Section 4—Site Characterization and Assessment of Potential Impacts

The site characterization and assessment of potential impacts for the Project is structured in accordance with 30 CFR 585 and the BOEM guidelines on the information requirements for a COP for OCS renewable energy activities on a commercial lease, as required by 30 CFR 585.626(a) and (b). The approach also considers the additional detailed information and certifications, as specified under 30 CFR 585.627, which support BOEM's compliance with NEPA regulations and other applicable laws and regulations.

The approach to site characterization and impact assessment involves the following steps, as illustrated in Figure 4-1.

- Identification and Analysis of Impact-producing Factors - Project activities and infrastructure, as described in Section 3, that could impact resources were identified as impact-producing factors (IPFs). Where specific Project specifications are not available because final design has not been completed, the Project design envelope was considered to include the range of possible impact-producing activities. A summary of Project activities, by phase, are compared to the IPFs considered in this impact assessment as a matrix and shown in Table 4-1. The extent of potential impact, resulting from IPFs, was identified and described for each IPF in Section 4.1.
- Characterization of Affected Environment – The environmental setting of the Project, including the footprint of the SFWF and the SFEC within federal and state waters of New York, and within the town of East Hampton, New York, is described for physical, biological, socioeconomic, cultural, and visual resources that have the potential to be impacted by Project activities. The affected environment for each resource includes a regional overview of the resource followed by characterization of the resource relative to the SFWF and the SFEC. The affected environment for each resource is described separately for the SFWF, SFEC - OCS, SFEC - NYS, and SFEC - Onshore.
- Impact Assessment – The impact assessment used in this document approximately follows an assessment of significance as discussed in 40 CFR 1508.27. The impact assessment for the SFWF and SFEC involves the evaluation of potential overlap of the IPF, in time and space, on the affected environment for each resource, during each Project phase, as shown in Table 4-1. The type and degree of potential impacts from proposed Project activities varies based on the characteristics of the resource (e.g., presence/absence, conservation status, abundance) and the IPF that may affect each resource. Potential impacts are discussed separately for the SFWF and SFEC.

  Potential impacts are characterized as direct or indirect and whether they result from construction, O&M, and/or decommissioning of the Project. Anticipated impacts are characterized as short-term or long-term and by intensity, as negligible, minor, moderate, or major. The following impact levels are used to provide consistency in the assessment of potential impacts:

  - **Direct or Indirect**: Direct effects are those occurring at the same place and time as the initial cause or action. Indirect effects are those that occur later in time or are spatially removed from the activity.

  - **Short-term or Long-term Impacts**: Short- or long-term impacts do not refer to any defined period. In general, short-term impacts are those that occur only for a limited period or only during the time required for construction activities. Impacts that are short-lived, such as noise from routine maintenance work during operations, may also be short-term if the activity is short in duration and the impact is restricted to a short, defined period. Long-term impacts are those that are likely to occur on a recurring or permanent basis, or impacts from which a resource does not recover quickly. In general, direct impacts associated with construction and decommissioning are considered short-term because they will occur within the no more than 2-year construction phase. Indirect impacts are determined to be either short-term or long-term depending on if resource recovery may take several years. Impacts associated with O&M are considered long-term because they occur over the 25-to-30-year life of the Project.

  - **Negligible, Minor, Moderate, or Major Impacts:** Negligible, minor, moderate, or major impacts are relative terms used to characterize the magnitude of an impact.

    - Negligible impacts are generally those impacts that, if perceptible, would not be measurable.

    - Minor impacts are those impacts that, if adverse, would be perceptible but, in context, avoidable with proper mitigation; and, if impacts are measurable, the affected system would be expected to recover completely without mitigation once the impact is eliminated.

    - Moderate impacts are those that, if adverse, would be measurable but would not threaten the viability of the affected system and would be expected to absorb the change or impact if proper mitigation or remedial action is implemented.

    - Major impacts are those impacts that, if adverse, would be measurable but not within the capacity of the affected system to absorb the change, and without major mitigation, could be severe and long lasting.

- Proposed Environmental Protection Measures – For each resource, if measures are proposed to avoid or minimize potential impacts, the impact evaluation included consideration of these environmental protection measures.

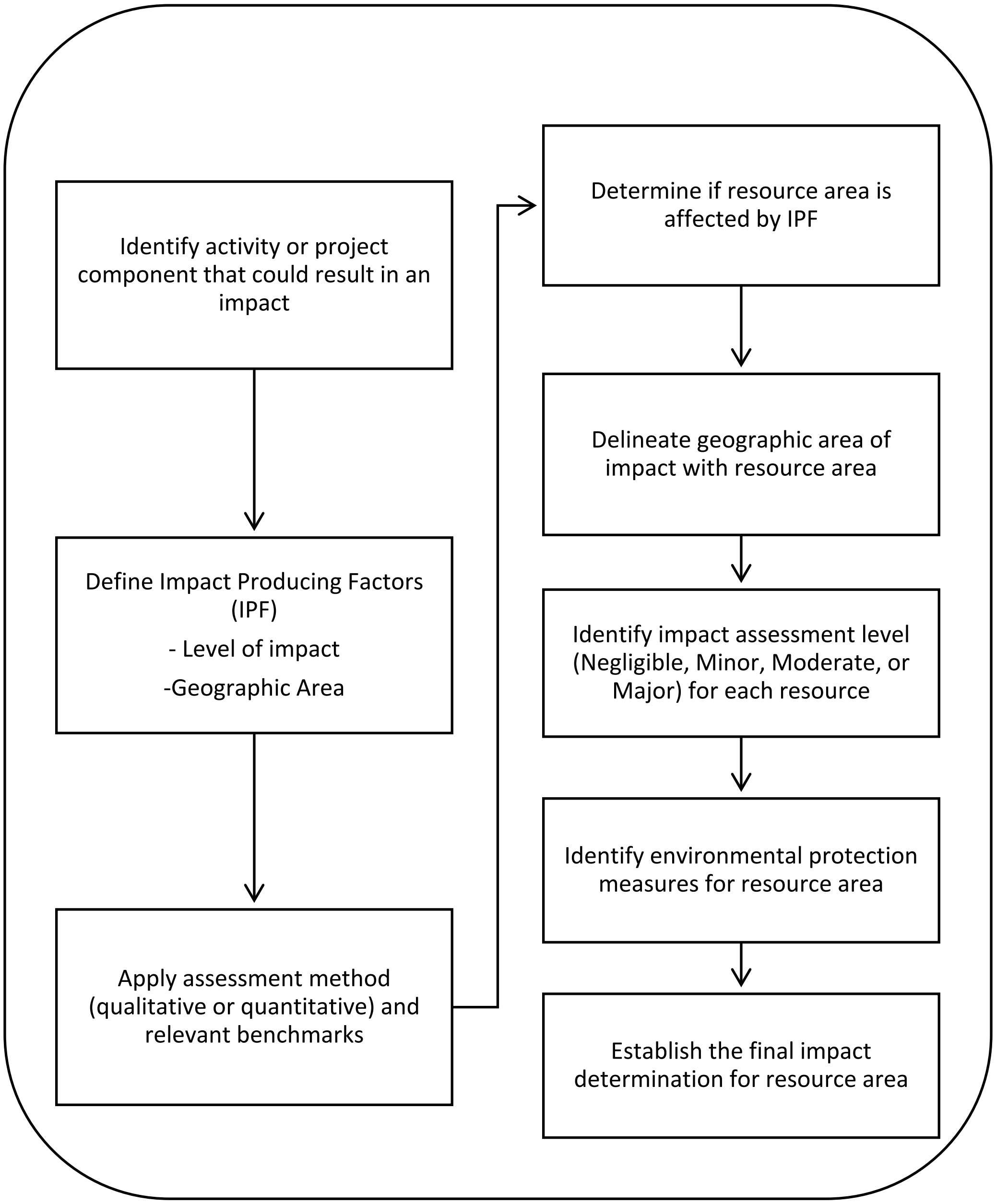

Figure 4.0-1. Illustration of Steps involved in the Proposed Impact Assessment

Table 4.0-1. Anticipated Project Activities and Possible Impact-producing Factors during Construction, Operations & Maintenance, and Decommissioning of the South Fork Wind Farm and South Fork Export Cable

SFWF and SFEC Activities	Seafloor/ Land Disturbance	Sediment Suspension/ Deposition	Noise	Electro-magentic Field	Discharges/ Releases	Trash Debris	Traffic	Air Emissions	Visible Structures	Lighting
CONSTRUCTION										
Equipment and Material Transportation										
Vessels	●	●	●		●	●	●	●		●
Port-side Support Activities										
Cranes and heavy equipment	●		●				●	●		
Vehicles	●		●				●	●		
SFWF WTG Installation										
Vessels and heavy equipment	●	●	●		●	●	●	●		●
Seafloor preparation	●	●								
Pile driving (Monopile, Jacket)	●	●	●							
Placement of GBS foundation	●	●								
Dredging for GBS foundation	●	●	●		●					
Placement of scour protection	●	●			●					
SFWF Inter-Array Cable Installation										
Vessels (dynamically positioned and other)	●	●	●		●	●	●	●		●
PLGR	●	●								
Self-propelled mechanical/hydro-jet plow	●	●								
SFEC Installation										
Vessels (dynamically positioned and other)	●	●	●		●	●	●	●		●
PLGR	●	●								

Table 4.0-1. Anticipated Project Activities and Possible Impact-producing Factors during Construction, Operations & Maintenance, and Decommissioning of the South Fork Wind Farm and South Fork Export Cable

SFWF and SFEC Activities	Seafloor/ Land Disturbance	Sediment Suspension/ Deposition	Noise	Electro-magentic Field	Discharges/ Releases	Trash Debris	Traffic	Air Emissions	Visible Structures	Lighting
Self-propelled mechanical and hydro-jet plow	●	●								
SFEC Sea-to-Shore Transition										
Vessels and heavy equipment	●	●	●		●	●	●	●		●
Sheet pile driving (Vibratory hammer)	●	●	●							
Cofferdam excavation	●	●	●		●					
HDD			●		●	●				
Transition vault excavation	●		●							
Construction vehicles	●		●				●	●		
SFEC Onshore										
Site preparation (clearing, grading)	●		●		●	●		●		
Trenching	●		●		●	●		●		
Vehicles	●		●				●	●		
SFEC - Interconnection Facility										
Site preparation (clearing, grading)	●		●		●	●		●		
Substation construction	●		●		●	●		●	●	
Vehicles	●		●				●	●		
OPERATIONS AND MAINTENANCE										
Material and Personnel Transportation										
Vessels	●	●	●		●	●	●	●		●
Aircraft			●					●		
Vehicles	●		●				●	●		
SFWF WTG Operation			●		●				●	●
SFWF Inter-Array Cable Operation				●						

Table 4.0-1. Anticipated Project Activities and Possible Impact-producing Factors during Construction, Operations & Maintenance, and Decommissioning of the South Fork Wind Farm and South Fork Export Cable

SFWF and SFEC Activities	Seafloor/ Land Disturbance	Sediment Suspension/ Deposition	Noise	Electro-magentic Field	Discharges/ Releases	Trash Debris	Traffic	Air Emissions	Visible Structures	Lighting
SFEC Offshore Cable Operation				●						
SFEC Onshore Cable Operation				●						
SFEC Substation Operation			●		●				●	●
DECOMMISSIONING										
Vessels	●	●	●		●	●	●	●		●
SFWF Foundation Removal (Monopile, Jacket, GBS)	●	●	●		●	●				
SFWF WTG Disassembly			●			●				
SFEC Offshore Cable Removal	●	●	●		●	●	●	●		
SFEC Onshore Cable (Abandonment)	●	●								
SFEC Substation (Repurposed or demolished)	●	●							●	●

4.1 Summary of Impact-producing Factors

The IPFs identified for the SFWF and SFEC, based on the construction, O&M, and decommissioning activities described in Section 3, are listed below. In this section, each IPF is characterized qualitatively and quantitatively (when possible) in accordance with the scope of each phase and activity. As presented in Table 4.1-1, the IPFs that have been evaluated and result in impacts that are negligible or greater are cross-referenced to each corresponding resource and COP section number.

