Mitigated	Project Stage*	Impact Producing Factor	Mitigation and Monitoring Measures	Source	Anticipated Enforcing Agency
Marine Mammals; Sea Turtles; Finfish, Invertebrates, and EFH; Benthic Resources	O&M	Accidental releases	US Wind must monitor indirect effects associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the US Wind Lease Area annually. Survey design and effort may be modified with review and concurrence by BOEM and BSEE. US Wind may conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. US Wind must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov and TIMSWeb) in an annual report, submitted by April 30, for the preceding calendar year. Photographic and videographic materials must be provided with the submission in TIMSWeb (TIFF or Motion JPEG 2000). Annual reports must include survey reports that include: the survey date; contact information of the operator; the location and pile identification number; photographic and/or video documentation of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Annual reports must also include claim data attributable to the Project from US Wind corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM or BSEE.	BOEM COP approval	BSEE

*C = Construction; O&M = Operations and Maintenance; D = Decommissioning

BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; COP = Construction and Operations Plan; DNREC = Department of Natural Resources and Environmental Control; EFH= essential fish habitat; EMF= electromagnetic field; EPA = Environmental Protection Agency; HAPC = habitat area of particular concern; HDD = horizontal directional drilling; IPF = impact producing factor; NMFS = National Marine Fisheries Service; NTL = Notice to Lessees; OSS = Offshore Substation; PSO = Protected species observer; TSS = Total suspended solids; USCG = U.S. Coast Guard; WTG = wind turbine generator

6.3 Alternative Project Designs that could Avoid/Minimize Impacts

The following discusses alternative turbine layouts and cable routes proposed for the Project. Although all alternatives are not specifically geared towards reducing the impacts on EFH, these alternatives would still benefit and minimize EFH impacts. Alternative A represents the No Action Alternative and Alternative B represents the Proposed Action. Appendix G provides the areal extent of impacts on benthic habitat types by project component and activity for each alternative, including the Proposed Action.

6.3.1 Alternative B – Proposed Action - Justification for Impacts to Trust Resources in Indian River Bay

US Wind has indicated the inclusion of a cable route in Indian River Bay as part of the Proposed Action is based on the ability to mitigate impacts to any trust resources through implementation of seasonal time of year restrictions, avoidance of wetlands and disturbance to sensitive habitats through the use of HDD and cable burial and other well-established mitigation measures. The Inshore export Cable Route also considered the various adverse effects resulting from terrestrial cable installation in densely populated areas subject to other existing easement interests and increased risk of adverse impacts to cultural resources. The Inshore Export Cable Route through Indian River Bay represents the shortest distance from the landfall to the POI, and Indian River Bay and Indian River is an area that experiences routine navigation dredging impacts.

After identification of the POI, US Wind evaluated routes from potential offshore export cable landing locations to the Indian River POI, which are identified as onshore export cable corridors. US Wind determined that the most efficient and least disruptive route from the proposed landing location at 3R’s Beach to the POI is by burying onshore export cables in Indian River Bay, using HDD at both transitions from land to water to avoid impacts to wetlands on the eastern portion of Indian River Bay and on the western side from Indian River. By implementing measures such as time of year restrictions for construction activities on land and in Indian River Bay, turbidity monitoring during cable burial, and installation via HDD, impacts to recreation, sensitive species, water quality, and more would be minimized and mitigated as described in Section 5. US Wind will continue to consult with stakeholders and agencies such as DNREC and USACE regarding additional measures as necessary.

In determining available routing for the export cables from landfall locations to the POI, numerous routes were evaluated. US Wind considered and rejected burying cables in Rehoboth Bay, north of Indian River Bay, due to concerns about sensitive bird and terrapin habitats, active aquaculture leases in Rehoboth Bay, and construction feasibility.

Terrestrial Onshore Export Cable Routes were identified within existing rights-of-way (ROW), to potentially limit soil disturbance. Some of the ROWs may already be crowded with buried utility lines and there has been resistance from legacy utility users to locating additional cables, particularly power cables, in the ROWs. The concern goes both ways because US Wind also does not wish to install cables in ROW locations that may be opened for future construction projects or utility maintenance.

Co-location of export cables in existing ROWs also creates significantly more risk of future disturbances and impacts due to the existence of multiple other users and utility lines within the ROW and the likely need to conduct maintenance and repair.

US Wind identified several terrestrial-based routes as alternatives. However, burying cables in Indian River Bay from the landfall to the POI is the shortest distance, installation can be achieved based on feedback from experienced cable installers, the burial depth is achievable and sufficient to protect the cable and minimize disturbances with and from outside parties, and mitigation measures are available to minimize environmental impacts.

The Inshore Export Cable Route through Indian River Bay also minimizes potential disturbance of cultural resources, avoids interference with ongoing and future infrastructure development projects in Delaware's coastal region, and avoids impacts to wetlands. Navigation dredging along the Inshore Export Cable Route occurs relatively frequently in portions of Indian River Bay and has been identified by DNREC as a priority area for dredging in the state.

Based on feedback from DNREC, US Wind will implement the following time of year restrictions to minimize impacts of sediment disturbance, including no in-water work (e.g.; cable installation, HDDs, dredging) within Indian River Bay between March 1 and September 30, and no HDD activities at the beach landfall from April 15 through September 15 to avoid impacts to spawning horseshoe crabs.. This window accommodates the general time of year restrictions for summer flounder (March 1st to September 30th) which would allow time for young of the year summer flounder to grow large enough to be less vulnerable to habitat-altering activities and then migrate out of the system. In addition, the construction window avoids impacts to horseshoe crabs (*Limulus polyphemus*) during their spawning season (April 15th to June 30th). Since the Indian River is used by large numbers of American Eel (*Anguilla rostrata*), DNREC also requested that in-water work not take place from March 1st to May 15th to allow upstream passage of elvers (young eels).

US Wind has worked to advance the Proposed Action that includes the Inshore Export Cable Route in Indian River Bay in discussions and consultations with key stakeholders, including the state of Delaware. US Wind contends the installation of the inshore export cables in Indian River Bay is the least disruptive when looking at the entirety of potentially affected resources. The mitigation measures, including time of year restrictions on construction activities, avoid, minimize, and mitigate impacts to NOAA trust species and other resources.

6.3.2 Alternative C – Landfall and Onshore Export Cable Routes

Alternative C was developed through the scoping process for the Draft EIS in response to comments requesting an alternative to minimize impacts on Indian River Bay. Under Alternative C, the Landfall and Onshore Export Cable Route Alternative ("Landfall Alternative"), the construction, O&M, and eventual decommissioning of an up to 2.2 GW wind energy facility on the OCS offshore Maryland would occur within the range of the design parameters outlined in the COP (US Wind 2023), subject to applicable mitigation measures. This alternative would result in terrestrial onshore export cable routing that avoids crossing Indian River Bay and the Indian River (i.e., Inshore Export Cable Route). Offshore Project components within the Lease Area (WTGs, OSSs, inter-array cables, and Met Tower) would be the same as the Proposed Action (Alternative B). Each of the below sub-alternatives may be individually selected, subject to meeting the purpose and need.

- Alternative C-1 (Figure 6-1) includes the Towers Beach landfall (i.e., exclusion of the 3R's Beach landfall), and a terrestrial Onshore Export Cable Route from the Towers Beach landfall to the Indian River substations (POI) (i.e., Onshore Export Cable Route 2). This would be contingent on selection of Offshore Cable Route 2 (northern route). Under Alternative C-1, the offshore export cables would make landfall at Towers Beach, approximately 5 miles (7.7 kilometer) north of the Indian River Inlet, in an existing parking lot within Delaware Seashore State Park. When the offshore cables reach the landfall, they will be pulled into a cable duct that positions the cables underground to subterranean transition vaults and then run via Onshore Export Cable Route 2 to the POI utilizing Delaware Department of Transportation (DelDOT) ROWs.

  When comparing Alternate C-1 to the Proposed Action (Alternative B), Alternative C-1 reduces the amount of EFH habitat to be impacted from inshore cable installation by 168.3 acres (68.1` hectares) avoiding routing through the Indian River Bay (Appendix G, Table G-1). Alternative C-1 does reduce the temporary and permanent impact acreage for EFH habitats by 55% and 4.25%, respectively (Appendix G, Table G-1). These reductions are realized since the Onshore Export Cable Route will be terrestrial instead of crossing through the Indian River Bay after landfall at Towers Beach.

  In addition, Alternate C-1 uses Offshore Export Cable Route 2 which adds an extra 6.4 acres (2.6 hectares) of temporary seafloor impact associated with cable installation (Appendix G, Table G-1). One other primary difference between Offshore Export Cable Route 1 and Offshore Export Cable Route 2, is that Route 2 extends into the sand tiger shark HAPC throughout almost the total length of this route (Figure 4-2). Offshore Export Cable Route 2 additionally has a higher proportion of Heterogenous complex and Large-grained Complex sediment habitat at 63.3% in comparison to 39.2% for Offshore Export Cable Route 2 (Table 3-1).

- Alternative C-2 (Figure 6-2) includes the 3R's Beach landfall similar to the Proposed Action (i.e., exclusion of the Towers Beach landfall); however, only terrestrial Onshore Export Cable Routes from the 3R's Beach landfall to the Indian River substation would be considered (i.e., Onshore Export Cable Routes 1a, 1b, and 1c). This would be contingent on selection of Offshore Cable Route 1 (southern route). When the offshore cables reach the landfall, they will be pulled into a cable duct that positions the cables underground to subterranean transition vaults and then run via an Onshore Export Cable Route to the specific POI utilizing DelDOT ROWs, except for portions of Onshore Export Cable Routes 1b and 1c that will utilize a Sussex County ROW under development.

  When comparing Alternate C-2 to the Proposed Action (Alternative B), Alternative C-2 reduces the amount of EFH habitat to be impacted from inshore cable installation by 168.3 acres (68.1 hectares) avoiding routing through the Indian River Bay (Appendix G, Table G-1). Alternative C-2 does reduce the temporary and permanent impact acreage for EFH habitats by 55% and 10.6%, respectively (Appendix G, Table G-1). These reductions are realized since the Onshore Export Cable Route will be terrestrial instead of crossing through the Indian River Bay after landfall at 3R's Beach.