- Seafloor and Land Disturbance
- Sediment Suspension and Deposition
- Noise
- Electromagnetic Fields (EMF)
- Discharges and Releases
- Trash and Debris
- Traffic
- Air Emissions
- Visible Structures
- Lighting

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Table 4.1-1. Summary of the Evaluation of Impact-producing Factors associated with the South Fork Wind Farm and South Fork Export Cable and Affected Physical, Biological, Cultural and Socioeconomic Resources

	Physical Resources				Biological Resources							Cultural Resources				Socioeconomic Resources								
Impact-producing Factor	**Air Quality**	**Water Quality & Water Resources**	**Geological Resources**	**Physical Oceanography & Meteorology**	**Coastal Habitat**	**Benthic & Shellfish Resources**	**Finfish & Essential Fish Habitat**	**Marine Mammals**	**Sea Turtles**	**Avian Species**	**Bat Species**	**Historic Properties**	**Marine Archaeological Resources**	**Terrestrial Archaeological Resources**	**Visual Resources**	**Population, Economy, & Employment**	**Housing & Property Values**	**Public Services**	**Recreation & Tourism**	**Commercial & Recreational Fishing**	**Commercial Shipping**	**Coastal Land Use & Infrastructure**	**Other Marine Uses**	**Environmental Justice**
Impact Evaluation Section Number	*4.2.1.2*	*4.2.2.2*	*4.2.3.2*	*4.2.4.2*	*4.3.1.2*	*4.3.2.2*	*4.3.3.2*	*4.3.4.2*	*4.3.5.2*	*4.3.6.2*	*4.3.7.2*	*4.4.1.2*	*4.4.2.2*	*4.4.3.2*	*4.5.2*	*4.6.1.2*	*4.6.2.2*	*4.6.3.2*	*4.6.4.2*	*4.6.5.2*	*4.6.6.2*	*4.6.7.2*	*4.6.8.2*	*4.6.9.2*
Seafloor and Land Disturbance		●	●	●	●	●	●	●	●	●	●		●	●					●	●		●		
Sediment Suspension and Deposition		●	●	●	●	●	●	●	●	●			●							●				
Noise						●	●	●	●	●	●	●				●	●		●	●				●
Electromagnetic Field						●	●	●	●											●				
Discharges and Releases		●			●	●	●	●	●	●									●	●		●		
Trash and Debris		●			●	●	●	●	●	●									●	●		●		
Traffic						●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●
Air Emissions	●																							
Visible Structures				●				●	●	●	●	●		●	●	●	●		●	●	●	●	●	●
Lighting						●	●	●	●	●	●	●			●		●		●		●	●	●	

4.1.1 Seafloor/Land Disturbance

The Project activities with the potential to adversely affect the seafloor and land during construction include installation of foundations for up to 15 WTGs and one OSS, the installation of the inter-array cables, submarine export cable, and terrestrial export cable, and the construction of the interconnection facility. During O&M, disturbance to the seafloor and land could result from the presence of infrastructure and temporarily anchored maintenance vessels. Over the life of the Project, the placement of foundations and scour protection will alter the seabed and associated habitat by replacing the existing seabed and habitat with hard structures that create a reefing effect that results in colonization by assemblages of both sessile and mobile animals. Decommissioning activities will have similar impacts to the seafloor and land as construction.

SFWF and SFEC activities that could result in potential impacts by seafloor and land disturbances were presented in Table 4.1-1 and are further described below. Resources potentially impacted by seafloor and land disturbance are identified in Table 4.1-2, and further described in Sections 4.2 through 4.6.

4.1.1.1 South Fork Wind Farm

During construction of the SFWF, seafloor disturbance will be associated with several of the following activities:

- Seafloor preparation, including clearing and/or leveling of the seafloor prior to foundation and cable installation
- Pile driving for jacket or monopile foundation types for WTG and/or OSS
- Placement of GBS as WTG and/or OSS foundations
- Dredging of ballast material for the GBS
- Placement of rock scour protection at the base of each foundation
- PLGR, submarine cable trenching, or burial for the SFWF inter-array cable
- Anchoring of vessels and equipment during construction (including the use of spuds)

SFWF design parameters were discussed in Section 3.1.2. The extent of anticipated seabed disturbance during the construction and O&M phase for each foundation type are presented in Table 3.1-1 and repeated here in Table 4.1-2. As noted above, seafloor disturbance impacts will likely occur during O&M by the presence of the bottom-founded infrastructure and maintenance vessels temporarily anchored at the WTGs. Impacts on physical, biological, cultural, and socioeconomic resources from seafloor and land disturbances are evaluated in the sections identified in Table 4.1-1.

Table 4.1-2. SFWF: Summary of Seafloor Disturbance
Maximum temporary and permanent seabed footprint for components of the SFWF

Project Component/Activity	Construction (Temporary)	Operation (Permanent)
Foundations[a, b]	Jacket: 2.3 acres Monopile: N/A GBS: N/A	Jacket: 4.3 acres Monopile: 14.6 acres GBS: 18.0 acres

Table 4.1-2. SFWF: Summary of Seafloor Disturbance
Maximum temporary and permanent seabed footprint for components of the SFWF

Project Component/Activity	Construction (Temporary)	Operation (Permanent)
Foundation cable protection	N/A	5.2 acres (2.1 ha)
Foundation ballast dredging (GBS only)	6000 short tons per WTG	N/A
Inter-array cable [c]	35.0 acres (14.1 ha)	10.09 acres (4.4 ha)
Inter-array cable protection [d]	N/A	12.5 acres (5.1 ha)
Vessel anchoring/mooring [e]	821 acres	N/A

Notes:

[a] Conservatively assumes up to 16 foundations will be installed, including 15 foundations for WTGs and 1 foundation for the OSS.

[b] In accordance with 33 CFR 323.3(c)(2), the pilings associated with the jacket foundation are not considered fill; however, in accordance with 33 CFR 322.3(b), all pilings placed on the OCS require authorization under Section 10 of the River and Harbors Act. Temporary footprint conservatively assumes the template has dimensions of 150 feet by 150 feet (45.7 m by 45.7 m) and will be used for 16 foundations. Permanent footprint includes scour protection for 16 foundations. There is no pile driving template used for monopile or GBS.

[c] Conservatively assumes the inter-array cable has a maximum length of 30 miles (48.3 km, 26.1 nm), a total permanent width of 3 feet (0.9 m), with an additional temporary width of 10.4 feet (3.2 m) for temporary seabed disturbance during installation.

[d] Additional cable protection consisting of concrete matting or rock for 300 feet (91.4 m) adjacent to each foundation for inter-array cable approach and for up to 10 percent of inter-array cable.

[e] Conservatively assumes that, during typical installation, 3 vessels will use anchors and that 3 vessels will use spud cans, and all six vessels will visit each of the 16 foundations. The vessels with anchors will have a total maximum ground disturbance of 4.51 acres (1.8 ha) per foundation and this ground-disturbing activity will happen 11 times at 16 foundations. The vessels with spud cans will have a total maximum ground disturbance of 0.15 acre (0.06 ha) per foundation and this ground-disturbing activity will happen 11 times at 16 foundations.

Seafloor Preparation

Preparation of the seafloor for the SFWF foundations and inter-array cable will generally involve a levelness check and the removal of boulders, debris, and other obstructions for the foundation installation area. The PLGR will be completed to clear the inter-array cable route of possible obstructions and debris, such as abandoned fishing nets, wires, and hawsers. Seafloor preparation is temporary, direct disturbance to the seafloor prior to construction and installation activities that will occur in the same area with a similar extent of disturbance.

Foundation Installation

Pile driving will be used to install jacket and monopile foundations to support the WTGs and OSS. Pile driving will disturb the seafloor at the point of pile penetration and the immediately adjacent area. During operations and maintenance, foundations will provide habitat that may be different from the existing seabed and that extends the entire water column. Similar bottom disturbance impacts will occur during decommissioning.

Pile-supported jacket foundations involve driving four steel piles into the seabed to support a single steel lattice superstructure for each WTG or OSS. A jacket foundation has a temporary impact footprint based on the use of a pile template with the dimensions of 150 feet by 150 feet. The template is used to align and install the four piles for each for the 16 foundations. The template is removed before the jacket is installed. Each one of the four piles supporting a jacket foundation is approximately 9 feet (2.7 m) in diameter. Each jacket foundation will result in approximately 2,180 ft^2 (202 m^2) of seafloor disturbance without scour protection and 11,835 ft^2 (1,099 m^2) if scour protection is installed around each jacket (see Table 3.1-2). Although scour is not anticipated to occur around the jacket foundation because of the relatively small diameter of the jacket piles, scour protection may be placed around the base of each jacket foundation.

Monopile foundation systems involve driving a single, large-diameter, steel monopile into the seafloor to support each WTG or OSS. A monopile foundation is approximately 36 feet (11 m) in diameter and has a footprint of 1,025 ft^2 (95 m^2). When considering the area of installed scour protection around the base of the monopile, the estimated seabed disturbance from each installed monopile foundation will be 39,765 ft^2 (3,694 m^2) (see Table 3.1-2).

Gravity Foundation Structure Foundation Placement

The GBS foundation system does not require pile driving. Seafloor disturbance associated with the GBS foundation results from seafloor preparation (including clearing, leveling, and placement of stone filter layer), placement of the GBS, dredging of GBS ballast material and finishing with scour protection. This foundation system consists of one large, pre-cast concrete, ballasted base that is placed on the seafloor for each WTG. At each foundation location, the seafloor is cleared and leveled within a 600-foot (183 m) radius, if necessary. Seafloor leveling may require some excavation. A filter layer of stones of approximately 200 feet (60 m) in diameter will be placed where the GBS structure to be placed. The GBS foundation is approximately 150 feet (46 m) diameter. The footprint of each GBS foundation is an estimated 17,675 ft^2 (1,642 m^2). Considering the addition of scour protection around the GBS base, the maximum permanent footprint of each GBS foundation is approximately 49,087 ft^2 (4,560 m^2) (Table 3.1-2).

Inter-Array Submarine Cable

Disturbance to the seafloor from inter-array cable installation results from PLGRs, mechanical and hydraulic trenching for cable burial, and travel of the self-propelled, tracked cable-laying equipment. The inter-array cable will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m) in the seabed. Where the inter-array cable emerges from the trench and is attached to the foundation, cable protection (e.g., engineered concrete mattresses) will be placed on the seabed near the WTG foundation. In addition, it is anticipated that a maximum of 10 percent of the inter-array cable (3.0 linear miles [4.8 km, 2.6 nm]) may not achieve the target burial depth if hard substrate or other unforeseen obstacles are encountered. Cable protection will be placed in areas where target burial depth is not achieved.

The design envelope parameters for the SFWF inter-array cable were defined in Table 3.1-4. Seafloor disturbance from inter-array cable installation is narrowly confined to the cable trench, the track width of the cable-laying equipment and area of cable protection. The total estimated inter-array cable trench footprint of 10.09 acres (4.4 ha). Except for approximately 12.5 acres (5.1 ha) of permanent impact to the seafloor caused by cable protection, the direct impact of trenching/cable installation is temporary. On both sides of the trench for approximately 30 miles (48.3 km) of inter-array cable laying, the cable laying equipment, with a track width of 5.2 feet (1.6 m), will move along the seafloor resulting in approximately 35.0 acres (14.1 ha) of temporary and surficial disturbance.

The depth of disturbance will be limited to the cross-section of the trench cut for cable laying. Some sediment transport is expected outside of the cable trench due to currents and is dependent on the sediment grain-size, composition, and hydro-jetting forces imposed on the sediment column, necessary to achieve desired cable burial depths. However, suspended sediments from the trench will likely settle back into the trench or in areas immediately adjacent to the trench. The potential effects on sediment resuspension and deposition are discussed in the following section.

Vessel Anchoring

Anchoring results in a range of shallow seafloor disturbances from the penetration of spuds or anchors, dragging of anchors and from the “sweeping” of anchor chains. The extent and severity of seafloor disturbances from vessel anchoring are influenced by several factors including spud/anchor size and configuration, wave and current conditions, vessel drag distances and the physical and biological characteristics of the seafloor where anchoring occurs. Post-construction seafloor surveys of the Block Island Wind Farm documented the variability of the residual impacts of construction activities in the context of benthic habitat types and the mobile or stable nature of the seafloor. Dynamic, mobile, and sandy seafloor types were observed to recover more quickly than stable seafloor types consisting of cobble and gravel (INSPIRE, 2017).