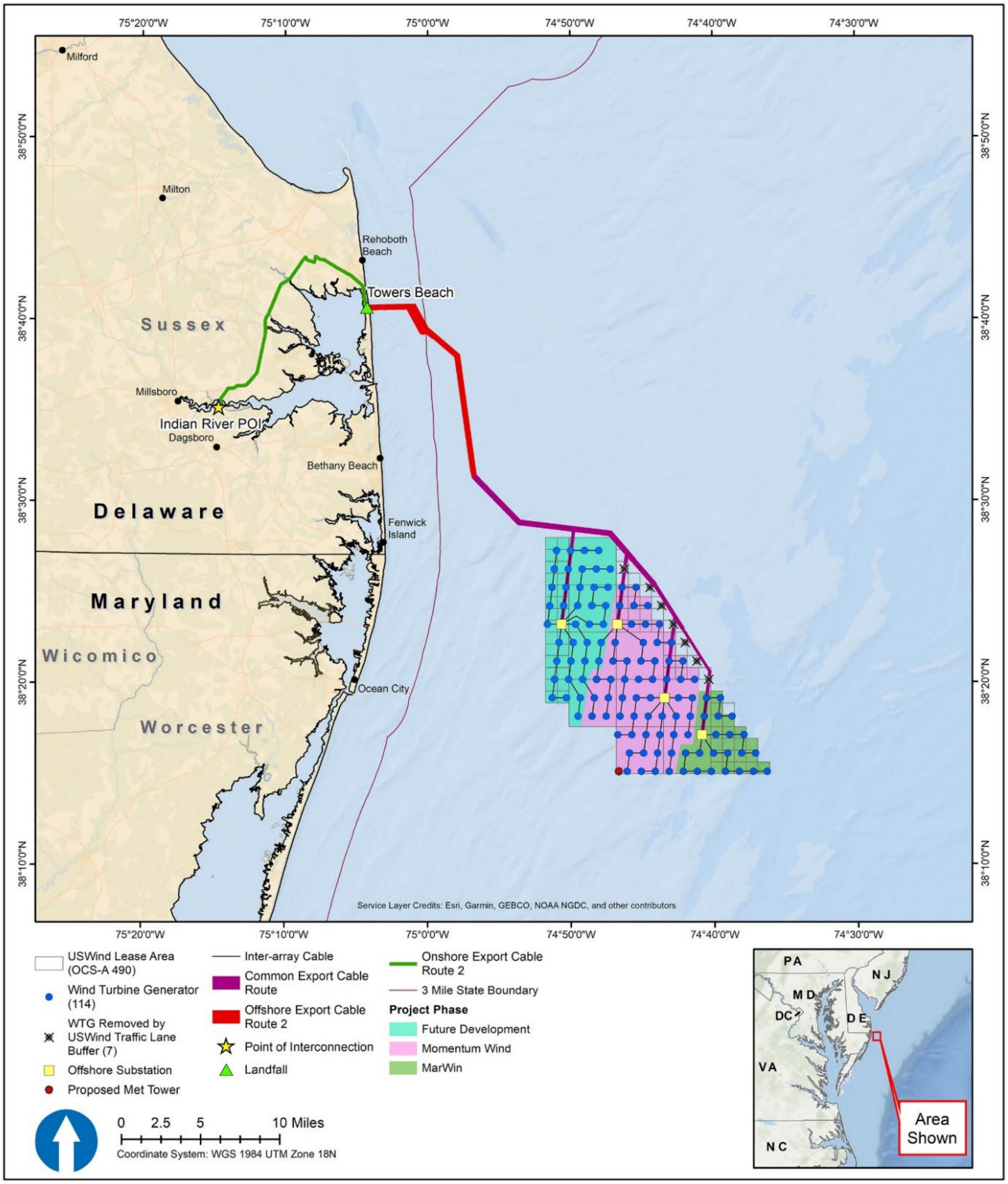

Figure 6-1. Alternative C-1 – Towers Beach Landfall Alternative
Source: US Wind 2023

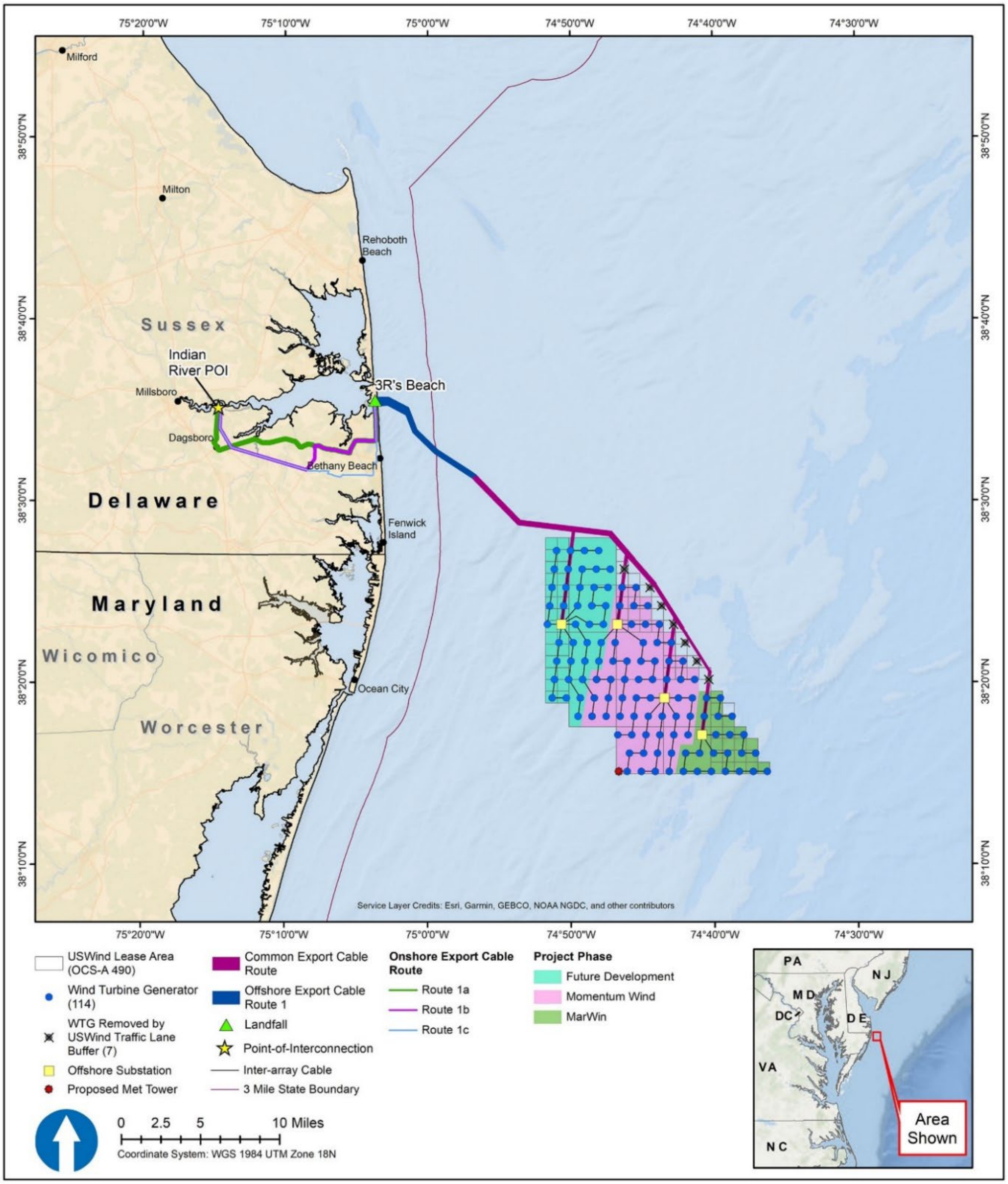

Figure 6-2. Alternative C-2 – 3R's Beach Landfall Alternative

Source: US Wind 2023

6.3.3 Alternative D – No Surface Occupancy to Reduce Visual Impacts

Alternative D (see Figure 6-3) was identified during the scoping process for the Draft EIS in response to public comments concerning the visual impacts of the Project. Under Alternative D, the Viewshed Alternative, the construction, O&M, and eventual decommissioning of an up to 2.2 GW wind energy facility on the OCS offshore Maryland would occur within the range of the design parameters outlined in the COP (US Wind 2023), subject to applicable mitigation measures. This alternative would result in the exclusion of 32 WTG positions and 1 OSS within 14 miles (22.5 kilometers) of shore associated with the future development phase. The 14-mile (22.5-kilometer) exclusion allows for full development of MarWin and Momentum and fulfillment of existing power purchase agreements, while still allowing site selection flexibility. The public comment process proposed a 15-mile (24.1 kilometer) exclusion zone for WTGs, but the difference of 1 mile in the exclusion zone is not likely to result in a significant reduction in impact. Thus, the benefit gained in an additional mile of exclusion (15 miles versus 14 miles [24.1 kilometers versus 22.5 kilometers]) would not warrant the added strain on the Project, given currently identified WTG capacity, and the risk of failure to meet current power purchase agreements.

When comparing the temporary impacts to EFH habitats related to Alternative D against the Proposed Action removing 32 WTGs and one OSS, results in a reduction of temporary impacts of approximately 6.1% (Appendix G, Table G-1). Permanent impacts to EFH habitats from Alternative D would translate into a 7.4% reduction in seafloor disturbance from structures, scour and cable protection (Appendix G, Table G-1).

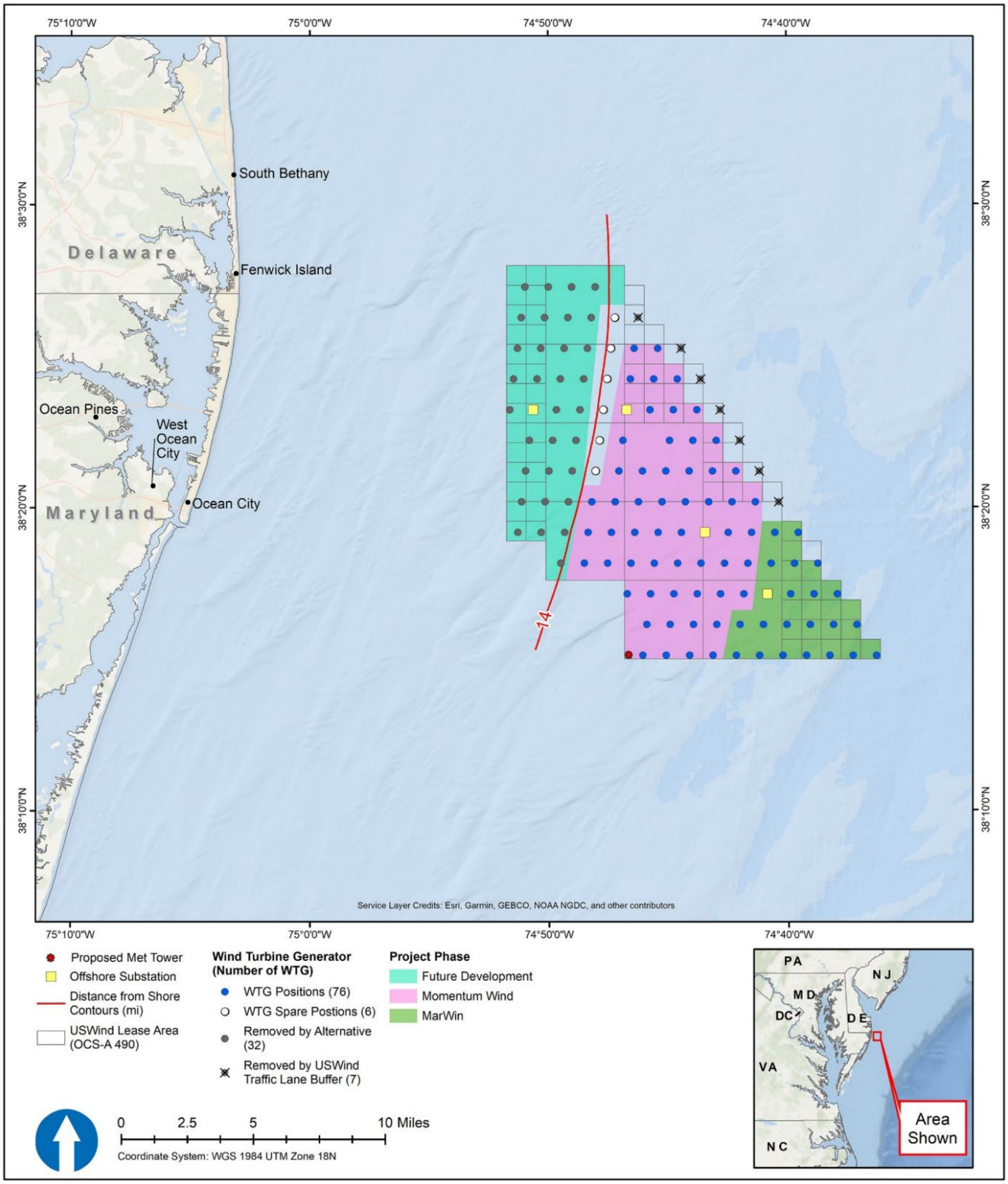

Figure 6-3. Alternative D – Viewshed Alternative that excludes 32 WTG positions and 1 OSS within 14 miles (22.5 kilometers) of shore associated with the future development phase

6.3.4 Alternative E – Habitat Impact Minimization

Alternative E (see Figure 6-4) was identified through the scoping process for the Draft EIS in response to comments received requesting an alternative to minimize impacts on offshore benthic habitats. Under Alternative E, the Habitat Impact Minimization Alternative, the construction, O&M, and eventual decommissioning of an up to 2.2 GW wind energy facility on the OCS offshore Maryland would occur within the range of the design parameters outlined in the COP (US Wind 2023), subject to applicable mitigation measures.

NMFS identified six habitat areas using data provided by US Wind and previously collected data and reports (e.g., Guida et al. 2017). These areas are characterized by large, landscape scale features such as high-relief sand ridge and trough complexes and deep holes/drop-offs, where loss of habitat and conversion of the bottom may result in adverse impacts. These areas produce habitat value for fish and shellfish through vertical relief, high rugosity, stratification of sediments, and presence of other benthic features.

Alternative E would result in the removal of 11 WTGs, associated inter-array cables, and repositioning the offshore export cable to avoid sensitive benthic habitats. This alternative would reduce the disturbance to sand ridge and trough features that support diverse invertebrate assemblages that serve important ecological functions for the benthic community and the complex food web they support. When comparing the temporary impacts to EFH habitats related to Alternative E against the Proposed Action removing 11 WTGs, results in a reduction of temporary impacts of approximately 1.65% (Appendix G, Table G-1). Permanent impacts to EFH habitats from Alternative E would translate into a 5.5% reduction in seafloor disturbance from structures, scour and cable protection (Appendix G, Table G-1).

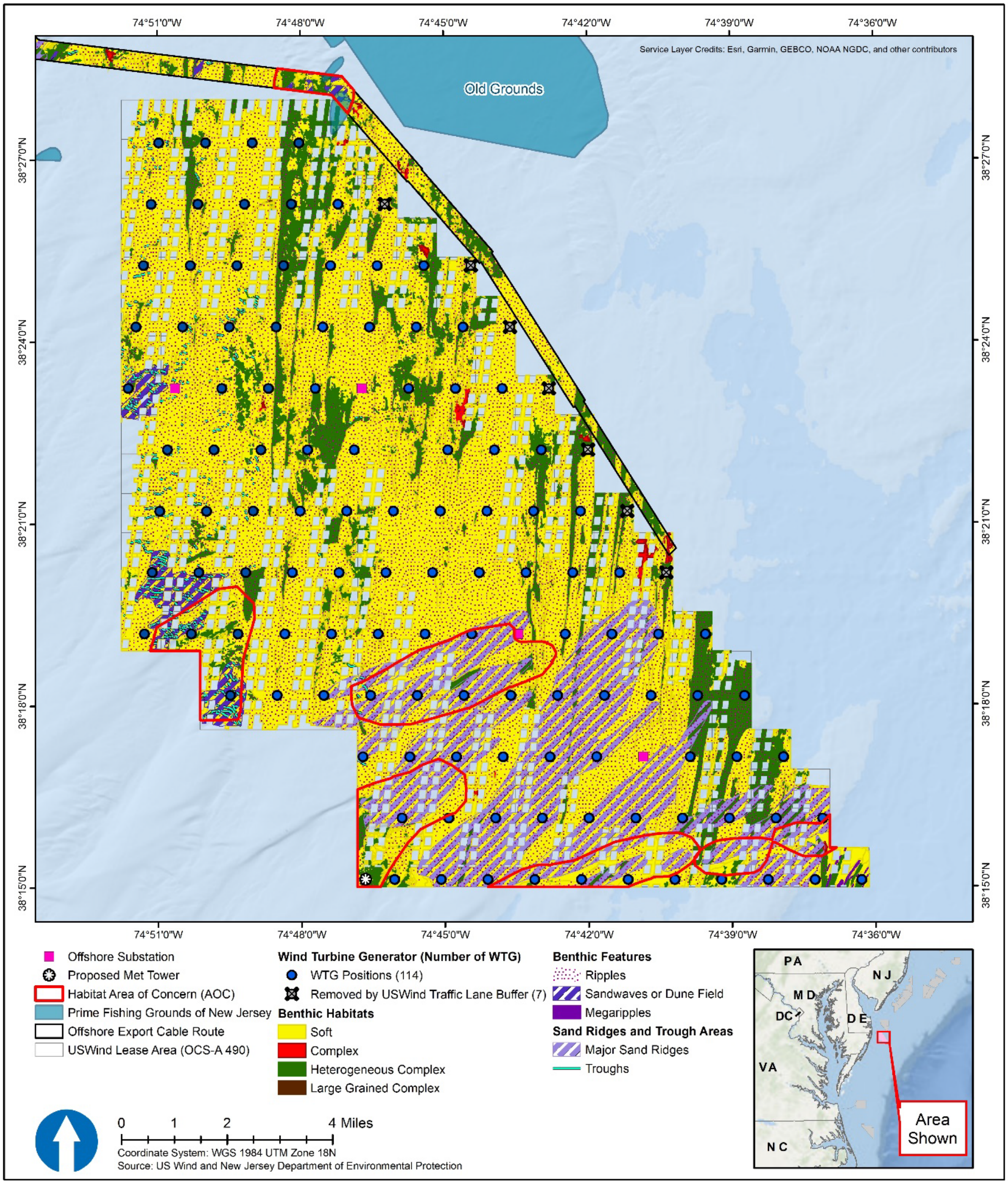

Figure 6-4. Alternative E – Habitat Impact Minimization Alternative

6.4 Adaptive Management Plans

If BOEM decides to approve the Project COP, the Record of Decision would state which of the mitigation and monitoring measures identified by BOEM in the Draft EIS Appendix G (BOEM 2023a) have been adopted, and if not, why they were not. As such, the Record of Decision would inform terms and conditions of COP approval and would compel compliance with or execution of identified mitigation and monitoring measures (40 CFR 1505.3). US Wind would be required to certify compliance with certain terms and conditions, as required under 30 CFR 285.633(a).

In regard to EFH, BOEM may require US Wind to develop a Lionfish Monitoring and Adaptive Management Plan. However, as stated this is dependent on the COP approval as well as a NMFS EFH Consultation. If approved, this program would be overseen by BSEE and NMFS.

7 NOAA Trust Resources

This section includes a discussion on anadromous fish, shellfish, crustaceans, or their habitats, which are not managed under a federal fisheries management plan. Some of these species, including diadromous fishes, serve as prey for a number of federally managed species and are therefore considered a component of EFH pursuant to the MSA. Eleven species of NOAA Trust Resources have been identified within the general vicinity of the Project area. Detailed species descriptions and life history information are provided in FMPs (MAFMC 1998; NEFMC 2017; NMFS 2009). 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 EFH species groups may utilize habitat within the Project area:

- River herring (alewife and blueback herring)
- American eel
- American shad
- Atlantic menhaden
- Striped bass
- Bivalves (blue mussel, eastern oyster, quahog, and soft-shell clams)
- Blue crab
- Horseshoe crab

Table 7-1. Trust Resources determination by species or EFH species group

Species	Life Stage Within Project Area	Impact Determination	Rationale for Determination
River herring (alewife, blueback herring)	Juvenile, Adult	Negligible short-term impacts	Short-term disturbance effects would occur over 303.6 acres (122.9 hectares) of offshore and inshore benthic habitat. Only a small area (tens of acres) would be affected at any given time. Benthic community structure would recover rapidly, within a few months of the activity.
American eel	Larvae, Juvenile, Adult	Negligible short-term impacts	Short-term disturbance effects would occur over 303.6 acres (122.9 hectares) of offshore and inshore benthic habitat. Only a small area (tens of acres) would be affected at any given time. Benthic community structure would recover rapidly, within a few months of the activity.
Striped bass	Juvenile, Adult	Negligible short-term and permanent impacts	Short-term noise disturbance from monopile installation would reduce habitat suitability for this species within a 10-mile (16.1-kilometer) radius of pile-driving activity in the wind farm. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. As an anadromous species, juveniles have the potential to occur within nearshore waters near the export cable. Individuals could be displaced for the short-term during construction activities, but long-term impacts are not expected.
Atlantic menhaden (forage species)	All	Negligible short-term and permanent impacts	Short-term noise disturbance from monopile installation would reduce habitat suitability for this species within a 10-mile (16.1-kilometer) radius of pile-driving activity in the wind farm. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. As an anadromous species, juveniles have the potential to occur within nearshore waters near the export cable. Individuals could be displaced for the short-term during construction activities, but long-term impacts are not expected.

Species	Life Stage Within Project Area	Impact Determination	Rationale for Determination
American shad	Juvenile, Adult	Negligible short-term and permanent impacts	Short-term noise disturbance from monopile installation would reduce habitat suitability for this species within a 10-mile (16.1-kilometer) radius of pile-driving activity in the wind farm. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. As an anadromous species, juveniles have the potential to occur within nearshore waters near the export cable. Individuals could be displaced for the short-term during construction activities, but long-term impacts are not expected.
Bivalves (blue mussel, eastern oyster, quahog, soft-shell clam)	All	Minor short-term and permanent impacts	Short-term disturbance effects would occur over 303.6 acres (122.9 hectares) of offshore and inshore benthic habitat. Only a small area (tens of acres) would be affected at any given time. Benthic community structure would recover rapidly, within a few months of the activity. 25.9 acres (10.5 hectares) of benthic habitat would be displaced or altered over the long term by placement WTG and OSS foundations and scour protection (boulders, concrete pillows). Lease Area and offshore cable route impacts have been sited to avoid and minimize overlap of long-term effects with known shellfish habitats in designated EFH. Based on the small area affected relative to the extent of designated EFH in the Project area and vicinity, the Project would have an insignificant effect on habitat for these species. The benthic community structure would adapt and recover rapidly, within a few months of the activity.
Blue crab	All	Minor short-term and permanent impacts	Blue crabs are known to occur within the Project area. Adults may use the habitat for spawning. Dredging associated with the Project would annually impact a minute portion of soft bottom habitat. Jet plow impacts could include increased local TSS, loss of larvae due to entrainment, or short-term displacement of individuals. However, these impacts are either short-term, limited in spatial extent, or insignificant to the success of the species.

Species	Life Stage Within Project Area	Impact Determination	Rationale for Determination
Horseshoe crab	All	Minor short-term and permanent impacts	Horseshoe crabs are known to occur within the Project area. Adults may use the habitat for spawning. Dredging associated with the Project would annually impact a minute portion of soft bottom habitat. Jet plow impacts could include increased local TSS, loss of larvae due to entrainment, or short-term displacement of individuals. However, these impacts are either short-term, limited in spatial extent, or insignificant to the success of the species.

EFH = essential fish habitat; OSS = offshore substation; TSS = total suspended sediment; WTG = wind turbine generator

8 Conclusions/Determination(s)

A total of forty-one managed species, finfish (24), elasmobranchs (14), and invertebrates (5) were identified with designated EFH within the Lease Area, offshore export and inshore export cable route footprints (Table 4-1). The life stages and EFH-designated species are discussed in Chapter 4. Project construction, installation, operation, maintenance, and conceptual decommissioning activities, described in Chapter 2, would result in some adverse effects on the EFH species listed in Table 4-1. Impact analyses of Project activities on EFH are analyzed in Chapter 5. Effects associated with construction activities, such as pile driving and jet plowing, are likely to be greater than those associated with operation and maintenance, which would include noise produced by operational WTGs and monitoring and maintenance vessel activity. EFH designated species with one or more demersal life stages are more likely to be subjected to long-term or permanent adverse impacts as long as the scour protection structures are in place than species with only pelagic life stages (Chapter 5). These permanent impacts are related to the installation of the WTG and OSS foundations as well as scour and cable protection placement that would potentially permanently convert soft bottom benthic habitats into hardbottom.