Temporary anchoring of vessels within the SFWF will occur during construction, O&M, and decommissioning for durations varying according to work activity as detailed in Section 3.1.3.1. Anticipated seabed disturbances from Project vessels were presented in Table 3.1-7. All vessel anchoring associated with the SFWF will occur within the maximum work area (MWA) (Figure 3.1.1) encompassing the WTGs and inter-array cable. During construction, jack-up or heavy lift barges, equipped with two to four spuds for positioning, will be used for WTG installation. Other vessels, including tugs, material barges and CTVs may be occasionally anchored using single or multiple anchors. Throughout inter-array cable installation, less frequent anchoring by the dynamically positioned vessel (DPV) for cable-laying is anticipated. During O&M, anchoring will be limited to vessels required to be onsite for an extended duration. Typically, CTVs are not expected to anchor when visiting the SFWF. During decommissioning, seafloor disturbances from anchoring will be similar to those expected during construction.

4.1.1.2 South Fork Export Cable

During construction of the SFEC, seafloor and land disturbance activities will be similar to those previously identified for the SFWF inter-array cable in addition to the following:

- Installation of the sea-to-shore transition consisting of a new onshore transition vault and HDD of the cable under the beach and intertidal water areas, which may also include a temporary cofferdam.
- Construction of the new interconnection facility, on land adjacent to the existing LIPA substation in East Hampton, New York
- Trenching and installation of the onshore segment of the export cable

Section 3.2 provides a discussion of the SFEC and Table 3.2-1 presents a summary of the design parameters for the SFEC – OCS, SFEC – NYS, and SFEC – Onshore. Estimated areas of seabed disturbance during construction of the SFEC are summarized in Table 4.1-3. Sea floor and land disturbance associated with decommissioning activities are expected to be similar to those associated with construction.

Table 4.1-3. Seafloor Disturbance

Maximum temporary and permanent seabed footprint for components of the SFEC

Project Component/Activity	Temporary	Permanent
SFEC – OCS submarine cable [a]	73.0 acres (29.5 ha)	21.1 acres (8.5 ha)
SFEC – OCS cable protection [b]	N/A	3.4 acres (1.4 ha)
SFEC – NYS submarine cable [a]	4.4 acres (1.7 ha)	1.3 acres (0.5 ha)
SFEC – NYS cable protection [b]	N/A	0.2 acres (0.08 ha)
SFEC – NYS sediment excavation for an offshore cofferdam for sea-to-shore transition [c]	850 yd^3 (650 m^3)	N/A

Notes:

[a] Conservatively assumes the SFEC has a total permanent width of 3 feet (0.9 m), with an additional temporary width of 10.4 feet (3.2 m) for temporary seabed disturbance during installation.

[b] Conservatively assumes additional cable protection, consisting of rock or concrete matting (8 feet long by 20 feet wide [2.4 by 6.1 m]), for up to 2 percent of the SFEC, where burial depth may be less than 4 feet (1.2 m), and for seven locations where the SFEC – OCS will cross utility crossings, each of which may need up to 180 linear feet (54.9 m) of concrete matting.

[c] Cofferdam will enclose an area that is 75 feet long by 25 feet wide to a depth of up to 12 feet (22.9 by 7.6 m to a depth of up to 3.7 m).

Seafloor Preparation

Site preparation of the seafloor along the SFEC – OCS and SFEC – NYS will be similar to the activities described for the SFWF inter-array cable in Section 3.1.3.3.

SFEC Sea-to-Shore Transition

SFEC-Offshore installation will begin at the offshore sea-to-shore transition point, which may include installation of a temporary cofferdam. The cofferdam will be fabricated of sheet pile or a pre-cast, multi-sectional gravity cell, as explained in Section 3.2.3.4. The cofferdam will enclose an area that is 75 feet long by 25 feet wide to a depth of up to 12 feet (22.9 by 7.6 m to a depth of up to 3.7 m). It will be located at least 1,750 feet (533 m) offshore from the mean high water line (MHWL) at the landing site in approximately 25 to 60 feet (7 to 18 m) of water depending on the landing site (see Figure 3.2-1). The cofferdam will occupy approximately 0.04 acres (0.02 ha) of seafloor. The area within the cofferdam or gravity cell may require the removal of sediment to facilitate the completion of the HDD process and pull back of conduit and cable.

No disturbance to the seafloor is expected between the offshore cofferdam location and the shore because the cable will be installed via HDD.

SFEC - OCS and SFEC - NYS Installation

The installation of the submarine export cable will follow similar methods described in Section 3.1.3.3 for the SFWF inter-array cable. Disturbance to the seafloor is characterized by the parameters provided in Table 4.1-4. Within the SFEC trench footprint the seafloor sediments will be fluidized and moved by the mechanical/hydro-jet plow. Once the cable is laid into the trench, the suspended sediment will settle back into the trench. Except for approximately 3.6 acres (1.5 ha) of permanent impact to the seafloor caused by anticipated cable protection, the direct impact of trenching/cable installation is temporary. On both sides of the trench for approximately 61.4 miles (98.8 km, 53.3 nm) of SFEC installation, the moving tracks, each with a maximum width of 5.2 feet (1.6 m), will move along the seafloor resulting in approximately 77.4 acres (23.3 ha) of temporary and surficial disturbance.

Table 4.1-4. SFEC Parameters: OCS and NYS Export Cable
Anticipated parameters for the export cable

Parameter	OCS	NYS
Cable diameter	8-12 inches (20 – 30.5 cm)	
Anticipated burial depth [a]	4 – 6 feet (1.2 – 1.8 m)	
Maximum trench depth	10 feet (3 m)	
Maximum permanent footprint for export cable [b]	21.1 acres (8.5 ha)	1.3 (0.53 ha)
Maximum length of export cable	57.9 miles (93.2 km)	3.5 miles (5.6 km)
Trench width	3 feet (0.9 m)	
Maximum permanent footprint for export cable protection [c]	3.4 acres (1.4 ha)	0.2 acres (0.08 ha)
Cable protection for each cable crossing [d]	3,600 ft^2 (334.5 m^2)	N/A
Additional cable protection [e]	122,285 ft^2 (11,360 m^2)	7,392 ft^2 (686.7 m^2)
Maximum temporary seabed disturbance[f]	73.0 acres (29.5 ha)	4.4 acres (1.78 ha)

[a] Burial depth is measured from the seabed to the top of the cable.

[b] Conservatively assumes the SFEC – OCS has a length of 57.9 miles (93.2 km) and the SFEC – NYS has a length of 3.5 miles (5.6 km), both of which have a total width of 3 feet (0.9 m).

[c] Conservatively assumes cable protection will be needed for up to seven cable crossings and for up to 2 percent of the export cable where burial depth may be less than 4 feet (1.2 m).

[d] Conservatively assumes additional cable protection, consisting of rock or concrete matting (8 feet long by 20 feet wide [2.4 by 6.1 m]), for up to seven existing cable systems, each of which may need up to 180 linear feet (54.9 m) of matting.

[e] Conservatively assumes additional cable protection, consisting of rock or concrete matting (8 feet long by 20 feet wide [2.4 by 6.1 m]), for up to 2 percent of the SFEC, where burial depth may be less than 4 feet (1.2 m).

[f] Conservatively assumes that cable is installed by equipment with two tracks, each of which has a maximum width of 5.2 feet (1.6 m) placed on each side of the trench, and that this equipment will be used for up to 57.9 miles (93.2 km) for the SFEC - OCS and up to 3.5 miles (5.6 km) for the SFEC - NYS.

Some sediment transport is expected outside of the cable trench and is dependent on the sediment grain-size, composition, and hydro-jetting forces imposed on the sediment column, necessary to achieve desired cable burial depths. However, suspended sediments from the trench will likely settle back into the trench or in areas immediately adjacent to the trench. The potential effects on sediment resuspension and deposition are discussed in the following section.

Vessel Anchoring

Seafloor disturbance from temporary vessel anchors during SFEC installation may occur at the sea-to-shore transition during cofferdam construction location and intermittently along the SFEC cable corridor, if the DP cable-laying vessel or other support vessels must anchor. Short-term, localized seafloor disturbance will occur from vessels anchoring during SFEC installation.

During O&M, anchoring will be limited to infrequent or emergency trips by maintenance vessels along the submarine export cable route. During decommissioning, seafloor disturbance associated with anchoring will generally be similar to that described for construction.

SFEC – Onshore Construction

Land disturbance will result from site clearance, excavation and filling associated with the construction of the onshore sea-to-shore transition, installation of the onshore cable, and construction of the interconnection facility. The construction sequence of these various activities was presented in Sections 3.2.2.2 and 3.2.2.3. Land disturbance will be localized to the immediate construction areas and limited to the duration of cable installation activities. Construction of the upland transition vault and HDD operations will temporarily impact previously disturbed areas at the seaward end of Beach Lane or parking lot of the Hither Hills State Park.

The onshore cable will be installed underground in a duct bank between the onshore transition vault and Interconnection facility. The duct bank will be located underground within public ROWs and alongside the tracks within the LIRR ROW. Multiple SFEC routes are under consideration and will result in the cable being installed in previously disturbed upland areas, avoiding sensitive resources, and upon completion, no appreciable change in land cover or imperviousness is expected. Excavation, grading and fill along the roadways and existing ROWs (for example, LIRR) may require cutting or trimming of vegetation and removal of large rocks from the construction work area to facilitate safe construction.

The SFEC – Interconnection Facility will occupy a 2.4-acre (0.97 ha) wooded parcel in a residential and commercial area in East Hampton. The footprint of the SFEC – Interconnection Facility will be up to 228 by 313 feet (69 m by 95 m), including the exterior wall, with a maximum equipment height of approximately 43 feet (12 m). Tree clearing, except for a vegetative buffer around the substation, as well as excavation, grading, and filling, will be conducted on the lease parcel to house the interconnection facility. The wooded area will be converted to an industrial use with expected changes to onsite drainage patterns that will be addressed during the environmental management and construction planning phase of the Project.

All earth disturbances from onshore construction activities will be conducted in compliance with the New York SPDES General Permit for Stormwater Discharges associated with Construction Activities and an approved Stormwater Pollution Prevention Plan (SWPPP).

4.1.2 Sediment Suspension and Deposition

Sediment suspension and deposition are naturally occurring processes in a highly dynamic oceanographic environment. On the continental shelf, tidal circulation and storm waves play important roles in the transport of sediment. Meteorological and oceanographic conditions within the SFWF and SFEC are discussed in Section 4.2.4. However, these processes are altered in areas of disturbance where construction activities occur or infrastructure is placed where it previously was not. Suspension of sediments into the water column, which is measured as turbidity, resulting from SFWF and SFEC construction, O&M, and decommissioning activities, may adversely impact water quality and marine life. Once in suspension in the water column, sediments are transported by currents, eventually settling back onto the seafloor, resulting in deposition. Deposition may adversely impact marine life by smothering or altering benthic habitats. The placement of infrastructure on the seafloor may change the local hydrodynamics of the area, causing the movement of surrounding sediment and potential undermining of foundations and submarine cables.

Changes to turbidity and deposition from Project activities depend on the nature of the activity, characteristics of the seafloor (stable or mobile), physical sediment characteristics, and hydrodynamics in the area of disturbance. SFWF and SFEC activities that could lead to sediment suspension and deposition are described below. The physical, biological, cultural, and socioeconomic resources impacted from sediment suspension and deposition are identified in Table 4.1-1.

4.1.2.1 South Fork Wind Farm

Construction

Sediment suspension and deposition resulting from bottom-disturbing construction and decommissioning activities are expected to be localized and short-term. Temporary sediment suspension and deposition within the SFWF will result from the following activities:

- Seafloor preparation
- Pile driving installation of monopile or jacket pile foundations
- Placement of GBS foundations
- Self-propelled mechanical and hydrojet plow burial of the inter-array cable
- Vessel anchoring

Decommissioning activities involving the removal of installed Project components will also result in sediment suspension and deposition, similar to construction, if similar vessels, equipment, and methods are used. Once constructed, the SFWF will result in localized changes to seafloor topography and bottom currents because of the presence of foundations and scour protection. The seafloor overlaying the buried inter-array cable is expected to return to pre-construction conditions over time and no long-term changes to sediment mobility and depositional patterns are expected.

Seafloor Preparation and Foundation Placement

Sediment suspension and deposition will be caused by bottom-disturbing activities during installation of all foundation types. The effect of these activities is expected to be localized to the activity and short-term. Any physical disturbances from seafloor clearing or leveling, placement of stone filter layers, vessel anchoring, pile driving or GBS foundation placement will cause small plumes of finer sediments to mobilize up into the water column where limited transport is anticipated. When the activity stops, the sediment suspension will abate and sediment is expected to settle out onto the seafloor.

SFWF Inter-Array Cable Installation

The installation (or removal) of the inter-array cable is the activity expected to result in the greatest amount of sediment suspension and deposition in the SFWF area. The mechanical and hydrostatic forces of the cable-laying process will result in temporary increases in sediment suspension and cause deposition in the vicinity of the inter-array cable corridors. RPS performed hydrodynamic and sediment dispersion modeling to assess potential environmental impacts from cable installation by the mechanical/hydro-jet plow. The complete Sediment Transport Analysis Report is provided as Appendix I to this COP.

The modeling for the SFWF inter-array assumed one pass of the cable-laying equipment between two WTGs within 1 day as a representative case. Model scenarios considered two seasonal tidal conditions to construct representative cases. It estimated the seabed footprint of sediment resuspension from hydro-jet plow trenching as approximately 3 feet (0.9 m) (trench surface width), and as the cable-laying equipment advances, the cable is lowered to its burial depth. The total volume of the trench between the two WTGs is estimated to be 3,063 yd^3 (2,342 m^3). Most of this material remains undisturbed at the seabed since the mechanical/hydro-jet plow does not directly excavate sediment from the trench. For modeling, it was assumed that the equipment would operate at a constant (sedimentation) production rate of 146.5 yd^3/hour (112 m^3/hour) (based on an advance rate of 220 feet/hour [67 m/hour]). The key results of the modeling relating to sedimentation and deposition from the SFWF inter-array cable installation (Appendix I) are as follows:

- The maximum predicted total suspended solids (TSS) concentration from the inter-array cable burial activities is 100 milligrams per liter (mg/L).
- Water column concentrations of 100 mg/L are predicted to extend up to 131 feet (40 m) from the source and TSS concentrations are predicted to return to ambient levels (<10 mg/L) within 0.3 hours from the conclusion of trenching.
- The maximum predicted deposition thickness is estimated to be 0.4 inch (10 mm) and limited to within 26 feet (8 m) of the burial route, covering an estimated cumulative area of 0.1 acre (0.04 ha).

Modeling results suggest that project-related sedimentation and deposition will not extend beyond the SFWF MWA and remain in federal waters. Water quality impacts will be short-term and relatively localized. Low amounts of sediment deposition will occur near the cable-laying activity.

Operations and Maintenance

During SFWF O&M, sediment suspension and deposition around the WTG foundations will be altered due to the localized changes in seafloor topography and hydrodynamics. The sediment around the WTG foundations will experience scour and backfilling subject to wave and current action with localized increases in turbidity. Potentially adverse impacts from these processes will be mitigated by installing scour protection for the monopile, jacket (if needed), and GBS foundation types. Scour protection is discussed in more detail in Section 3.1.3.2, and the impact parameters for scour protection are presented in Table 3.1-2.

4.1.2.2 South Fork Export Cable

Section 3.2.3 presented a description of the sequence of cable installation activities. Installation of the SFEC by the mechanical/hydro-jet plow, cofferdam installation, and vessel anchoring will result in sediment suspension and changes in depositional patterns along the proposed cable corridor. Decommissioning of the SFEC or removal of the submarine cable, would result in similar temporary impacts to construction phase impacts. Where the SFEC target burial depth is achieved, the seafloor is expected to return to pre-construction conditions over time and no long-term changes to sediment mobility and depositional patterns would be expected during O&M, apart from areas where armoring is required. In the rare instance that the SFEC must be visually inspected or repaired during O&M, excavation in and around the SFEC would result in short-term, localized sediment suspension and deposition.

Construction

SFEC – OCS and SFEC – NYS Cable Installation

Installation of the SFEC between the sea-to-shore transition to the OSS will be conducted using a DP cable-laying vessel and mechanical/hydro-jet plow as described for the SFWF inter-array cable. The potential for sedimentation and deposition from this activity is similar to that explained for the SFWF inter-array cable. However, the length and location of the SFEC is different than the inter-array cable and sediment transport modeling was conducted to better understand the effects of SFEC installation by mechanical/hydro-jet plow on sediments.

As further detailed in Appendix I, sediment transport analysis for the SFEC included simulation of the cable installation between the sea-to-shore transition at Beach Lane and the SFWF OSS (61 miles [98.3 km]) using a simultaneous trench and lay process. The seabed footprint of sediment resuspension from hydro-jet plow trenching is approximately 3 feet (0.9 m) (trench surface width), and as the cable-laying equipment advances, the cable is lowered to its burial depth (6 feet [1.8 m] of maximum cover). The total volume of the SFEC trench is estimated to be 214,943.4 yd^3 (164,366 m^3) although most of this material will remain undisturbed at the seabed since the mechanical and hydraulic trencher does not directly excavate sediment from the trench. For modeling, it was assumed that the equipment would operate at a constant [sedimentation] production rate of 146.5 yd^3/hour (112 m^3/hour) (based on an advance rate of 220 feet/hour (67 m/hour). The key results of the modeling relating to sedimentation and deposition from the SFEC installation are as follows:

- The sediment plume that arises during trenching is transient, and generally oscillates with the tide.
- In New York State waters, the plume is oriented in a northeast/southwest configuration, reflecting the tidal current patterns near Long Island, which are aligned with the nearshore topography. As the trencher moves into deeper waters, past Montauk, the plume assumes more of a north/south orientation.
- The highest TSS concentrations are predicted to occur in locations (Figure 26, Appendix I) where the mechanical/hydro-jet plow passes over pockets of finer sediments (e.g., between VC-217 and VC-220, and again between VC-235 and the end of the route) but concentrations above 30 mg/L otherwise remain within approximately 100 m of the source during the simulation. The cross-section view presented in Figure 37, Appendix I (bottom) suggests that peak TSS concentrations will remain near the seabed, and plumes above 10 mg/L are not predicted to extent vertically beyond 9.8 feet (3 m) of the source at any time during the simulation.
- Sedimentation (Figures 38 through 44, Appendix I) is limited to the area immediately adjacent to the burial route (typically within 328 feet [100 m]) and the pattern of deposition appears more uniform when compared with the TSS concentrations in the water column.
- The maximum predicted TSS concentration during the SFEC - NYS segment of the simulation is 578 mg/L. TSS concentrations at or above 100 mg/L are predicted to extend a maximum of 120 m from the source and TSS concentrations are predicted to remain elevated above ambient levels (greater than 10 mg/L) for 1.3 hours after the trencher passes into federal waters. Sediment deposition does not reach the level of 0.39 inch (1.0 cm) within NYS waters (that is, maximum predicted deposition thickness resulting from the SFEC - NYS is 0.39 inch [9.9 mm]).
- For the portion of the installation in federal waters (SFEC-OCS) the maximum predicted TSS concentration is 1,347 mg/L. TSS concentrations at or above 100 mg/L are predicted to extend a maximum of 1,115 feet (340 m) from the source and TSS concentrations are predicted to remain elevated above ambient levels (greater than 10 mg/L) for 1.4 hours after the conclusion of trenching. The maximum predicted deposition thickness is 0.45 inch (11.4 mm). Sedimentation at or above 0.39 inch (1.0 cm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.74 ha) of the seabed.

SFEC – Onshore Installation

Excavation, grading, filling, and construction vehicle movements associated with HDD operations, cable trenching, duct installation, laydown and staging, and interconnection facility construction during construction of the SFEC – Onshore increases the potential for soil erosion and sedimentation of local waterways by stormwater.

SFEC construction activities causing earth disturbance and the potential for soil erosion and sedimentation will be further addressed by the New York Public Service Commission's (NYPSC's) Article VII Certification and associated Environmental Management and Construction Plan (EM&CP, Construction Plan) detailing site-specific construction activities and the environmental best management practices (BMPs) to be implemented, which will be filed prior to construction. The SFEC will also be constructed in accordance with an approved SWPPP and the conditions of the SPDES General Permit for Stormwater Discharges from Construction Activity.

Operation and Maintenance

Sediment suspension and deposition may result from armoring placed over the SFEC – OCS and SFEC – NYS where target burial is not achieved or crossing of existing telecommunications cables requires armoring. The introduction of rock or engineered concrete mattresses to areas of the seafloor can cause local disruptions to circulation, currents, and natural sediment transport patterns. Under normal circumstances these segments of the SFEC are expected to remain covered as accretion of sediment covers the cable and the armoring. In nonroutine situations, these segments may be uncovered and re-burial might be required.

4.1.3 Noise

Noise is defined as unwanted sound, be it underwater or in-air (or airborne). Sound becomes an adverse impact when it interferes with the normal habits or activities of fish, wildlife or people. Recognition or perception of sound as noise, however is very subjective and circumstantial based on the receptor's experience as well as the characteristics of sound (DOI-MMS, 2007). The reception or perception of sound depends on many factors including the sound source (power level), frequency, distance between source and reception (sound pressure level [SPL]), receptor's hearing capability and physiology, and a suite of environmental factors including media (air, water, sediment), temperature, barriers, and other sounds. In this section, sources of noise from Project activities are identified and discussed as potential IPFs.

Noises generated by the SFWF and SFEC will transmit through the water and/or air. Underwater noises are those noises that transmit through the water column as the result of working engines or machines below the surface of the water (for example, vessel propeller or thruster) or noise transmitted through an underwater structure as waves of energy that propagate sound throughout the water column (for example, spinning WTG, impact or vibratory pile driving). In-air noises refer to those noises that are generated above the surface of the water and transmit through the atmosphere. For some activities, both in-air and underwater noises will be generated. During impact or vibratory pile driving, the pile driving hammer impacts the top of the steel pile generating sound waves through the air above the water and down through the water column. Noise-emitting activity and equipment abovedeck on work vessels can also generate sound both above and below the water in a similar way.

SFWF and SFEC activities that are expected to generate noise are presented in Table 4-1. The primary sources of noise associated with the SFWF and SFEC will occur during construction. Decommissioning may result in similar noise generation if it involves the removal of Project components with comparable equipment and methods as construction. Operational noises will result from the operation of the WTG (SFWF) and the interconnection facility (SFEC) with occasional vessel and vehicle noise produced from routine maintenance activities. Most of the construction noises will be underwater: vessel noise, including DPV thrusters; impact pile driving; vibratory hammer pile driving; and, mechanical/hydro-jet plow for cable laying. However, general construction, including HDD operations and port activity, as well as pile driving will generate in-air noise.

Three studies were conducted to evaluate project-related noise in support of this COP. Appendix J contains the three acoustic assessments: 1) Evaluation of Potential In-air Noise Impacts for the SFWF and SFEC; 2) Underwater Acoustic Modeling of Construction Noise; and 3) SFWF and SFEC Onshore Sound Study. Summary-level information from the results of these studies is included in this discussion of noise as an IPF. Also, the results of the acoustics assessments provide the basis for the evaluations of potential impacts on biological and socioeconomic resources in the affected environment presented in Sections 4.3 and 4.6.

4.1.3.1 South Fork Wind Farm

Underwater and in-air sound will be generated during SFWF construction and decommissioning by pile-driving, power equipment used to install the WTGs (for example, cranes, compressors) and inter-array cables, and the movement of vessels, including DPVs. Construction vehicles and equipment will generate noise at ports used for construction staging. Possible O&M noises will result from the rotors of operational turbines, vessels, and infrequently from O&M activities onshore. The different sound-generating activities are further described and assessed below.

Vessel Noise

Ship traffic is widely recognized as the leading contributor of noise to the ocean environment and varies depending on several factors related to vessel size, load, draft, propeller size, and mission or activity (DOI-MMS, 2007). Vessel noise is the also seen as the main contributor to ambient ocean noise in the low-frequency (LF) band that is audible by marine life (NRC, 2003; Hildebrand, 2009). A large portion of the noise from vessel traffic comes from engines and propeller cavitation, and those noises predominately occupy the LF spectral bands (Richardson et al., 1995). In the open water, vessel traffic can influence ambient background noise at distances of thousands of kilometers; however, the effects of vessel traffic noise in shelf and coastal waters are variable due to sound reflection, refraction, and absorption by the bathymetric and geological characteristics of the area.