The construction phase of the Project would generate impacts such as noise, related to vessel activity and pile driving, EMF, and new structures within the Lease Area and offshore export and inshore export cable routes. With the new structures, habitat conversion would impact the different life stages of EFH finfish and invertebrate species to varying degrees depending on the location, timing, and species affected by an activity. Short-term impacts from construction include construction-related crushing and burial effects (Section 5.1.1), underwater noise impacts (Section 5.1.1.2.2), and disturbance of bottom substrates through cable installation resulting in increased turbidity and sedimentation. Impacts from Project operation and maintenance would occur, although at lower levels than those produced during construction and conceptual decommissioning. Offshore structures would result in long-term effects on benthic and pelagic habitat (Section 5.1.3.1) as long as the scour protect pads are in place. BOEM anticipates the impacts on the EFH species resulting from the Proposed Action alone would range from short-term to permanent. Therefore, BOEM expects the overall impact on finfish and invertebrate EFH species relative to the construction activity alone would be short-term and because the effects would be indirect, localized, and, for the most part, temporary with benthic EFH resources recovering fully within weeks to months after construction is complete. Overall, the small areas that will be disturbed for the Proposed Action, especially with the majority in soft bottom sand habitats, relative to the large geographic range of the diverse fish species indicates that population impacts on fish are not expected. Most impacts would be avoided; if impacts occur, they may result in the loss of a few individuals. The proposed mitigation measures put forward by US Wind (Table 6-1), and any future additional mitigation measures set forth by BOEM or other federal agencies (Table 6-2) could further reduce impacts (but would most likely not change the impact determinations).

Project decommissioning would occur at the end of the 33-year designed lifetime. The decommissioning would require a separate EFH consultation at that time.

Table 8-1 details short-term, long-term, and permanent adverse effects on habitat suitability resulting from the proposed activities described in Section 5 and overall EFH effect determinations by managed species and life stage. Beneficial impacts associated with the presence of structures are not represented in Table8-1. 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 managed species and life stage.

Table 8-1. Summary of effects in the Action Area on EFH by impact mechanism and EFH effect determinations for managed species and life stages

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality Turbidity	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Gadids	Atlantic cod (*Gadus morhua*)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Adult	Benthic complex	Yes	Yes	--	Yes	No	Yes	No	No
	Pollock (Pollachius virens)	Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	--
	Red hake (Urophycis chuss)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Surface	Yes	--	--	--	--	Yes	--	No
		Juvenile	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Silver hake (Merluccius bilinearis)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Surface	Yes	--	--	--	--	Yes	--	No
		Juvenile	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	--
Other finfish	Atlantic butterfish (*Peprilus triacanthus*)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Pelagic/benthic non-complex	Yes	Yes	No	Yes	Yes	Yes	No	No
		Adult	Pelagic/benthic non-complex	Yes	Yes	No	Yes	Yes	Yes	No	No
	Atlantic herring (*Clupea harengus*)	Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Black sea bass (Centropristis striata)	Larvae	Benthic complex	Yes	Yes	--	Yes	No	Yes	No	No
		Juvenile	Benthic complex	Yes	Yes	--	Yes	No	Yes	No	No
		Adult	Benthic complex	Yes	Yes	--	Yes	No	Yes	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality Turbidity	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Other finfish (cont'd)	Bluefish (Pomatomus saltatrix)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Monkfish (Lophius americanus)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
	Scup (Stenotomus chrysops)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	--
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	--
		Juvenile	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
Flatfish	Summer flounder (Paralichthys dentatus)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex/complex	Yes	--	--	Yes	Yes	Yes	No	No
	Windowpane flounder (*Scophthalmus aquosus*)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Witch flounder (Glyptocephalus cynoglossus)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Surface	Yes	--	--	--	--	Yes	--	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality Turbidity	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Flatfish (cont'd)	Yellowtail flounder (*Limanda ferruginea*)	Eggs	Surface	Yes	--	--	--	--	Yes	--	No
		Larvae	Surface	Yes	--	--	--	--	Yes	--	No
		Juvenile	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
Highly migratory species	Atlantic mackerel (*Scomber scombrus*)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Atlantic Albacore tuna (*Thunnus alalunga*)	Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
	Atlantic bluefin tuna (*Thunnus thynnus*)	Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Atlantic skipjack tuna (*Katsuwonus pelami*)	Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Atlantic yellowfin tuna (*Thunnus albacares*)	Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
Coastal Migratory	Cobia (Rachycentron canadum), Spanish mackerel (Scomberomorus maculatus), and king mackerel (Scomberomorus cavalla)	Eggs	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Larvae	Pelagic	Yes	--	Yes	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality Turbidity	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Sharks	Atlantic angel shark (*Squatina dumeril*)	Juvenile	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Blue shark (Prionace glauca)	Neonate/YOY	Pelagic	Yes	--	No	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Common thresher (*Alopias vulpinus*)	Neonate/YOY	Pelagic	Yes	--	No	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Dusky shark (Carcharhinus obscurus)	Neonate/YOY	Pelagic	Yes	--	No	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Sand tiger shark (*Carcharias taurus*)	Neonate/YOY	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Juvenile	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Subadult	Benthic complex/non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Sandbar shark (Carcharhinus plumbeus)	Neonate/YOY	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Juvenile	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Subadult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Shortfin mako shark (*Isurus oxyrinchus*)	Neonate/YOY	Pelagic	Yes	--	No	No	--	Yes	No	No
		Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality Turbidity	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Sharks (cont'd)	Tiger shark (Galeocerdo cuvier)	Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Smooth dogfish (*Mustelus canis*)	Juvenile	Pelagic	Yes	--	No	No	--	Yes	No	No
		Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
	Spiny dogfish (Squalus acanthias)	Subadult	Pelagic	Yes	--	No	No	--	Yes	No	No
		Adult	Pelagic	Yes	--	No	No	--	Yes	No	No
Skates	Clearnose skate (*Raja eglanteria*)	Juvenile	Benthic non-complex/complex	No	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
	Little Skate (Leucoraja erinacea)	Juvenile	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex/complex	No	Yes	--	Yes	Yes	Yes	No	No
	Winter skate (Leucoraja ocellata)	Juvenile	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
		Adult	Benthic non-complex/complex	Yes	Yes	--	Yes	Yes	Yes	No	No
Invertebrates	Atlantic sea scallop (Placopecten magellanicus)	Eggs	Benthic complex	Yes	Yes	--	Yes	No	Yes	No	No

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Appendix A. Offshore Sediment Transport Modeling Report (provided under separate cover)

Appendix B. Lease Area and Offshore Export Cable Corridors Benthic Report (provided under separate cover)

Appendix C. Information to Support the EFH Assessment (provided under separate cover)

Appendix D. Onshore Export Cable Corridors Benthic Report (provided under separate cover)

Appendix E. Habitat Table Group Reference against CMECES

Table E-1. Habitat table group referenced against CMECS (class, subclass and groups)

Habitat Table Group	Class	Subclass	Group(s)
Rocky (general, to include all: granule-pebble, cobble, boulder, ledge/bedrock) Note that CMECS Biotic Subclasses Benthic Macroalgae and Attached Fauna should be addressed in the characterization of rocky habitats.	Substrate Class: Rock Substrate	Substrate Subclass: Bedrock	N/A
		Substrate Subclass: Megaclast	N/A
	Substrate Class: Unconsolidated Mineral Substrate – with 5% or greater of particles 2 millimeter (mm) to <4,096 mm	Substrate Subclass: Coarse Unconsolidated Substrate	Substrate Group: Gravels
			Substrate Group: Gravel Mixes
			Substrate Group: Gravelly
Soft bottom Mud (intertidal, shallow-water, and deep) Note that CMECS Biotic Subclasses Soft Sediment Fauna and Inferred Fauna should be addressed in the characterization of mud habitats	Substrate Class: Unconsolidated Mineral Substrate – with <5% or greater of particles 2 mm to <4,096 mm	Substrate Subclass: Fine Unconsolidated Substrate – with >50% of particles <0.625 mm	Substrate Group: Slightly Gravelly (Note: this CMECS category label is not used in the Recommendations for Mapping Fish Habitat, but it is incorporated into the classification of the Fine Unconsolidated Substrate substrates)
			Substrate Group: Sandy Mud
			Substrate Group: Mud
Soft bottom Sand (with and without sand ripple, shoals, waves/ridges) Note that CMECS Biotic Subclasses Soft Sediment Fauna and Inferred Fauna should be addressed in the characterization of sand habitats	Substrate Class: Unconsolidated Mineral Substrate – with <5% or greater of particles 2 mm to <4,096 mm	Substrate Subclass: Fine Unconsolidated Substrate – with ≥50% of particles 0.625 mm to <2 mm	Substrate Group: Slightly Gravelly (Note: this CMECS category label is not used in the Recommendations for Mapping Fish Habitat, but it is incorporated into the classification of the Fine Unconsolidated Substrate substrates)
			Substrate Group: Sand
			Substrate Group: Muddy Sand
Submerged Aquatic Vegetation	Biotic Class: Aquatic Vegetation Bed	Biotic Subclass: Aquatic Vascular Vegetation	Biotic Group: Seagrass Bed
			Biotic Group: Freshwater and Brackish Tidal Aquatic Vegetation
Tidal Marsh (i.e., saltmarsh and brackish marsh)	Biotic Class: Emergent Wetland	Biotic Subclass: Emergent Tidal Marsh	Biotic Group: Brackish Marsh
			Biotic Group: Freshwater Tidal Marsh
			Biotic Group: High Salt Marsh
			Biotic Group: Low and Intermediate Salt Marsh
		Biotic Subclass: Vegetated Tidal Flats	Biotic Group: Vegetated Freshwater Tidal Mudflat
			Biotic Group: Vegetated Salt Flat and Panne
	Biotic Class: Scrub-Shrub Wetland	Biotic Subclass: Tidal Scrub-Shrub Wetland	Biotic Group: Brackish Tidal Scrub-Shrub
			Biotic Group: Freshwater Tidal Scrub-Shrub
			Biotic Group: Saltwater Tidal Scrub-Shrub
			Biotic Group: Tidal Mangrove Shrubland
	Biotic Class: Forested Wetland	Biotic Subclass: Tidal Forest/Woodland	Biotic Group: Brackish Tidal Forest/Woodland
			Biotic Group: Freshwater Tidal Forest/Woodland
			Biotic Group: Saltwater Tidal Forest/Woodland
			Biotic Group: Tidal Mangrove Forest

Habitat Table Group	Class	Subclass	Group(s)
Shellfish Reefs and Beds (e.g., hard clams, Atlantic surfclam, mussels, oysters)	Substrate Class: Shell Substrate	Substrate Subclass: Shell Reef Substrate	Substrate Group: Clam Reef Substrate
			Substrate Group: Crepidula Reef Substrate
			Substrate Group: Mussel Reef Substrate
			Substrate Group: Oyster Reef Substrate
		Substrate Subclass: Shell Rubble if dominated by living shells	Substrate Group: Clam Rubble
			Substrate Group: Crepidula Rubble
			Substrate Group: Mussel Rubble
			Substrate Group: Oyster Rubble
	Biotic Class: Faunal Bed	Biotic Subclass: Mollusk Reef Biota	Biotic Group: Mussel Reef
			Biotic Group: Oyster Reef
			Biotic Group: Gastropod Reef
		Biotic Subclass: Attached Fauna	Biotic Group: Attached Mussels
			Biotic Group: Attached Oysters
		Biotic Subclass: Soft Sediment Fauna	Biotic Group: Clam Bed
			Biotic Group: Mussel Bed
			Biotic Group: Oyster Bed
			Biotic Group: Scallop Bed
Shell Accumulations	Substrate Class: Shell Substrate	Substrate Subclass: Shell Hash	Substrate Group: Clam Hash
			Substrate Group: Crepidula Hash
			Substrate Group: Mussel Hash
			Substrate Group: Oyster Hash
		Substrate Subclass: Shell Rubble if dominated by non-living shells	Substrate Group: Clam Rubble
			Substrate Group: Crepidula Rubble
			Substrate Group: Mussel Rubble
			Substrate Group: Oyster Rubble
Other Biogenic (e.g., cerianthids, corals, emergent tubes – polychaetes) Areas with corals or dense aggregations of epifauna or emergent infauna should be identified and characterized	Biotic Class: Reef Biota	Biotic Subclass: Deepwater/ Coldwater Coral Reef Biota	Biotic Group: Deepwater/Coldwater Stony Coral Reef
			Biotic Group: Deepwater/Coldwater Stylasterid Coral Reef
			Biotic Group: Colonized Deepwater/Coldwater Reef
		Biotic Subclass: Shallow/Mesophotic Coral Reef Biota	Biotic Group: Branching Coral Reef
			Biotic Group: Columnar Coral Reef
			Biotic Group: Encrusting Coral Reef
			Biotic Group: Foliose Coral Reef
			Biotic Group: Massive Coral Reef
			Biotic Group: Plate Coral Reef
			Biotic Group: Table Coral Reef
			Biotic Group: Turbinate Coral Reef
			Biotic Group: Mixed Shallow/Mesophotic Coral Reef