During SFWF construction and decommissioning, the operation of vessels will transmit sound through both water and air. The vessels will be used to ferry workers and transport materials to offshore construction sites, lay inter-array cables, and provide work platforms for construction. Underwater vessel noise will result from turning propellers or DP thrusters; engine and other vessel noises being projected though vessel hulls; and the interactions of waves with the vessel's hull. Construction vessel noises are expected to be produced within the SFWF during installation and assembly of foundations, WTGs, OSS, and inter-array cable. Otherwise, noise from vessel movements will occur primarily at the beginning or end of each construction day, between Project ports, and whenever vessels move to or from the construction site transporting crews or equipment. During SFWF O&M, vessel noise will result from routine trips to the wind farm or in cases of emergency. Vessel noise during decommissioning is expected to be similar to construction vessel noise if the SFWF is removed using comparable vessels, equipment, and methods. Apart from the DPVs used to install the inter-array cable, project-related construction, O&M, and decommissioning vessels are not expected to contribute significantly to the underwater or in-air noise from regular vessel traffic present in the waters in and around the SFWF and the port areas to be utilized by the Project.

The underwater noise from the cavitation on the propeller blades of the DPV thrusters is considered the dominant IPF of all the project-related vessel noises. DPV thrusters are known to generate significant underwater noise with continuous source levels ranging from 150 to 180 decibels (dB) referenced to (re) 1 micropascal (μPa) at 1 m (BOEM, 2013; Matthews, 2012). The predictive noise modeling conducted by JASCO Applied Sciences (JASCO) demonstrates representative sound propagation from DPVs completing cable-laying activities for the SFWF inter-array cable and the SFEC (Appendix J). The DPV thrusters generate nonimpulsive sound with the distance to unweighted SPLs (L_p) from the DP ranged from 164 feet (50 m) to the 166 dB isopleth, to greater than 8.7 miles (14 km) to the 120 dB isopleth. The implications of DP thruster propagation in terms of impacts to marine mammals, sea turtles, and finfish are discussed in Sections 4.3.3, Section 4.3.4, Section 4.3.5, and Appendix P.

Inter-Array Cable Installation Sound

SFWF inter-array cable installation will be completed using the mechanical/hydro-jet plow. The plow is expected to generate sound underwater as it progresses along the seafloor but not above the water's surface. The sound from the plow is predominantly from the high-pressure water jetted into the seafloor from the mechanical/hydro-jet plow to create a trench for the cable to lay into. This underwater hydraulic sound is expected to be masked by DPV thrusters that will be operating at the same time. Therefore, the mechanical/hydro-jet plow is not considered the source of a noise IPF.

Aircraft Noise

Helicopters may be used to a limited extent for emergency transport between the SFWF and onshore landing locations and will not generate a noise IPF. As discussed in Appendix J, sound levels from helicopters flying back and forth to the SFWF are not expected to last for extended periods of time at points other than existing helipads or to reach levels of potential impact to wildlife or people.

General Construction Noise – Ports and other Onshore Facilities

During construction of the SFWF, heavy equipment, vehicles, and power tools will be used to support fabrication, installation, and maintenance activities. It is expected that most, if not all, of these activities will occur at existing ports in Connecticut, Massachusetts, New York and/or Rhode Island where there will be other ongoing industrial activities, independent of the SFWF. Construction sounds specifically related to SFWF activities at existing port facilities are expected to be similar to operational sounds associated with routine activities at these existing ports and therefore, are not considered a noise IPF.

Pile Driving Noise

In-air and underwater noise will result from the use of impact pile drivers to install the SFWF monopile or jacket foundations. Pile driving sound levels vary with pile size (diameter and wall thickness), subsurface/ geotechnical characteristics, hammer energy and type of pile driver. Pile driving sounds propagate both above and below the sea surface although sound transmission is different in water than in air making it difficult to compare airborne and underwater sound levels.

Impact pile-drivers typically utilize a weight (sometimes referred to as a piston or hammer) to impact the top of a pile to force it into the seafloor. The repetitive hammer blows drive the pile into the seafloor, similar to hammering a nail into a piece of wood. Piles are driven until the desired resistance is achieved (typically measured in blow counts per foot or inch) or the pile fails to advance (known as refusal). The primary sources of noise associated with impact driving are the impact of the hammer on the pile/drive cap and the noise radiated from the pile.

In-Air Noise from Pile driving

Driving of monopiles or jacket piles will generate in-air impulse sounds as the hammer strikes the pile. This sound source will only last as long as the duration of pile driving and take place exclusively offshore within the SFWF work area. In-air noise is expected to reach 94 A-weighted decibels (dBA) at 50 feet from the source to 60 dBA at 2,400 feet from the source (Appendix J). No pile driving noise from the SFWF is expected to reach the shore.

Underwater Noise from Pile driving

Underwater noise from pile driving is considered an important IPF because of its potential impacts on marine life such marine mammals, sea turtles, and certain finfish. To define underwater impulsive sounds from pile driving, an acoustic modeling study was completed by JASCO and is presented in Appendix J. JASCO used its acoustic propagation model, Full Waveform Range-dependent Acoustic Model (FWRAM) to predict the propagation of underwater sound. The sound propagation modeling incorporates site-specific environmental data that describes the bathymetry, sound speed in the water column, and seabed geoacoustics in the SFWF. Two locations were selected within the SFWF to model representative sound fields associated with potential monopile or jacket foundation pile driving. DWSF also supplied the following information for the model: pile-driving equipment, pile specifications, pile-driving schedules, soft start procedures, and noise attenuation technologies.

Modeling estimated the distances of impulse sound propagation to certain acoustic thresholds as published by federal and state agencies for marine mammals, sea turtles and finfish. These distances are used to define this particular IPF so the impact evaluations could be completed. These evaluations are presented in Sections 4.3.3, Section 4.3.4, Section 4.3.5, and Appendix P.

4.1.3.2 South Fork Export Cable

The potential for noise to be generated during construction or decommissioning of the SFEC is the result of vessel use, including the DPV for cable installation; aircraft use; sheet pile cofferdam installation by vibratory hammer; installation of the SFEC – Onshore; and construction of the SFEC - Interconnection Facility. During SFEC O&M, there will be no underwater noise. Only the OSS is expected to generate in-air sound.

Vessel Noise

Vessel noise, both underwater and in-air, during construction, O&M, and decommissioning of the SFEC is expected to similar the vessel noise described for the SFWF above. As is expected to be the case with the installation of the SFWF inter-array cable, the DPV thrusters will be the dominant underwater sound source during SFEC construction and decommissioning. Unlike the installation of the SFWF inter-array cable that will occur within the offshore SFWF work area, DPV operations performing SFEC installation will occur over approximately 50 to 60 miles (80.5 to 96.6 km) from the SFWF to the sea-to-shore transition point just off the shore (approximately 2,100 feet [640 m]) of Long Island.

Submarine Cable Installation Sound

As described for the installation of the SFWF inter-array cable by mechanical/hydro-jet plow, SFEC cable installation is not expected to generate impact-producing sound beyond that described above for the DPV thruster.

Aircraft Noise

Aircraft noise from nonroutine helicopter use is expected to generally be the same as discussed for SFWF above.

General Construction Noise – Ports and other Onshore Facilities

During the construction of the SFEC, vehicle, vessel, and equipment sounds associated with staging and support activities at existing ports are similar to those described for the SFWF above.

Offshore Cofferdam Installation

As described in Section 3.2.3.4, a temporary cofferdam may be located approximately 1,700 feet (518 m) offshore from the MHWL at the potential landing site (Beach Lane or Hither Hills) to facilitate cable pull-in at the sea-to-shore transition. The cofferdam will be sited at a location with approximately 25 to 60 feet (7 to 18 m) of water depth. The cofferdam will be installed using either sheet pile or gravity cell.

If the temporary cofferdam is constructed of steel sheet pile, vibratory hammer pile driving will be used for installation and removal. Vibratory hammering, which is a nonimpulsive (or continuous) sound source, differs from the impact hammering, which is an impulsive sound source, in several ways. The propagation characteristics of the vibratory hammering differ from the impact hammering because the location is close to shore and the duration of the installation is estimated to be short (roughly 12 to 24 hours). The threshold criteria for vibratory hammering also differs from the impact hammering being used for SFWF foundation installation.

The distance from shore and the likelihood the sound will be masked by ambient sounds or other construction noises diminish the circumstances that people will be exposed to disturbing noise. The in-air noise evaluation in Appendix J estimated cofferdam installation noise levels at 62 dBA at the shoreline, which is within both applicable state and local noise standards.[3]

Underwater continuous or nonimpulsive sound from cofferdam installation is expected to propagate over considerable distances and is a concern with respect to potential noise-related impacts on marine life. JASCO included vibratory hammer sound predictions in its underwater acoustic modeling study presented in Appendix J. Modeling estimated the distances of nonimpulse sound propagation to certain acoustic thresholds as published by federal and state agencies for marine mammals, sea turtles and finfish. These evaluations are presented in Sections 4.3.3, 4.3.4, and 4.3.5, and Appendix P.

SFEC - Onshore Installation Noise

Construction activities would introduce temporary noise sources associated with the different phases of SFEC - Onshore installation. The following summarizes the different phases of construction:

- An HDD rig, mud pump, crane, generator, backhoe, and other HDD installation activities are expected to take approximately 10 to 12 weeks and would HDD activities would be completed outside the summer season. Construction at the sea-to-shore transition site would also include site preparation and excavation for the vault.
- The SFEC – Onshore cable route begins at the sea-to-shore transition vault and would run to the SFEC – Interconnection Facility at Cove Hollow Road. A duct bank would be located underground along public road ROWs and the LIRR ROW and would not include any

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[3] *See* Section 3 – Regulatory Context of the SFEC Sound Study (VHB 2018) in Appendix J for applicable noise standards.

overhead lines before arriving at the SFEC – Interconnection Facility. Wherever possible, the SFEC - Onshore route would be located within the existing paved section of the road ROW. Underground cable construction typically includes concrete saws, jackhammers, or hoe rams to remove existing pavement and small backhoes, trenchers, and dump trucks to install the cable and replace the paved surface. SFEC - Onshore cable installation is expected to take approximately 9 to 12 months and would occur during daytime hours.

- Construction of the SFEC – Interconnection Facility would take approximately 6 to 9 months and would occur during daytime hours. Substation construction would include the following activities:
  - Site preparation, excavation, and grading (this is typically the loudest phase of substation construction)
  - Construction of foundations for the control building, transformer, reactors, and switchgear
  - Construction of electrical grounding, duct banks, and underground conduits
  - Installation of appropriate drainage systems and station service including electrical and water
  - Installation of all above ground structures including transformer, switchgear, and cable systems

VHB (2018) modeled construction noise for the SFEC - Onshore components listed above using standard methods for energy and transmission line projects in a manner that is consistent with federal guidelines (Appendix J). The construction noise model accounts for the types of construction equipment, the number of each type of equipment, the amount of time they typically operate during a work period (usage factor), and the distance between receptor locations and the equipment. For typical daytime construction activities, construction noise is evaluated according to the 8-hour energy-average L_{eq}(8h). For construction activities that may occur continuously, such as HDD, construction noise is evaluated according to the 24-hour energy-average L_{eq}(24h).

Noise emissions of construction equipment is based on reference data from the Federal Highway Administration's (FHWA's) Roadway Construction Noise Model (RCNM) and other project-specific equipment specifications. RCNM includes a database of sound emissions for commonly used construction equipment such as dump trucks, backhoes, concrete saws, air compressors, and portable generators.

For stationary construction, including HDD and construction at the SFEC – Interconnection Facility, Cadna-A has been used to predict sound at nearby receptor locations. The model includes specific locations of the equipment, heights of the construction noise sources, terrain, and location and height of intervening objects such as sound walls surrounding the HDD site. The model provides construction sound level contours from the sites. For construction of the SFEC - Onshore, which moves linearly along public road ROWs and the LIRR ROW, the FHWA RCNM model is used to predict construction noise levels. The model provides sound level versus distance results (Table 4.1-5).

Table 4.1-5. Construction Equipment Noise Emissions

Construction Activity	Construction Equipment	Sound Level (dBA)	Utilization Factor
SFEC - Onshore Construction in Roadway or Railway	Dump Truck[a]	76 dBA at 50 feet	40%
	Backhoe[a]	78 dBA at 50 feet	40%
	Jackhammer, Hoe Ram, or Concrete Saw [a]	90 dBA at 50 feet	20%
	Generator (75 kW)[b]	56 dBA at 50 feet	40%
SFEC – Interconnection Facility Construction	Crane[a]	76 dBA at 50 feet	10%
	Backhoe[a]	78 dBA at 50 feet	40%
	Dump Truck[a]	76 dBA at 50 feet	40%
HDD On-Shore Entry/Exit Site	HDD Rig[c]	70 dBA Sound Power	100%
	Mud pump[d]	67 dBA Sound Power	50%
	Crane [a]	76 dBA at 50 feet	10%
	Generator (75 kW)[b]	56 dBA at 50 feet	40%
	Backhoe [a]	78 dBA at 50 feet	40%

Sources:

[a] FHWA, 2011.
[b] Whisper Watt Ultra Silent 75 kW Generator.
[c] Vermeer, Caterpillar
[d] eNoise Control Case Study (Sound Power Level, 98 dBA).

SFEC – Interconnection Facility Noise

Operation of the SFEC – Interconnection Facility would introduce new sources of noise (Appendix J includes site-specific noise-modeling). The SFEC – Interconnection Facility is assumed to include: One main power and one dynamic volt-amperes-reactive (DVAR) transformer rated for 650 kV Basic Insulation Level (BIL) and 108 mega-volt-amperes (MVA); two oil-cooled reactors rated for 35 mega-volt-amperes-reactive (MVAr); and, one control house with exterior HVAC equipment. Based on the results of the modeling:

- Sound from the SFEC – Interconnection Facility is modelled to be 37 dBA at the closest receptor property line location. At all other receptor locations, sound from the SFEC – Interconnection Facility would be 35 dBA or lower.
- Nighttime ambient sound measures near the substation site indicate that existing ambient nighttime sound levels range from 37.3 to 42.2 dBA (L_{eq}). Sound from the SFEC – Interconnection Facility is modelled to be below existing nighttime ambient sound levels at all receptor locations. The greatest increase in future noise would be 2.6 dBA at the closet receptor property line location. At all other receptor locations, future sound levels would increase 2 dB or less. Future increases in sound of less than 3 dBA is typically below the threshold of perception.

For additional data on the measured ambient sound levels and predictive operational sounds from the SFEC – Interconnection Facility, please see Tables 10 and 11 in Appendix J.

4.1.4 Electromagnetic Field

4.1.4.1 SFWF Inter-Array Cable and SFEC

Operations

EMF are physical fields produced by electrically charged objects. Like all wiring and equipment connected to the electrical system, the electric and magnetic fields (EMF) surrounding cables such as the SFWF inter-array and the SFEC, will oscillate with a frequency of 60 Hertz (Hz). The magnetic field results from the flow of electricity along the cable and the magnetic flux density is reported in units of milligauss (mG), where 1 Gauss (G) = 1,000 mG. The magnetic field will be strongest at the surface of the cable and will decrease rapidly with distance from the cables. An electric field is created by the voltage applied to the conductors within the cable, but this electric field is totally shielded from the marine environment by grounded metallic sheaths and steel armoring around the cable. However, the oscillating nature of the 60-Hz magnetic field will induce a weak electric field around the cable that, similar to the magnetic field, will vary in strength based on the flow of electricity along the cable. The electric field is measured in units of millivolts/meter (mV/m).

Two assessments of electric and magnetic fields were conducted in support of the Project by Exponent. Appendix K contains the offshore and onshore EMF assessments that examined the potential for EMF generation from the SFWF inter-array cable and the SFEC offshore segments and SFEC – Onshore, respectively. The modeling of magnetic field and induced electric fields at the Project site was used in the analysis of the available scientific literature on the sensitivity of marine species to EMF. Resources potentially impacted by SFWF and SFEC EMF are identified in Table 4.1-1, and further described in Sections 4.2 through 4.6. The key findings from the offshore and onshore EMF reports (Exponent, 2018a, b) are provided as follows:

- Offshore, modeling results under winter normal conductor (WNC) conditions confirm that the maximum magnetic fields at 3.3 feet (1 m) above the seabed are below 200 mG everywhere along the offshore portion of the Project.
- Calculated magnetic-field levels for offshore are further found to be below reported thresholds for effects on the behavior of magnetosensitive fish, and calculated induced electric-field levels are found to be below reported detection thresholds of local electrosensitive fish.
- Onshore, the proposed cables were modeled for line loadings equal to the WNC ratings as well as the maximum assumed output of the SFWF turbines. Modeling results under WNC conditions show that the maximum magnetic field ±50 feet from the duct bank centerline in all portions of the route are below 200 mG for the proposed configurations of the transmission lines.
- The electric field from the underground and submarine transmission cables is blocked by the cable armoring as well as the earth and therefore will not be a direct source of any electric field outside the cables.

4.1.5 Discharges and Releases

Discharges and releases of liquids and solid waste to the ocean or land pose a threat to water quality and risks to marine life from exposure, ingestion, or entanglement. Routine or accidental (non-routine) fuel spills, wastewater discharges and solid waste releases associated with SFWF and SFEC activities are possible but considered unlikely during normal construction, O&M, and decommissioning activities.

4.1.5.1 South Fork Wind Farm

Construction and Decommissioning

Routine Discharges and Disposal

The greatest volume of vessel traffic and overall project-related activity will occur during the construction phase (of both the SFWF and SFEC). Routine discharges of wastewater (e.g., gray water or black water) or liquids (e.g., ballast, bilge, deck drainage, stormwater) outside of state waters may occur from vessels, WTGs, or the OSS during construction and decommissioning; however, those discharges and releases are anticipated to have negligible impacts because all vessel waste will be offloaded, stored, and disposed of in accordance with all applicable local, state and federal regulations, such as the EPA and USCG requirements for discharges and releases to surface waters. In addition, compliance with applicable project-specific management practices and requirements will minimize the potential for adversely impacting water quality and marine life.

In accordance with the Oil Pollution Act of 1990 (OPA-90) and the MARPOL 73/78 international treaty, owners and operators of certain vessels are required to prepare Vessel Response Plans (VRP) approved by the USCG. In additional, the USCG regulates the at-sea discharges of vessel-generated waste under the authority of the Act to Prevent Pollution from Ships. All Project vessels will be required to comply with the applicable USCG pollution prevention requirements. Additionally, all vessels less than 79 feet (24.1 m) will comply with the Small Vessel General Permit issued by EPA on September 10, 2014 for compliance with National Pollutant Discharge Elimination System (NPDES) permitting.

Accidental or Non-Routine Spills or Releases

During construction and decommissioning, there is increased probability of spills and accidental releases of fuels, lubricants, and hydraulic fluids. BMPs for fueling and power equipment servicing greatly minimizes the potential for spills and accidental releases and will be incorporated into the SFWF and SFEC Oil Spill Response Plan (OSRP; Appendix D). Accidental releases are minimized by containment and clean-up measures detailed in the OSRP.

During all SFWF phases, certain hazardous materials necessary to support the installation of the WTGs will be transported to and from the SFWF and ports, including the SFWF O&M facility. The transport of this material may result in the accidental discharges of small volumes of hazardous materials, such as oil, solvents, or electrical fluids. The OSS will have transformers that contain large reservoirs of electrical insulating oil (such as mineral oil), as well as smaller amounts of additional fluids, such as diesel fuel and lubricating oil. Per the information requirements outlined in 30 CFR 585.626, a list of solid and liquid wastes generated, including disposal methods and locations, as well as federally regulated chemical products, is found in Appendix F. SFWF and SFEC activities that could result in potential discharges and releases are presented in Table 4.1-1, and are further described below. Resources potentially impacted by discharges and releases are identified in Table 4.1-1, and further described in Sections 4.2 through 4.6.

Operation and Maintenance

The WTGs will be designed to contain any potential leakage of fluids, thereby preventing the discharge fluids into the ocean. During WTG maintenance, small leaks could occur during servicing of hydraulic units or gearboxes. During WTG operation, small accidental leaks could occur because of broken hoses, pipes, or fasteners. Any accidental leaks within the WTGs are expected to be contained within the hub and main bed frame or tower. During operations, the only discharges to the sea that are anticipated are those associated with vessels performing maintenance. BMPs for fueling and power equipment servicing greatly minimizes the potential for spills and accidental releases. Accidental releases are minimized by containment and clean-up measures detailed in the OSRP (Appendix D).

4.1.5.2 South Fork Export Cable

Discharges and releases of liquids and solid waste to the ocean or land from SFEC construction, O&M, and decommissioning is similar to those described for the SFWF. The SFEC is a solid dielectric cable and is not liquid filled so there is no risk of cable rupture and release. Vessels used during SFEC construction or decommissioning will also comply with applicable local, state, and federal regulations and project-specific plans and procedures. The potential for discharges and releases from SFEC - Onshore construction will be governed by New York State regulations and the Project’s Construction Plan. O&M of the SFEC – Interconnection Facility represents low potential for discharges and releases during routine operations.

The sea-to-shore transition, which include an HDD of the cable under the beach and intertidal water areas, will require the use of HDD drilling fluid, which typically consists of a water and bentonite mud mixture or another non-toxic drilling fluid. Bentonite is a natural clay that is mined from the earth, and similar to the clay minerals that are present in the drilling location. While the mixture is not considered toxic, if released, DWSF will implement BMPs during construction to minimize potential release for a frac-out of the drilling fluid associated with HDD activities.

4.1.6 Trash and Debris

Solid wastes and construction debris will be generated predominantly during construction and decommissioning of the SFWF and SFEC. Per the information requirements outlined in 30 CFR 585.626, a list of solid and liquid wastes generated, including disposal methods and locations is presented in Appendix F. The discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.300) and the USCG (MARPOL, Annex V, Pub. L. 100−220 [101 Stat. 1458]). The SFWF and SFEC activities that could result in the generation of trash and debris are presented in Table 4-1 and are further described below. Resources potentially affected by discharges and releases are identified are identified in Table 4.1-1, and further described in Sections 4.2 through 4.6.

Construction and Decommissioning

It is anticipated that comprehensive measures, in accordance with applicable federal, state, and local laws, will be implemented prior to and during SFWF and SFEC construction to avoid, minimize, and mitigate impacts related to trash and debris disposal. Offshore, trash and debris will be contained on vessels and offloaded at port/construction staging areas. Material that has been shredded and can pass through a 25-millimeter (mm) mesh screen may be disposed according to 33 CFR 151.51-77. All other trash and debris returned to shore will be disposed of or recycled at licensed waste management and/or recycling facilities. Disposal of any solid waste or debris in the water will be prohibited. Good housekeeping practices will be implemented to minimize trash and debris in the SFWF and SFEC work areas, offshore and onshore.

Operations and Maintenance

During operation of the SFWF and SFEC, the generation of trash and debris is likely to be limited. The overall quantity of trash and debris is likely to be small because most maintenance activities are unlikely to produce much of this type of material. The nominal amounts of trash and debris generated by maintenance activities will be managed in accordance with federal, state, and local laws and not disposed of at sea or on land.

4.1.7 Traffic (Vessels, Vehicles, and Aircraft)

Anticipated traffic related to the SFWF and SFEC will include water vessels, onshore vehicles, and helicopters. An overview of anticipated vessel usage is provided in Table 3.1-6. SFWF and SFEC activities that could result in potential impacts by traffic (vessels, vehicles, and aircraft) are presented in Table 4-1 and are further described below. Impacts to physical, biological, cultural, and socioeconomic resources from project-related traffic are evaluated in the sections identified in Table 4.1-1. The impacts of traffic on marine navigation are evaluated in Section 4.6.6, Commercial Shipping; Section 4.6.8, Other Marine Uses; and Appendix X, Navigational Risk Assessment.

4.1.7.1 South Fork Wind Farm

Marine Vessel Traffic

A temporary increase in vessel traffic will occur during construction of the SFWF. Vessel traffic will occur at the SFWF and along routes between SFWF and the ports used to support Project construction, O&M, and decommissioning. Timing of vessel traffic will be clarified once final construction schedules are issued and approved. The amount of time vessels will transit back and forth to SFWF and how long they will remain on station varies according to foundation type and is greatly dependent on final design factors, weather, sea conditions, and other natural factors. The larger installation vessels, like the floating/jack-up crane barge and DP cable-laying vessel, will generally travel to and out of the construction area at the beginning and end of the SFWF construction and not on a regular basis. Tugs and barges transporting construction equipment and materials will make more frequent trips while smaller support vessels carrying supplies and crew may travel to the SFWF daily. However, construction crews responsible for assembling the WTGs will hotel onboard installation vessels at sea thus, limiting the number of crew vessel transits expected during SFWF installation.