Habitat Table Group	Class	Subclass	Group(s)
Continued from above			Biotic Group: Colonized Shallow/Mesophotic Reef
	Biotic Class: Faunal Bed	Biotic Subclass: Glass Sponge Reef Biota	Biotic Group: Glass Sponge Reef
		Biotic Subclass: Mollusk Reef Biota	Biotic Group: Gastropod Reef
		Biotic Subclass: Worm Reef Biota	Biotic Group: Sabellariid Reef
			Biotic Group: Serpulid Reef
		Biotic Subclass: Attached Fauna	Biotic Group: Attached Corals
		Biotic Subclass: Soft Sediment Fauna	Biotic Group: Diverse Soft Sediment Epifauna
			Biotic Group: Larger Tube-Building Fauna
			Biotic Group: Small Tube-Building Fauna
			Biotic Group: Burrowing Anemones
			Biotic Group: Brachiopod Bed
			Biotic Group: Soft Sediment Bryozoans
			Biotic Group: Hydroid Bed
			Biotic Group: Pennatulid Bed
			Biotic Group: Sponge Bed
			Biotic Group: Tunicate Bed
Pelagic (offshore and estuarine)			
Habitat for Sensitive Life Stages (i.e., demersal eggs, spawning activity-discrete areas)	Not defined by CMECS but by managed spp. that occur in the project area		
Habitat Areas of Particular Concern	Not defined by CMECS but by managed spp. that occur in the project area		

Appendix F. Essential Fish Habitat (EFH)-designated species in the Project area

Table F-1. Essential Fish Habitat (EFH)-designated species in the Project area

	Eggs			Larvae/ Neonates[a]			Juveniles			Adults				
Species	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	HAPC	EFH Description
Atlantic albacore tuna (*Thunnus alalunga*)							•	•						General habitat description: Juveniles migrate to northeastern Atlantic waters in the summer for feeding. Adults are commonly found in northern Atlantic waters in September and October for feeding. Juveniles: EFH for juvenile albacore tuna is designated as pelagic offshore waters of the U.S. Atlantic east coast from Cape Cod to Cape Hatteras.
Atlantic angel shark (*Squatina dumeril*)				•	•		•	•		•	•			General habitat description: Insufficient data is available to differentiate EFH between all life and stages, therefore EFH is the same. Neonates are born in the spring/early summer at depths between 59 and 89 feet (18 and 27 meters) (Castro 2011). Neonates/Juveniles/ Adults: EFH in the Atlantic Ocean includes continental shelf habitats from Cape May, New Jersey to Cape Lookout, North Carolina, which encompasses the Project area.
Atlantic bluefin tuna (*Thunnus thynnus*)							•	•		•				General habitat description: Bluefin tuna inhabit northeastern waters to feed and move south to spawning grounds in the spring. Bluefin tuna is considered a Species of Concern because they support important recreation and commercial fisheries, and population size is unknown (NOAA 2020). Juveniles: EFH for juvenile bluefin tuna is waters off Cape Cod to Cape Hatteras within an area of the slope. Adults: EFH for adult bluefin tuna is pelagic waters from the mid-coast of Maine to the Mid-Atlantic.
Atlantic butterfish (*Peprilus triacanthus*)	•	•		•	•		•	•	•	•	•	•		General habitat description: Butterfish are found in the Lease Area throughout the year and are present in nearshore areas in the fall, and therefore may be impacted by cable installation (NOAA 2021b). Butterfish larvae are common in high salinity and mixing zones where bottom depths are between 134 and 1,148 feet. Juvenile and adult butterfish are generally found over sand, mud, and mixed substrates in bottom depths between 33 to 918 feet (NOAA 2013). Eggs: EFH is designated for butterfish eggs in pelagic habitats with depths under 4,921 ft and average temperatures between 48°F to 71°F in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and in patches on the continental shelf/slope from Maine southward to Cape Hatteras, North Carolina. Larvae: EFH for butterfish larvae is designated as pelagic habitats in inshore estuaries and embayments from Boston Harbor to Chesapeake Bay and over the continental shelf, from the Gulf of Maine to Cape Hatteras. Juveniles/Adults: EFH for juvenile and adult butterfish is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound on the inner and Outer Continental Shelf from the Gulf of Maine to Cape Hatteras.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Atlantic cod (*Gadus morhua*)	•			•	•						•			General habitat description: These areas include all habitats that contain structurally complex areas, including eelgrass, mixed sand and gravel, and rocky habitats (NEFMC 2017) which are particularly important for juvenile Atlantic cod as it provides protection from predation and readily available prey sources. Cod spawn primarily in bottom habitats composed of sand, rocks, pebbles, or gravel during fall, winter, and early spring (NOAA 2013). Cod eggs are found in the fall, winter, and spring in water depths less than 361 feet. Eggs: EFH for Atlantic cod eggs is designated as surface waters from the Gulf of Maine to southern New England. Larvae: EFH for larval cod is pelagic waters (depths of 98 to 230 feet) from the Gulf of Maine to the Mid-Atlantic and are primarily observed in the spring (Lough 2004). Adults: EFH for adult cod is designated as bottom habitats with substrates composed of rocks, pebbles, or gravel from the Gulf of Maine to southern New England and the middle Atlantic south to Delaware Bay.
Atlantic herring (*Clupea harengus*)							•	•	•	•	•			General habitat description: Larvae are free-floating and generally observed between August and April in areas with water depths from 164 to 295 feet. Juvenile and adult herring are found in areas with water depths from 66 to 427 feet. Atlantic herring were captured in the Northeast Fisheries Science Center (NEFSC) multispecies bottom trawl surveys (1948 to 2016) throughout the year within the Lease Area. Juveniles/Adults: EFH for juvenile and adult herring is pelagic and bottom habitats in the Gulf of Maine, Georges Bank, southern New England, and the Mid-Atlantic region.
Atlantic mackerel (*Scomber scombrus*)	•						•	•		•	•			General habitat description: Eggs float in the upper 33 to 49 feet of the water column, while larvae can be found in depths ranging from 33 to 427 feet (Studholme et al. 1999).The depth preference of juvenile mackerel shifts seasonally as they are generally found higher in the water column (66 to 164 feet) in the fall and summer, deeper (66 to 230 ft) in the winter, and widely dispersed (98 to 295 feet) in the spring (NOAA 2022b; Studholme et al. 1999). Eggs: EFH for mackerel (egg stages) is pelagic habitats in inshore estuaries and embayments from Great Bay to Long Island, in inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras (NOAA 2013). Juveniles: EFH for juvenile Atlantic mackerel is designated in pelagic waters with bottom depths of 33 to 361 feet. Adults: EFH for adult mackerel includes pelagic habitats the same region as for juveniles, but in waters with bottom depths less than 230 ft.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Atlantic sea scallop (Placopecten magellanicus)	•	•		•	•		•	•		•	•			General habitat description: All life stages have the same EFH spatial designation, which extends across much of the greater Atlantic region. During the larval stage, scallops are free-swimming and occur within the water column and near the seafloor. Hard substrate is particularly important as it provides essential habitat for settling larvae, which were found to have higher survival rates when attaching to hard surfaces rather than shifting sand or macroalgae. Eggs: Because sea scallop eggs are heavier than seawater and remain on the seafloor until the larval stage, EFH is designated in benthic habitats in inshore areas and the continental shelf. Larvae: EFH for the larval stage (referred to as "spat") includes benthic and pelagic 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, gravel, and macroalgae and other benthic organisms. Spat that settle on shifting sand do not survive. Juveniles/Adults: EFH for juvenile and adult sea scallops include sand and gravel substrates in the benthic habitats in depths of 59 to 361 feet (NEFMC 2017).
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) (Atlantic stock)										•	•	•		General habitat description: The juvenile and adult Atlantic sharpnose EFH for the Atlantic stock were expanded from North Carolina to Chesapeake Bay and Delaware Bay. Atlantic Ocean EFH includes areas between the mid-coast of Florida and Cape Hatteras, with seasonal summer distribution in the northern part of the range as water temperatures increase in the northern areas. Adults: EFH for this life stage extends from portions of Delaware Bay and Cape May, New Jersey to the mid-coast of Florida with seasonal summer distribution in the northern part of the range. Offshore depth extent for this life stage is 591 feet.
Atlantic skipjack tuna (*Katsuwonus pelamis*)										•	•			General habitat description: Designated EFH for spawning, eggs, and larvae is restricted to the Gulf of Mexico and Atlantic waters off the coast of Florida. 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 is also located on the Blake Plateau and in the Florida Straits through the Florida Keys. EFH also includes areas in the central Gulf of Mexico, offshore in pelagic habitats seaward of the southeastern edge of the West Florida Shelf to Texas.
Atlantic surfclam (*Spisula solidissima*)							•	•						General habitat description: Surfclams are generally located from the tidal zone to a depth of about 125 feet (NOAA 2013). The Atlantic surfclam occupies areas along the continental shelf from southern portions of the Gulf of St. Lawrence to Cape Hatteras, North Carolina (Cargnelli et al. 1999b). Juveniles: EFH for surfclams is throughout the substrate, to a depth of 3 ft below the water/sediment interface, from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic Exclusive Economic Zone (EEZ). EFH is designated in the Lease Area and Offshore Export Cable Route for juvenile life stages.
Atlantic yellowfin tuna (*Thunnus albacares*)							•	•						General habitat description: The Atlantic yellowfin tuna is a global species with a wide range from the central region of the Gulf of Mexico from Florida to Southern Texas and from the mid-east coast of Florida and Georgia to Cape Cod. They are also located south of Puerto Rico. Juveniles: EFH for juveniles is in offshore-pelagic waters from Cape Cod to the mid-east coast of Florida.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Black sea bass (Centropristis striata)				•	•		•	•	•	•	•			General habitat description: Adults are generally associated with structurally complex habitats. Juveniles and adults are most commonly observed in the spring and fall (Drohan et al. 2007; NOAA 2021c). 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), from the Gulf of Maine to Cape Hatteras, North Carolina. Juveniles: Black sea bass juveniles are usually found in association with rough bottom, shellfish and eelgrass beds, human-made structures in sandy shelly areas; offshore clam beds and shell patches may also be used during the wintering. Adults: EFH for juvenile and adult black sea bass is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2013). Structured habitats (natural and man-made), sand and shell are usually the substrate preference.
Bluefish (Pomatomus saltatrix)	•	•		•	•		•	•	•	•	•	•		General habitat description: Bluefish inhabit pelagic waters in and north of the Mid-Atlantic Bight for much of the year but make seasonal migrations south in the winter (Shepherd and Packer 2006). Eggs/Larvae: Eggs are found in mid-shelf waters ranging from 98 to 230 feet in southern New England to Cape Hatteras. Eggs are not found in estuarine waters. Larvae are found in oceanic waters (Able and Fahay 1998; Shepherd and Packer 2006). Juveniles: Juveniles found in pelagic waters over the continental shelf (from the coast out to the limits of the EEZ) from Massachusetts to Cape Hatteras. From Cape Hatteras south Juvenile found over the continental shelf from the coast out to the eastern wall of the Gulf Stream through Key West, Florida (Shepherd and Packer 2006). Adults: Adults are found in oceanic, nearshore, and continental shelf waters. Adults are observed in the inland bays of New Jersey from May through October and are not associated with a specific substrate (Stone et al. 1994). The species migrates extensively and is distributed based on season and size of the individuals within the schools (Shepherd and Packer 2006). There are two predominant spawning areas on the east coast: one during the spring that is located offshore from southern Florida to North Carolina and the other during summer in the Mid-Atlantic Bight (Wilk 1982).
Blue shark (Prionace glauca)							•	•		•	•			General Habitat Description: The blue shark is a pelagic, highly migratory species, occurring in temperate and tropical inshore and offshore waters, and ranging from Newfoundland and the Gulf of St. Lawrence south to Argentina (DFO 2017). Prefers deep, clear waters with temperatures ranging from 50°F to 68°F (Castro 1983). Juveniles/Adults: EFH for juvenile and adult blue sharks is waters from the southern part of the Gulf of Maine to Cape Hatteras (Lent 1999).
Clearnose skate (*Raja eglanteria*)							•	•	•	•	•	•		General habitat description: Clearnose skate juvenile and adult EFH is defined as saline-waters of coastal bays of the Mid-Atlantic to Saint John's River, Florida. 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 the other bays and estuaries. EFH for juvenile clearnose skates occurs from the shoreline to 98 feet, 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, including the high salinity zones of Chesapeake Bay, Delaware Bay, and the other bays and estuaries. EFH for adult clearnose skates occurs from the shoreline to 131 feet, primarily on mud and sand, but also on gravelly and rocky bottom.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Cobia (Rachycentron canadum)* Spanish mackerel (Scomberomorus maculatus) King mackerel (Scomberomorus cavalla)*		•	•	•	•	•	•	•	•	•	•			General habitat description: These species prefer warmer waters but migrate into the Mid-Atlantic Bight and farther north in the summer (NOAA 2022c). All life stages: EFH for all life stages occurs in the South- and Mid-Atlantic Bights and includes sandy shoals of capes and offshore bars, high profile rocky bottom, and barrier island ocean side waters, from the surf to the shelf-break zone. EFH also includes Sargassum from the Gulf Stream shoreward. For cobia, EFH also includes high salinity bays, estuaries, seagrass habitats, and the Gulf Stream, which disperses pelagic larvae.
Common thresher shark (*Alopias vulpinus*)[c]				•	•	•	•	•	•	•	•	•		General habitat description: Common thresher sharks occur in coastal and oceanic waters but are more common in 15 to 45 feet water depths. All life stages: EFH for all life stages is coastal and pelagic waters from Cape Cod to North Carolina and in other localized areas off the Atlantic Coast.
Dusky shark (Carcharhinus obscurus)[c]				•	•		•	•		•	•			General habitat description: Dusky sharks migrate to northern areas of their range in the summer and return south in the fall as water temperatures decrease. Dusky shark is a Species of Concern because the northwestern Atlantic/Gulf of Mexico population is estimated to be at 15% to 20% of the mid-1970s abundance (Cortés et al. 2006). Although commercial and recreation fishing is prohibited, the main threat to the dusky shark population is from bycatch and illegal harvest. Neonate: EFH for neonate dusky shark includes offshore areas of southern New England to Cape Lookout, North Carolina (NMFS 2017). Juveniles/Adults: EFH for juvenile and adult dusky sharks is waters over the continental shelf from southern Cape Cod to Florida (NMFS 2009).
Little skate (Leucoraja erinacea)							•	•	•			•		General habitat description: Demersal species that has a range from Nova Scotia to Cape Hatteras and is highly concentrated in the Mid-Atlantic Bight and on Georges Bank. Found year-round on Georges Bank and tolerates a wide range of temperatures (Packer et al. 2003a). Prefers sandy or pebbly bottom but can also be found on mud and ledges (Collette and Klein-MacPhee 2002). Juveniles/Adults: EFH is similar for both life stages and includes intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the mid-Atlantic region. EFH primarily occurs on sand and gravel substrates, but also is found on mud (NEFMC 2017).
Longfin inshore squid (*Doryteuthis pealeii*)	•	•					•	•		•	•			General habitat description: Longfin inshore squids lay eggs in masses referred to as “mops” that are demersal and anchored to various substrates and hardbottom types, including shells, lobster pots, fish traps, boulders, submerged aquatic vegetation, sand, and mud (NOAA 2013). Female longfin squid lay these egg mops during 3-week periods, which can occur throughout the year (Hendrickson 2017). Known longfin squid spawning grounds, which coincide with areas of concentrated squid fishing. Pre-recruits (juveniles) and recruits (adults) inhabit inshore areas in the spring and summer and migrate to deeper, offshore areas in the fall to overwinter (NOAA 2013). Eggs: EFH for longfin inshore squid eggs is inshore and offshore bottom habitats from Georges Bank to Cape Hatteras. Juveniles/Adults: EFH for juveniles and adults, also referred to as pre-recruits and recruits, is pelagic habitats inshore and offshore continental shelf waters from Georges Bank to South Carolina.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Monkfish (Lophius americanus)	•	•		•	•									General habitat description: Monkfish eggs float near the surface in veils that dissolve and release zooplanktonic larvae after 1 to 3 weeks (MADMF 2017). Monkfish eggs and larvae are generally observed from March to September. Eggs/Larvae: EFH for monkfish eggs and larvae is surface and pelagic waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras.
Northern shortfin squid (Illex illecebrosus)								•						General habitat description: Highly migratory species distributed in the northwest Atlantic Ocean between the Sea of Labrador and the Florida Straits. Its range is from Newfoundland to Cape Hatteras, North Carolina (Hendrickson and Holmes 2004). Juveniles: EFH is pelagic habitats along the outer continental shelf and slope as far south as South Carolina, on Georges Bank, and on the inner continental shelf off New Jersey and southern Maine and New Hampshire. Juveniles are generally found over bottom depths between 135 and 1,312 feet (41 and 400 meters) where bottom temperatures are 49.1°F to 61.7°F (9.5°C to 16.5°C) and salinities are 34.5 to 36.5 ppt. They also inhabit pelagic habitats in the Gulf Stream where water temperatures are above 60.8°F (16°C) and migrate onto the shelf as they grow. Juveniles make daily vertical migrations, moving up in the water column at night and down in the daytime. They feed primarily on euphausiids at night near the surface.
Ocean quahog (Arctica islandica)							•			•	•			General habitat description: Ocean quahogs prefer fine- to medium-grain sand substrates. The greatest concentrations are found south of Nantucket where they inhabit waters below 60°F and are found further offshore as their range progresses south (Cargnelli et al. 1999c). All life stages: EFH for all life stages is designated throughout the substrate, to a depth of 3 feet below the water/sediment interface from Georges Bank and the Gulf of Maine throughout the Atlantic Exclusive Economic Zone (NOAA 2013).
Pollock (Pollachius virens)					•									General habitat description: Pollock eggs are buoyant upon fertilization and occur in the water column (Cargnelli et al. 1999c). The larval stage lasts between 3 and 4 months and is also pelagic. Larvae: EFH designations for larvae includes pelagic inshore and offshore habitats in the Gulf of Maine, Georges Bank, and southern New England, but larvae can be found farther south in the Mid-Atlantic region, with bays and estuaries also included in these regions.
Red hake (Urophycis chuss)	•	•	•	•	•	•	•	•	•	•	•	•		General habitat description: Juvenile red hake are pelagic and congregate around floating debris for a time before descending to the bottom (Steimle et al. 1999a). Although adult red hake are generally demersal, they can be found in the water column (Steimle et al. 1999a). Eggs/Larvae: EFH for red hake eggs and larvae is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Juveniles: EFH for juvenile red hake is bottom habitats with a substrate of shell fragments. Adults: EFH for adult red hake is bottom habitats in depressions with sandy or muddy substrates in the same locations as other life stages.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Sand tiger shark (Carcharias taurus)[b]				•	•	•	•	•	•	•	•	•	•	General habitat description: Neonate sand tiger sharks inhabit shallow coastal waters within the 25-meter isobath (NMFS 2017). The sand tiger shark is a Species of Concern because population levels are estimated to be only 10% of pre-fishery conditions. Neonates: EFH for sand tiger shark neonates is along the U.S. Atlantic east coast from Cape Cod to northern Florida. Juveniles: EFH for juvenile sand tiger sharks is designated in estuarine bay habitats from northern Florida to Cape Cod (NFMS 2017). Adults: EFH for adult sand tiger sharks includes inshore bay and adjacent coastal and offshore waters throughout the Mid-Atlantic (NFMS 2017).
Sandbar shark (Carcharhinus plumbeus)				•	•	•	•	•	•	•	•	•	•	General habitat description: Sandbar sharks are a bottom-dwelling shark species that primarily forages for small bony fishes and crustaceans (NMFS 2009). Larvae/Neonate: Sandbar sharks bare live young (NMFS 2017). Juveniles: EFH for juvenile sandbar shark includes coastal areas of the U.S. Atlantic between southern New England and Georgia (NMFS 2017). Adults: EFH for adult sandbar sharks is coastal areas from southern New England to Florida.
Scup (Stenotomus chrysops)			•	•	•	•	•	•	•	•	•	•		General habitat description: Scup occupy inshore areas in the spring, summer, and fall and migrate offshore to overwinter in warmer waters on the Outer Continental Shelf (Steimle et al. 1999b). Scup was a dominant finfish species captured in the NEFSC multispecies bottom trawl survey during spring, summer, and fall surveys and in the Massachusetts Division of Marine Fisheries trawl surveys in the spring and fall. Juveniles/Adults: EFH for juvenile and adult scup are the inshore and offshore demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2013).
Shortfin mako shark (Isurus oxyrinchus)[c]				•	•		•	•		•	•			General habitat description: EFH for shortfin mako sharks in the Atlantic Ocean includes pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) to Cape Cod (seaward of the 200-meter bathymetric line); coastal and offshore habitats between Cape Cod and Cape Lookout, North Carolina; and localized habitats off South Carolina and Georgia. All life stages: EFH for all life stages is combined and considered the same due to insufficient data needed to differentiate EFH by life stage.
Silver Hake (Merluccius bilinearis)	•	•			•									General habitat description: Silver hake (also known as whiting) eggs and larvae are observed all year with peaks in egg observations from June through October and peaks in larvae observations from July through September. Eggs/Larvae: EFH for the egg and larval stages is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras.

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Smooth dogfish (Mustelus canis)[c]				•	•	•	•	•	•	•	•	•		General habitat description: Smooth dogfish are primarily demersal and undergo temperature-stimulated migrations between inshore and offshore waters to a maximum depth of 656.2 feet (NMFS 2017). All life stages: Due to insufficient information on the individual life stages (neonate, juvenile, and adult), EFH for smooth dogfish is designated for all life stages combined and occurs in both the Project area. EFH for smooth dogfish includes coastal areas and inshore bays and estuaries from Cape Cod Bay to South Carolina, inclusive of inshore bays and estuaries (e.g., Delaware Bay, Long Island Sound). EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina (NMFS 2017).
Spiny dogfish (Squalus acanthias)							•	•	•	•	•	•		General habitat description: The spiny dogfish is widely distributed throughout the world, with populations existing on the continental shelf of the northern and southern temperate zones, which includes the North Atlantic from Greenland to northeastern Florida, with concentrations from Nova Scotia to Cape Hatteras. Based on seasonal temperatures, spiny dogfish migrate up to 994.2 miles along the east coast. Juveniles/Adults: EFH for juvenile and adult spiny dogfish is waters on the continental shelf from the Gulf of Maine through Cape Hatteras (NOAA 2013). NEFSC bottom trawl surveys collected spiny dogfish juveniles at depths ranging from 36 to 1,640.4 feet. Adults are found in deeper waters inshore and offshore from the shallows to 2,952.7 feet deep (Collette and Klein-MacPhee 2002).
Summer flounder (Paralichthys dentatus)	•			•	•	•	•	•	•	•	•	•	•	General habitat description: Eggs are generally observed between October and May, while larvae are found from September through February. Juvenile summer flounder inhabit inshore areas such as salt marsh creeks, seagrass beds, and mudflats in the spring, summer, and fall and move to deeper waters offshore in the winter. Adults inhabit shallow coastal and estuarine areas during the warmer seasons and migrate offshore during the winter (Packer et al. 1999). Eggs/Larvae: EFH for eggs and larvae is pelagic waters found over the continental shelf from the Gulf of Maine to Cape Hatteras. Juveniles/Adults: EFH for juvenile and adult summer flounder is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras. HAPC is designated as areas of 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 (NOAA 2013).
Tiger shark (Galeocerdo cuvier)							•	•		•	•			General habitat description: Tiger sharks are a warm-water shark species and primarily remain south of the Mid-Atlantic Bight; however, they will occasionally travel farther north during the warmer summer months (NMFS 2017). Juveniles/Adults: EFH for these life stages extends from Georges Bank to the Florida Keys in offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (NMFS 2017).