During SFWF O&M, vessel traffic will be limited to routine maintenance visits and nonroutine maintenance, as needed. Limited crew and supply runs using smaller support vessels will be required. Marine vessel traffic impacts during SFWF O&M will be based on the moderate size of the maintenance vessel and the number of vessel trips. Impacts are more fully evaluated in the navigation assessment in Section 4.6.6, Commercial Shipping, Section 4.6.8, Other Marine Uses, and Appendix X, Navigational Risk Assessment.

Vehicular Traffic

Vehicular traffic during SFWF construction will include truck and automobile traffic over existing roads and highways to support various activities on land and at sea. The majority of vehicular traffic will be within and around the potential ports identified to support SFWF construction. It is expected that the greater proportion of SFWF components will be transported by sea; however, some components and equipment will arrive by land at varying frequencies throughout the construction period. Project-related deliveries will result in loading and unloading traffic as well as vehicle movements to complete assembly, fabrication, and staging of SFWF components and equipment. Vehicular traffic volumes and frequencies associated with the SFWF are not expected to have a measurable impact on traffic in and around the selected port facilities.

Aircraft Traffic

Anticipated aircraft traffic includes only infrequent, emergency helicopter trips to and from the SFWF during construction, O&M, and decommissioning. Estimated helicopter use for the SFWF is 24 hours per year. A winch deck for emergency evacuation is proposed as part of the OSS platform. Based on the very low anticipated frequency of aircraft traffic, the impact of air traffic is expected to be minimal for both the SFWF and SFEC during construction, O&M, and decommissioning.

4.1.7.2 South Fork Export Cable

Marine Vessel Traffic

Construction of the SFEC will require various vessel types including a DP cable-laying vessel, tugs, barges, and work and transport vessels. Cable installation will begin at the offshore site of the sea-to-shore transition point and proceed to the SFWF OSS. A comparable level of vessel activity is expected during decommissioning. During O&M, very limited vessel usage is expected for survey vessels and small maintenance vessels tasked with investigating any reported problems.

Vehicular Traffic

During SFEC installation, the transport of materials, personnel, and equipment in and out of the ports where staging, assembly, and fabrication take place will result in temporary increases in traffic along nearby roadways. During SFEC – Onshore installation, construction vehicles, including site worker vehicles, will result in temporary (mostly daytime) increases in traffic within the relatively dense, residential areas of East Hampton, New York. Vehicular traffic attributed to the SFEC will occur over a relatively short period and include heavy equipment (for example, excavators, dump trucks, and paving equipment) for onshore cable installation and interconnection facility construction.

Onshore construction activities will abide by local construction ordinances and occur primarily during normal daylight hours except for certain activities associated with cable installation at the landing sites. The increase in any construction traffic in East Hampton, New York would be comparable to typical roadway or utility construction work. New York State Law requires that the SFEC - Onshore be constructed in compliance with a detailed plan that includes traffic and other control measures.

During O&M, vehicle traffic will be limited to the anticipated use of a pickup truck making routine visits to the Interconnection Facility and occasional operational emergency visits. These limited additional trips are not expected to contribute to local traffic in any way.

Aircraft Traffic

Similar to anticipated aircraft traffic from the SFWF, helicopter usage associated with the SFEC would be primarily during the construction or decommissioning phase and during emergencies. It is estimated that a helicopter will be used 24 hours per year during SFEC construction.

4.1.8 Air Emissions

Air emissions associated with construction, O&M, and decommissioning of the SFWF and SFEC depend on many factors, such as location, scope, type, and capacity of equipment; and schedule. Primary emission sources associated with the SFWF and SFEC will be from engine exhaust of marine vessel traffic, heavy equipment, and onshore vehicles during construction (Table 3.1-6). In general, most criteria pollutant emissions will be from internal combustion engines burning diesel fuel and will include primarily nitrogen oxides (NO_x) and carbon monoxide (CO), lesser amounts of volatile organic compounds (VOCs) and particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) – mostly in the form of particulate matter less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$), and negligible amounts of sulfur oxides (SO_x). Project air emissions are subject to the regulations summarized in Section 4.2.1.

SFWF and SFEC activities that could result in air emissions are presented in Table 4-1 and are further described below. Resources potentially impacted by air emissions are identified in Table 4.1-1, and further described in Section 4.2.1.4. In addition, an inventory of project-related air emissions is provided as Appendix L to this COP.

4.1.8.1 South Fork Wind Farm

SFWF construction, O&M and decommissioning activities will rely on combustion engines to transport crew, equipment, and materials. These project-related emission sources will be located offshore and onshore during all Project phases. Primary SFWF emissions sources include the vessels and vehicles included in Table 3.1-6. In addition, general and specialized construction equipment, utilized offshore on vessels and work platforms and onshore at regional ports, have the potential to emit pollutants during SFWF construction. These emission sources are included in the emissions inventory found in Appendix L.

SFWF construction vessels will transit between onshore support/staging facilities at ports located in Connecticut, Massachusetts, New York, and Rhode Island and the SFWF work area. Most of these vessels and onboard construction equipment will utilize diesel engines burning low sulfur fuel while some larger construction vessels may use bunker fuel. SFWF O&M activities will likely consist of small vessels transiting to and from the SFWF to service the WTGs or the OSS over the 25- to 30-year operational life of the SFWF. The estimated duration of usage for vessels is also provided in Appendix L.

4.1.8.2 South Fork Export Cable

Primary SFEC emissions sources include the vessels and vehicles included in Table 3.1-6 and further assessed in Appendix L. The SFEC – OCS and SFEC – NYS will mainly involve the DP cable-laying vessel and support vessels. The remainder of the vessels will be similar to, but fewer than, the vessels used during SFWF construction. Also, like the SFWF, construction staging and laydown for offshore construction will occur at port facilities in Connecticut, Massachusetts, New York, or Rhode Island.

Construction of the SFEC - Onshore will include an increase in construction equipment and vehicles, that are expected to emit (or have the potential to emit) air pollutants. Construction activities that will utilize primarily diesel-powered equipment include HDD operations, trenching/duct bank construction, and cable pulling and termination. In addition, a localized increase in fugitive dust may result during onshore construction activities. Any fugitive dust generated during construction of the SFEC - Onshore will be managed in accordance with the Project’s Construction Plan.

4.1.9 Visible Structures

The SFWF and SFEC components that will be permanently visible and occupy space underwater, above water and on land have the potential to impact resources. Vessels, vehicles, and equipment used during SFWF and SFEC construction will be visible for a limited time and only from certain locations on the OCS, Long Island, and the ports to be used during construction. The temporary nature of these source during construction have such a negligible anticipated impact on resources that they are not considered further in this discussion. Once the Project is constructed, the visible structures will be the WTGs and the SFEC – OSS.

SFWF and SFEC activities resulting in visible structures are presented in Table 4-1 and are further described below. Resources potentially impacted by visible structures are identified in Table 4.1-1, and further described in Sections 4.2 through 4.6. Impacts to visual resources and viewsheds are summarized in Section 4.5, Visual Resources and analyzed in Appendix U, Visual Assessment Report – Substation and Appendix V, Visual Impact Assessment Report - Offshore.

4.1.9.1 South Fork Wind Farm

During the O&M phase, the WTGs will occupy space in the ocean and above the water's surface. The WTG specifications, as they define the current SFWF design envelope, are discussed in Section 3.1.2.2.

The WTGs will be visible from points on land and water and the degree of visibility is dependent on a range of physical factors including elevation, weather conditions, sea state, and visual obstructions. Visual quality and significance of impact depends on the existing visual landscape and viewer groups, as discussed in Section 4.5 and associated appendices. Upon decommissioning, the WTGs will no longer be visible as they will be dissembled and removed from the area. The evaluation of potential impacts is the subject of Appendix V, Visual Impact Assessment Report – Offshore.

4.1.9.2 South Fork Export Cable

Visual infrastructure associated with the SFEC is limited to the SFEC - Interconnection Facility. Construction activity will result in some visible site disturbance, such as tree clearing, earth moving, and facility installation, all of which could temporarily alter the visual character of the landscape. Following construction activities, temporarily disturbed areas around the periphery of the substation expansion will be seeded (and stabilized, if necessary) to reestablish vegetative cover in these areas. The potential visibility of the substation is evaluated in Appendix U, Visual Assessment Report – Substation.

Once constructed, the SFEC – Interconnection Facility may be viewed from a few areas within approximately 0.25 mile (450.6 m) of the proposed site. Much of the SFEC – Interconnection Facility will be screened from view from most nearby areas by dense, mature vegetation that ranges in height between approximately 50 and 70 feet (15 to 21 m). Where visible, it is expected that views of the SFEC – Interconnection Facility will be limited to the uppermost portions of the proposed lightning masts (the tallest structures in the proposed station). Where the SFEC – Interconnection Facility is visible from greater distances, the lightning masts, even if visible, will be difficult to distinguish on the horizon because of their narrow profile and gray color.

4.1.10 Lighting

The impacts of lighting depend on the lighting source and factors that can affect light transmission, both in air and water. In air, the transmission of light can be affected by atmospheric moisture levels, cloud cover, and type and orientation of lights. In water, turbidity levels and waves can affect transmission distance and intensity. SFWF and SFEC activities that could result in potential impacts by lighting are presented in Table 4-1 and are further described below. Resources potentially impacted by lighting are identified in Table 4.1-1 and further described in Sections 4.2 through 4.6.

4.1.10.1 South Fork Wind Farm

In general, lights will be required on offshore platforms and structures, vessels, and construction equipment during construction, operation, and decommissioning of SFWF. There will be a temporary increase in the amount of lighting during construction and decommissioning due to the presence of work vessels. During operations, offshore structures will require lighting that conforms to BOEM guidelines and USCG requirements. Project construction lighting will meet USCG requirements, when required by federal regulations. BOEM has indicated that offshore lighting should meet standard specifications in Federal Aviation Administration (FAA) Advisory Circulars 70/7460-1L (FAA, 2015) and 150/5345-43H (FAA, 2016), and USCG standards for marine navigation lighting.

The FAA issued Advisory Circular outlines steps to clearly mark/light meteorological towers and their supporting guy wires; however, this federal guidance currently consists of recommendations for towers under 200 feet (61 m). Further, FAA navigation lighting and marking recommendations apply to structures that are up to 12 nm (22 km) offshore. Structures located in the SFWF are outside of 12 nm (22 km), and under the jurisdiction of BOEM. FAA regulations also require wind turbines be properly illuminated during construction, O&M, and decommissioning so that helicopter and airplane pilots can identify and avoid these structures (FAA, 2015).

Control, lighting, marking, and safety systems will be installed on each WTG; the specific systems will vary depending on the turbine selected, and will be reviewed by the selected Certified Verification Agent and provided in the FDR.

Offshore turbines must be visible not only to pilots in the air, but also mariners navigating on water. In daylight, offshore wind turbines do not require lighting if the tower and components are painted white. The FAA and USCG consider white-colored turbines to be the most effective early warning technique for both pilots and mariners (Patterson, 2005). Marine Navigation Lighting (MNL) is regulated by the USCG through Federal Regulation 33 CFR 67 [63]. Structures must be fitted with lights for nighttime periods. No daytime lighting is required. A conceptual lighting scheme was developed in accordance with federal regulations is included in the Navigation Risk Assessment presented as Appendix X. A summary of this conceptual scheme is provided as follows:

- WTGs 1, 8, 11, 13 and 14 are considered Class A structures (Special Peripheral WTGs). As such, they will be equipped with a flashing white light visible to 5 nm.
- WTGs 2, 7, 9 and 12 are considered Class B structures (Intermediate Peripheral WTGs). These will be equipped with a flashing white light visible to 3 nm.
- WTGs 2, 4, 5, 6, 10 and 16 are Class C structures (Internal WTGs). These must be fitted with white or red lights visible to at least 1 nm.

- All WTGs must be fitted with low intensity short range lights (150 yards or 137.2 m) for proximity navigation.
- The Electric Service Platform must be equipped with one or more lights. The number and arrangement of the lights will depend on the horizontal length of the platform.
- In addition to MNL, foundations must be painted yellow from the maximum water level to 50 feet up the WTG tower. Corner WTGs must be equipped with sensor-operated foghorns which must be audible at 0.5 nm.