Species	Eggs			Larvae/ Neonates[a]			Juveniles			Adults			HAPC	EFH Description
	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route		
Windowpane flounder (*Scophthalmus aquosus*)	•	•	•	•	•	•	•	•	•	•	•	•		General habitat description: Windowpane flounder are usually associated with non-complex benthic habitats (Collette and Klein-MacPhee 2002) from the Gulf of Saint Lawrence to Florida (Gutherz 1967). Spawning occurs from April to December along areas of the Northwest Atlantic. Eggs: EFH for eggs is surface waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Larvae: EFH for larvae is pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Juvenile/Adults: EFH for juvenile and adult life stages is bottom habitats that consist of mud or fine-grained sand substrate around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2013).
Winter skate (Leucoraja ocellata)							•	•	•	•	•	•		General habitat description: Demersal species that has a range from the southern coast of Newfoundland to Cape Hatteras and has concentrated populations on Georges Bank and the northern section of the Mid-Atlantic Bight (Packer et al. 2003b). The winter skate has very similar temperature ranges and migration patterns as the little skate. Juveniles/Adults: EFH for juvenile and adult winter skate includes sand and gravel substrates in sub-tidal benthic habitats in depths from the shore to 262 to 295 feet from eastern Maine to Delaware Bay, on the continental shelf in southern New England and the mid-Atlantic region, and on Georges Bank.
Witch flounder (Glyptocephalus cynoglossus)	•	•		•	•		•			•	•			General habitat description: Witch flounder is a groundfish species with a range from the Gulf of Maine to Cape Hatteras, North Carolina (Cargnelli et al. 1999e). They tend to concentrate near the southwest portion of the Gulf of Maine (Collette and Klein-MacPhee 2002). Spawning occurs from May through September and peaks in July and August. Eggs: EFH for eggs is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Larvae: EFH for larvae is surface waters to 820 ft in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Juveniles/Adults: They are found over mud, clay, silt, or muddy sands at depths ranging from 66 to 5,135 feet, although the majority are found at 295 to 984 feet (Cargnelli et al. 1999e).

	Eggs			Larvae/ Neonates[a]			Juveniles			Adults				
Species	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	Lease Area	Offshore Export Cable Route	Inshore Export Cable Route	HAPC	EFH Description
Yellowtail flounder (Limanda ferruginea)	•	•		•	•		•			•	•			General habitat description: This groundfish species ranges along the Atlantic Coast of North America from Newfoundland to the Chesapeake Bay, with the majority located on the western half of Georges Bank, the western Gulf of Maine, east of Cape Cod, and southern New England (Collette and Klein-MacPhee 2002). Present on Georges Bank from March to August. Spawning occurs in both inshore areas as well as offshore on Georges Bank in July. Eggs/Larvae: EFH for eggs and larvae is surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Chesapeake Bay. Juveniles: EFH for juveniles occurs on sand and muddy sand between subtidal and benthic habitats at 263 feet in coastal waters in the Gulf of Maine and on the continental shelf on Gorges Bank and in the mid-Atlantic, including high-salinity zones in bays and estuaries. Adults: EFH for adults occurs on sand or sand with mud, shell hash, gravel, and rocks at depths between 82 and 295 feet from the Gulf of Maine to the mid-Atlantic, including high-salinity zones in bays and estuaries (NOAA 2013).

[*] No life stage breakdown provided

[a] Shark species emerge from egg cases fully developed and are referred to as neonates

[b] Indicates Species of Concern

[c] Indicates EFH designations are the same for all life stages or designations are not specified by life stage

Appendix G. Areal Extent of Impacts on Benthic Habitat for Alternatives

Table G-1. Areal Extent of Impacts on Benthic Habitat for Alternative B – Proposed Action

				Benthic Habitat Type Impact (acres)					
Proposed Project Component			Option	Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Wind Turbine Generators	Permanent	Foundations	Monopile	2.4	0.37	0	0	2.8	Area based on 11-meter diameter pile at WTG location
Wind Turbine Generators	Permanent	Scour Protection	Monopile	19.6	3.1	0	0	22.7	Area based on 33-meter diameter around WTG location, minus the monopile footprint
Wind Turbine Generators	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	63.5	11.3	0.03	0	74.8	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Permanent	Foundation	Monopile	0.19	0	0	0	0.19	Area based on two 11-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket on suction bucket	1.4	0	0	0	1.4	Area based on eight 15-meter diameter suction buckets per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket with pin piles	0.096	0	0	0	0.096	Area based on eight 4-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Large-pile jacket[3]	0.056	0	0	0	0.056	Proposed foundation type. Area based on eight 3-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Monopile	1.5	0	0	0	1.5	Area based on two 33-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Jacket on suction bucket	N/A	N/A	N/A	N/A	N/A	Scour protection is built into the suction buckets and is already included in the area calculation.
Offshore Substations	Permanent	Scour Protection	Jacket with pin piles	0.79	0	0	0	0.79	Area based on eight 12-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Large-pile jacket	0.45	0	0	0	0.45	Area based on 9-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs

[3] Large-pile jacket is proposed OSS foundation type

Proposed Project Component			Option	Benthic Habitat Type Impact (acres)					Notes on Methods
				Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket on suction bucket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket with pin piles	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Large-pile jacket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
MET Tower	Permanent	Foundation	IBGS	0.003	0	0	0	0.003	Area based on three 1.8-meter diameter piles
MET Tower	Permanent	Scour protection	IBGS	N/A	N/A	N/A	N/A	N/A	N/A
MET Tower	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	IBGS	0.34	0.15	0	0	0.49	2,000 square foot area, using radius of 25.2 meters around the proposed Met Tower location.
Inter-Array Cables	Permanent	Cable protection	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of cable protection based on a maximum route length of 202.2 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Inter-Array Cables	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation)	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of temporary impacts based on cable length of 202.2 kilometers, with a disturbance width of 0.6 meters.
Offshore Export Cables (common and route 1)	Permanent	Cable protection	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of cable protection based on a maximum route length of 186 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.

Proposed Project Component			Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Export Cables (common and route 1)	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation, HDD gravity cells)	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of temporary impacts based on cable length of 186 kilometers, with a disturbance width of 0.6 meters.
Inshore Export Cables (Indian River Bay)	Permanent	Cable protection	Inshore export cable	0	0	0	0	0	Area of cable protection based on a maximum route length of 68.1 kilometers.
Inshore Export Cables (Indian River Bay)	Temporary	Seafloor disturbance (grapnel run, cable installation, vessel anchoring, HDD gravity cells)	Inshore export cable	168.3	0	0	0	168.3	Area of temporary impacts based on cable length of 68.1 kilometers, with a disturbance width of 10 meters. This would be included in the area assumed for dredging access (below) and is not additive to the impacts.
Inshore Export Cables (Indian River Bay)	Temporary	Dredging for barge access	Inshore export cable	39	0	0	0	39	Assumed entire 40-meter corridor is impacted. Used common corridor and south route as defined in EFH (most conservative).
Maximum Total Temporary Impact				279	24	0.59	0.01	303.6	Total of temporary Project impacts. The large-pile jacket foundation was used for the OSSs.
Maximum Total Permanent Impacts				64.9	16	0.56	0.01	80.9	Total of permanent Project impacts. The large-pile jacket foundation was used for the OSSs.

Table G-2. Areal Extent of Impacts on Benthic Habitat for Alternative C-1 – Landfall at Tower Road and Onshore Export Cable Routes Alternative

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Wind Turbine Generators	Permanent	Foundations	Monopile	2.4	0.37	0	0	2.8	Area based on 11-meter diameter pile at WTG location
Wind Turbine Generators	Permanent	Scour Protection	Monopile	19.6	3.1	0	0	22.7	Area based on 33-meter diameter around WTG location, minus the monopile footprint
Wind Turbine Generators	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	63.5	11.3	0.03	0	74.8	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Permanent	Foundation	Monopile	0.19	0	0	0	0.19	Area based on two 11-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket on suction bucket	1.4	0	0	0	1.4	Area based on eight 15-meter diameter suction buckets per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket with pin piles	0.096	0	0	0	0.096	Area based on eight 4-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Large-pile jacket[4]	0.056	0	0	0	0.056	Proposed foundation type. Area based on eight 3-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Monopile	1.5	0	0	0	1.5	Area based on two 33-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Jacket on suction bucket	N/A	N/A	N/A	N/A	N/A	Scour protection is built into the suction buckets and is already included in the area calculation.
Offshore Substations	Permanent	Scour Protection	Jacket with pin piles	0.79	0	0	0	0.79	Area based on eight 12-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Large-pile jacket	0.45	0	0	0	0.45	Area based on 9-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.

[4] Large-pile jacket is proposed OSS foundation type

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket on suction bucket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket with pin piles	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Large-pile jacket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
MET Tower	Permanent	Foundation	IBGS	0.003	0	0	0	0.003	Area based on three 1.8-meter diameter piles
MET Tower	Permanent	Scour protection	IBGS	N/A	N/A	N/A	N/A	N/A	N/A
MET Tower	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	IBGS	0.34	0.15	0	0	0.49	2,000 square foot area, using radius of 25.2 meters around the proposed Met Tower location.
Inter-Array Cables	Permanent	Cable protection	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of cable protection based on a maximum route length of 202.2 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Inter-Array Cables	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation)	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of temporary impacts based on cable length of 202.2 kilometers, with a disturbance width of 0.6 meters.
Offshore Export Cables (common and route 2)	Permanent	Cable protection	Offshore export cable	18.7	15.0	0.29	0.069	34	Area of cable protection based on a maximum route length of 229.3 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Offshore Export Cables (common and route 2)	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation, HDD gravity cells)	Offshore export cable	18.7	15.0	0.29	0.069	34	Area of temporary impacts based on cable length of 229.3 kilometers, with a disturbance width of 0.6 meters.
Maximum Total Temporary Impacts				110.7	30	0.34	0.08	135.3	Total of temporary Project impacts. The large-pile jacket foundation was used for the OSSs.
Maximum Total Permanent Impacts				67	22	0.31	0.08	90	Total of permanent Project impacts. The large-pile jacket foundation was used for the OSSs.

Table G-3. Areal Extent of Impacts on Benthic Habitat for Alternative C-2 – Landfall at 3R's Beach and Onshore Export Cable Routes Alternative

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Wind Turbine Generators	Permanent	Foundations	Monopile	2.4	0.37	0	0	2.8	Area based on 11-meter diameter pile at WTG location
Wind Turbine Generators	Permanent	Scour Protection	Monopile	19.6	3.1	0	0	22.7	Area based on 33-meter diameter around WTG location, minus the monopile footprint
Wind Turbine Generators	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	63.5	11.3	0.03	0	74.8	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Permanent	Foundation	Monopile	0.19	0	0	0	0.19	Area based on two 11-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket on suction bucket	1.4	0	0	0	1.4	Area based on eight 15-meter diameter suction buckets per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket with pin piles	0.096	0	0	0	0.096	Area based on eight 4-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Large-pile jacket[5]	0.056	0	0	0	0.056	Proposed foundation type. Area based on eight 3-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Monopile	1.5	0	0	0	1.5	Area based on two 33-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Jacket on suction bucket	N/A	N/A	N/A	N/A	N/A	Scour protection is built into the suction buckets and is already included in the area calculation.
Offshore Substations	Permanent	Scour Protection	Jacket with pin piles	0.79	0	0	0	0.79	Area based on eight 12-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Large-pile jacket	0.45	0	0	0	0.45	Area based on 9-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.

[5] Large-pile jacket is proposed OSS foundation type

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket on suction bucket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket with pin piles	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Large-pile jacket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
MET Tower	Permanent	Foundation	IBGS	0.003	0	0	0	0.003	Area based on three 1.8-meter diameter piles
MET Tower	Permanent	Scour protection	IBGS	N/A	N/A	N/A	N/A	N/A	N/A
MET Tower	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	IBGS	0.34	0.15	0	0	0.49	2,000 square foot area, using radius of 25.2 meters around the proposed Met Tower location.
Inter-Array Cables	Permanent	Cable protection	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of cable protection based on a maximum route length of 202.2 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Inter-Array Cables	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation)	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of temporary impacts based on cable length of 202.2 kilometers, with a disturbance width of 0.6 meters.
Offshore Export Cables (common and route 1)	Permanent	Cable protection	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of cable protection based on a maximum route length of 186 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Offshore Export Cables (common and route 1)	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation HDD gravity cells)	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of temporary impacts based on cable length of 186 kilometers, with a disturbance width of 0.6 meters.
Maximum Total Temporary Impacts				110.7	24	0.59	0.01	135.3	Total of temporary Project impacts. The large-pile jacket foundation was used for the OSSs.
Maximum Total Permanent Impacts				67	16	0.56	0.01	84	Total of permanent Project impacts. The large-pile jacket foundation was used for the OSSs.

Table G-4. Areal Extent of Impacts on Benthic Habitat for Alternative D – No Surface Occupancy to Reduce Visual Impacts Alternative

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Wind Turbine Generators	Permanent	Foundations	Monopile	1.8	0.35	0	0	2.1	Area based on 11-meter diameter pile at WTG location
Wind Turbine Generators	Permanent	Scour Protection	Monopile	14.0	2.6	0	0	16.6	Area based on 33-meter diameter around WTG location, minus the monopile footprint
Wind Turbine Generators	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	48.2	8.6	0.03	0	56.8	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Permanent	Foundation	Monopile	0.14	0	0	0	0.14	Area based on two 11-meter diameter piles per foundation for 3 OSSs
Offshore Substations	Permanent	Foundation	Jacket on suction bucket	1.1	0	0	0	1.1	Area based on eight 15-meter diameter suction buckets per foundation for 3 OSSs
Offshore Substations	Permanent	Foundation	Jacket with pin piles	0.07	0	0	0	0.07	Area based on eight 4-meter diameter piles per foundation for 3 OSSs
Offshore Substations	Permanent	Foundation	Large-pile jacket[6]	0.048	0	0	0	0.048	Proposed foundation type. Area based on eight 3-meter diameter piles per foundation for 3 OSSs
Offshore Substations	Permanent	Scour Protection	Monopile	0.56	0	0	0	0.56	Area based on two 33-meter diameter scour protection areas, minus the foundation footprint, for 3 OSSs
Offshore Substations	Permanent	Scour Protection	Jacket on suction bucket	N/A	N/A	N/A	N/A	N/A	Scour protection is built into the suction buckets and is already included in the area calculation.
Offshore Substations	Permanent	Scour Protection	Jacket with pin piles	0.6	0	0	0	0.6	Area based on eight 12-meter diameter scour protection areas, minus the foundation footprint, for 3 OSSs
Offshore Substations	Permanent	Scour Protection	Large-pile jacket	0.34	0	0	0	0.34	Area based on 9-meter diameter scour protection areas, minus the foundation footprint, for 3 OSSs
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	1.84	0.01	0	0	1.85	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.

[6] Large-pile jacket is proposed OSS foundation type

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket on suction bucket	1.84	0.01	0	0	1.85	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket with pin piles	1.84	0.01	0	0	1.85	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Large-pile jacket	1.84	0.01	0	0	1.85	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
MET Tower	Permanent	Foundation	IBGS	0.003	0	0	0	0.003	Area based on three 1.8-meter diameter piles
MET Tower	Permanent	Scour protection	IBGS	N/A	N/A	N/A	N/A	N/A	N/A
MET Tower	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	IBGS	0.34	0.15	0	0	0.49	2,000 square foot area, using radius of 25.2 meters around the proposed Met Tower location.
Inter-Array Cables[7]	Permanent	Cable protection	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of cable protection based on a maximum route length of 202.2 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Inter-Array Cables[8]	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation)	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of temporary impacts based on cable length of 202.2 kilometers, with a disturbance width of 0.6 meters.
Offshore Export Cables (common and route 1)	Permanent	Cable protection	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of cable protection based on a maximum route length of 186 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Offshore Export Cables (common and route 1)	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation, HDD gravity cells)	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of temporary impacts based on cable length of 186 kilometers, with a disturbance width of 0.6 meters.

[7] Inter-array cable impacts overstated because IAC were not re-sited due to loss of 32 WTG locations

[8] Inter-array cable impacts overstated because IAC were not re-sited due to loss of 32 WTG locations

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Inshore Export Cables (Indian River Bay)	Permanent	Cable protection	Inshore export cable	0	0	0	0	0	Area of cable protection based on a maximum route length of 68.1 kilometers.
Inshore Export Cables (Indian River Bay)	Temporary	Seafloor disturbance (grapnel run, cable installation, vessel anchoring, HDD gravity cells)	Inshore export cable	168.3	0	0	0	168.3	Area of temporary impacts based on cable length of 68.1 kilometers, with a disturbance width of 10 meters. This would be included in the area assumed for dredging access (below) and is not additive to the impacts.
Inshore Export Cables (Indian River Bay)	Temporary	Dredging for barge access	Inshore export cable	39	0	0	0	39	Assumed entire 40-meter corridor is impacted. Used common corridor and south route as defined in EFH (most conservative).
Maximum Total Temporary Impacts				263.1	21	0.59	0.01	284.9	Total of temporary Project impacts. The large-pile jacket foundation was used for the OSSs.
Maximum Total Permanent Impacts				60.9	16	0.56	0.01	76.9	Total of permanent Project impacts. The large-pile jacket foundation was used for the OSSs.

Table G-5. Areal Extent of Impacts on Benthic Habitat for Alternative E – Habitat Impact Minimization Alternative

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres): Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Wind Turbine Generators	Permanent	Foundations	Monopile	2.16	0.37	0	0	2.5	Area based on 11-meter diameter pile at WTG location
Wind Turbine Generators	Permanent	Scour Protection	Monopile	17.5	3.1	0	0	20.6	Area based on 33-meter diameter around WTG location, minus the monopile footprint
Wind Turbine Generators	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	57.7	10.2	0.03	0	68.0	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Permanent	Foundation	Monopile	0.19	0	0	0	0.19	Area based on two 11-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket on suction bucket	1.4	0	0	0	1.4	Area based on eight 15-meter diameter suction buckets per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Jacket with pin piles	0.096	0	0	0	0.096	Area based on eight 4-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Foundation	Large-pile jacket[9]	0.056	0	0	0	0.056	Proposed foundation type. Area based on eight 3-meter diameter piles per foundation for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Monopile	1.5	0	0	0	1.5	Area based on two 33-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Jacket on suction bucket	N/A	N/A	N/A	N/A	N/A	Scour protection is built into the suction buckets and is already included in the area calculation.
Offshore Substations	Permanent	Scour Protection	Jacket with pin piles	0.79	0	0	0	0.79	Area based on eight 12-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Permanent	Scour Protection	Large-pile jacket	0.45	0	0	0	0.45	Area based on 9-meter diameter scour protection areas, minus the foundation footprint, for 4 OSSs
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Monopile	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.

[9] Large-pile jacket is proposed OSS foundation type

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket on suction bucket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Jacket with pin piles	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
Offshore Substations	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	Large-pile jacket	2.45	0.02	0	0	2.47	Temporary construction area defined as 300-meter radius around WTG location. Actual construction disturbance would be approximately 2,500 m^2, which consists of less than 1% of the total potential construction area.
MET Tower	Permanent	Foundation	IBGS	0.003	0	0	0	0.003	Area based on three 1.8-meter diameter piles
MET Tower	Permanent	Scour protection	IBGS	N/A	N/A	N/A	N/A	N/A	N/A
MET Tower	Temporary	Seafloor Disturbance (vessel anchoring, jack-up vessels, seabed preparation)	IBGS	0.34	0.15	0	0	0.49	2,000 square foot area, using radius of 25.2 meters around the proposed Met Tower location.
Inter-Array Cables[10]	Permanent	Cable protection	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of cable protection based on a maximum route length of 202.2 kilometers, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.
Inter-Array Cables[11]	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation)	Inter-array cable	26.1	3.8	0.02	0.01	29.9	Area of temporary impacts based on cable length of 202, kilometers, with a disturbance width of 0.6 meters.
Offshore Export Cables (common and route 1)	Permanent	Cable protection	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of cable protection based on a maximum route length of 186,046 meters, of which maximum of 10% may be protected. Width of cable protection (mattresses) is 6 meters.

[10] Inter-array cable impacts overstated because IAC were not re-sited due to loss of 11 WTG locations

[11] Inter-array cable impacts overstated because IAC were not re-sited due to loss of 11 WTG locations

Proposed Project Component	Duration	Activity	Option	Benthic Habitat Type Impact (acres) Soft Bottom	Heterogeneous Complex	Complex	Large grained Complex	Total	Notes on Methods
Offshore Export Cables (common and route 1)	Temporary	Seafloor disturbance (grapnel run, cable installation, seabed preparation, HDD gravity cells)	Offshore export cable	18.3	8.76	0.54	0	27.6	Area of temporary impacts based on cable length of 186 kilometers, with a disturbance width of 0.6 meters.
Inshore Export Cables (Indian River Bay)	Permanent	Cable protection	Inshore export cable	0	0	0	0	0	Area of cable protection based on a maximum route length of 68.1 kilometers.
Inshore Export Cables (Indian River Bay)	Temporary	Seafloor disturbance (grapnel run, cable installation, vessel anchoring, HDD gravity cells)	Inshore export cable	168.3	0	0	0	168.3	Area of temporary impacts based on cable length of 68.1 kilometers, with a disturbance width of 10 meters. This would be included in the area assumed for dredging access (below) and is not additive to the impacts.
Inshore Export Cables (Indian River Bay)	Temporary	Dredging for barge access	Inshore export cable	39	0	0	0	39	Assumed entire 40-meter corridor is impacted. Used common corridor and south route as defined in EFH (most conservative).
Maximum Total Temporary Impacts				273.2	23	0.59	0.01	296.8	Total of temporary Project impacts. The large-pile jacket foundation was used for the OSSs.
Maximum Total Permanent Impacts				64.9	16	0.56	0.01	80.9	Total of permanent Project impacts. The large-pile jacket foundation was used for the OSSs.

Appendix H. Indian River Bay Sediment Transport Model (provided under separate cover)

Appendix I. Offshore Electrical and Magnetic Field Assessment
(provided under separate cover)

Appendix J. Onshore Magnetic Field Assessment (provided under separate cover)

Appendix K. Multi-Species Pile Driving Calculator Tool (provided under separate cover)