USCG-approved navigation lighting is required for all vessels during construction, O&M, and decommissioning. All vessels operating between dusk and dawn are required to turn on navigation lights. During night time construction, temporary work lighting will illuminate work areas on vessel decks or service platforms of adjacent WTGs or OSS platform. In addition, cable laying may occur 24 hours a day during certain periods, and these vessels will be illuminated at night for safe operation.

As discussed above, vessel and equipment lighting used during construction, O&M, and decommissioning will be temporary as vessels travel between the shore and SFWF and conduct maintenance activities at SFWF. Impacts of navigational and aviation lighting on WTGs during O&M are considered long-term but highly dependent on properties of the light. Upon decommissioning, all lighting will be removed.

4.1.10.2 South Fork Export Cable

During SFEC construction and decommissioning, lighting also will be necessary for illuminating the onshore work staging areas, at the ports, and on the vessels. Many of the onshore areas used for staging will be part of an industrial port where artificial lighting already exists. The SFEC – Interconnection Facility lighting will be designed to the minimum standard necessary for substation safety and security per utility operational requirements, as well as state and local regulations.

4.2 Physical Resources

4.2.1 Air Quality

Specific requirements for submittal of air emissions information within this COP are provided in 30 CFR 585.659, which directs COP submittals to follow the regulations in 40 CFR 55 – *Outer Continental Shelf Air Regulations*. BOEM's COP guidelines mirror these regulations, requiring that a copy of the air emissions analysis prepared for the OCS air permit application be provided in the COP. DWSF completed a Project-specific emissions inventory by estimating Project-related air emissions as the basis for an air permit application to the EPA in accordance with 40 CFR 55.6. This emissions inventory includes both potential emissions regulated and not regulated by the *Outer Continental Shelf Air Regulations*, as explained in this section, and is provided as Appendix L to this COP.

Under the authority of the Clean Air Act (CAA), EPA regulates air quality on the OCS, including emissions from the construction, operation, and decommissioning of the SFWF and SFEC. Section 328 (a)(4)(c) of the CAA defines an OCS source to include any equipment, activity, or facility that emits, or has the potential to emit, any air pollutant; is regulated or authorized under the OCS Lands Act; and is located on the OCS or in or on waters above the OCS. This definition includes vessels when they are permanently or temporarily attached to the seabed (40 CFR 55.2). For the OCS air permit application, DWSF inventoried anticipated emissions from vessels associated with the Project while operating at the SFWF or within 25 nautical miles (46.3 km) of the activity. OCS activities located within 25 nautical miles (46.3 km) of the seaward boundary of a state are subject to the same requirements as those applicable to the corresponding onshore area (COA) and to general conformity.

In addition to the information specifically provided to support the OCS air permit, all estimated air emissions are included in the COP to allow for BOEM's assessments to fulfill its NEPA and CAA obligations. Under NEPA, BOEM will assess Project-related impacts to air resources. Under the CAA, BOEM is obligated to make a general conformity determination based on 40 CFR 51, Subpart W and Part 93, Subpart B, entitled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans." The General Conformity Rule applies to all federal actions except highway and transit programs. Title I, Section 176(c)(1) of the CAA defines conformity as the upholding of "an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards." Therefore, BOEM's approval of the COP, and associated air pollutant emissions, should not cause or contribute to new violations of NAAQS; increase the frequency or severity of any existing violation of the NAAQS; or delay timely attainment of the NAAQS or interim emission reductions.

This section defines the affected environment as it relates to air resources and potential emissions from the SFWF and SFEC. It also summarizes the potential emissions from the three phases of the Project and presents them categorically according to the expected CAA review (OCS Air Permit versus [vs.] General Conformity). The methodology and detailed results of the Project's air emissions inventory are found in Appendix L.

4.2.1.1 Affected Environment

Regional Overview

Air quality in the RI-MA WEA is described in the revised environmental assessment completed as part of BOEM's NEPA review for the RI-MA WEA and summarized here (BOEM, 2013). Vessels are the predominant emission source in the region, as traffic transits to and from the many Northeastern commercial ports. Southerly winds through the region have the potential to transport these emissions onshore. Conversely, air quality in the SFWF and SFEC is also influenced by onshore sources, as pollutants may be carried to the SFWF and SFEC by westerly winds. In comparison to existing emission sources regularly transiting the region, an incremental increase in vessel traffic and related emissions will result from Project construction, O&M, and decommissioning but the volumes of these pollutants are expected to be low (BOEM, 2013).

The CAA requires the EPA to establish NAAQS to protect public health and welfare. The NAAQS are based on total concentrations of pollutants in the ambient air (i.e., outdoor air that is accessible to the public (40 CFR 50.1(e)). The EPA developed these ambient air quality standards for six common pollutants, known as criteria pollutants, for which ambient air quality standards exist: CO; lead; nitrogen dioxide (NO_2); ozone (O_3); particulate matter (PM); and sulfur dioxide (SO_2). PM is a mixture of solid particles and liquid droplets found in the air and includes particles of varying sizes and is categorized as PM_{10} and $PM_{2.5}$ (EPA, 2016a).

The NAAQS comprise both primary and secondary standards. The primary standards protect the health of particularly vulnerable populations, such as asthmatics, children, and the elderly. Secondary standards are based on protecting the welfare of the public against negative impacts, such as decreases in visibility and damage to crops, animals, vegetation, and buildings (EPA, 2016b). The NAAQS for each of the criteria pollutants are presented in Table 4.2-1.

Table 4.2-1. Criteria Pollutants and National Ambient Air Quality Standards

Pollutant	Primary/ Secondary	Averaging Time	Standard	
CO	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead	Primary and Secondary	Rolling 3-month average	0.15 µg/m^3	Not to be exceeded
NO_2	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and Secondary	1 year	53 ppb	Annual mean
O_3	Primary and Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
$PM_{2.5}$	Primary	1 year	12.0 µg/m^3	Annual mean, averaged over 3 years
	Secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years
PM_{10}	Primary and Secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	Primary and Secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
SO_2	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: 40 CFR 50

Note:

Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m^3).

The CAA contains timeframes and milestones for states to meet and maintain NAAQS for criteria pollutants. Areas that do not meet the NAAQS based on an evaluation of available air quality data are designated as nonattainment areas (NAAs). The EPA reviews the NAAQS every 5 years and may update the standards based on new scientific information and establish new monitoring requirements. Each state is required to monitor the ambient air to determine whether it meets each standard. If monitoring shows that the air quality does not meet a standard, the state must develop and implement pollution control strategies to attain that standard. Once air quality meets a standard, a state must develop a plan to maintain that standard while accounting for future economic and emissions growth (MassDEP, 2016).

In addition to the criteria pollutants discussed, air pollutants can be categorized as toxic or hazardous air pollutants (HAPs) or greenhouse gasses (GHGs). There are no ambient air quality standards for HAPs or GHG; however, emissions are regulated through national manufacturing standards and permit requirements. HAPs, also known as toxic air pollutants or air toxics, are those pollutants known or suspected to cause cancer or other serious health impacts, such as reproductive impacts or birth defects, or adverse environmental impacts (EPA, 2017). Examples of HAPs include benzene (which is found in gasoline); dioxin; asbestos; toluene; and metals, such as cadmium, mercury, chromium, and lead compounds.

GHGs are gases that trap heat in the atmosphere and include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gasses. The largest source of GHG emissions from human activities in the United States is from burning fossil fuels (mostly coal and natural gas) for electricity, heat, and transportation (EPA, 2018a).

The scope of the affected environment for the assessment of potential Project-related emissions and impacts to ambient air quality encompass offshore areas and those states and counties where Project activities may occur. As described in Section 3.1.3.1, Project activities may use several regional, existing port facilities from South Brooklyn Marine Terminal (Kings County, New York) to New Bedford Marine Commerce Terminal (Bristol County, Massachusetts), and several other ports in Connecticut and Rhode Island. Therefore, for the purposes of this discussion, it is assumed that Project-related air emissions could occur near or within one or more of the following counties, depending on the ports used by the SFWF and SFEC:

- New London, New Haven, and Fairfield Counties, Connecticut
- Barnstable, Bristol, Dukes, and Nantucket Counties, Massachusetts
- Nassau, Suffolk, and Kings Counties, New York
- Washington, Newport, Kent, Providence, and Bristol Counties, Rhode Island

The CT DEEP, Bureau of Air Management, Ambient Air Monitoring Group monitors air quality to protect public health and the environment. CT DEEP's ambient air monitoring network monitors for ozone, $PM_{2.5}$, NO_2, SO_2, CO, and lead, as well as VOCs, aldehydes, polycyclic aromatic hydrocarbons (PAHs), mercury, and dioxin. According to EPA, the New York-Northern New Jersey-Long Island Area and the Greater Connecticut areas are currently designated as moderate nonattainment for the 2008 ozone (8-hour) NAAQS (EPA, 2018b). The current trend is improvement for ozone standard attainment designations for New York Metro and the Greater Connecticut Area areas (CT DEEP, 2017).

Massachusetts Department of Environmental Protection (MassDEP) is the responsible agency for monitoring air quality and assessing compliance with the NAAQS for each of the criteria pollutants. MassDEP's Air Assessment Branch operates a network of 24 air monitoring stations that measure ambient concentrations of criteria pollutants, noncriteria pollutants (HAPs and others), and meteorological data (MassDEP, 2017). The most recent MassDEP monitoring data report (for the year 2016) shows that Massachusetts is in attainment with all the NAAQS criteria pollutant standards.[4] Trends for criteria pollutants and some HAPs have generally been downward in Massachusetts over the last several decades. MassDEP regulations establish a nonattainment new source review (NNSR) preconstruction review program for new major sources or major modifications in an NAA. NOx and VOCs are nonattainment pollutants in Massachusetts because the state is in an ozone transport region. Major source thresholds are 50 tons per year (tpy) NOx or 50 tpy VOCs.

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[4] Massachusetts was previously designated as nonattainment for the 1979 1-hour ozone standard (0.12 ppm) and 1997 8-hour ozone standard (0.08 ppm). Through a combination of state and regional controls, Massachusetts' air quality attained the 1997 standards by the 2009 attainment deadline. In 2008, EPA lowered the 8-hour ozone standard to 0.075 ppm. In April 2012, EPA designated Dukes County as nonattainment (marginal classification) for the 2008 ozone standards and designated the remainder of Massachusetts as unclassifiable/attainment. Based on the most recent monitoring data, Dukes County attained the 2008 ozone standard by the 2015 attainment deadline (MassDEP, 2016).

The NYSDEC Division of Air Resources is the responsible agency for monitoring air quality and assessing compliance with the NAAQS for each of the criteria pollutants. NYSDEC operates a network of 50 air monitoring stations that measure ambient concentrations of criteria pollutants, HAPs (at 12 monitoring stations), and meteorological data (NYSDEC, 2017a). Long Island is considered Region 1, which has four monitoring stations. The most recent NYSDEC monitoring data report (2015) shows that New York State is in attainment with all the NAAQS criteria pollutant standards, except for ozone, which is designated as moderate nonattainment (EPA, 2018c). Trends for HAPs have generally been downward in New York over the last 10 years (NYSDEC, 2017b).

The New York State Energy Research and Development Authority (NYSERDA) *New York State Greenhouse Gas Inventory: 1990 to 2014* is based on EPA protocols and methodologies and includes an estimate of current GHG emissions produced within New York State from 1990 to 2014. Emissions of GHGs gradually increased from 1990, peaked in 2005, and then began to decline since. In 2014, emissions were approximately 8 percent lower than in 1990. This reduction stands in contrast to the 7 percent national increase in total GHG emissions over the same period. Energy-related emissions were 13 percent lower in 2014 relative to 1990 levels (NYSERDA, 2017).

The RI DEM, in conjunction with the Rhode Island Department of Health, operates a network of eight air monitoring stations throughout the state that measure ambient concentrations of criteria pollutants; toxic air pollutants (or HAPs); and ozone precursors, which are substances that react in the atmosphere to form ground-level ozone (RI DEM, 2016). The most recent RI DEM monitoring data report shows that Rhode Island is in attainment with all the NAAQS criteria pollutant standards. Emissions of GHG in Rhode Island have been estimated at 11.3 million metric tons of carbon dioxide equivalent (CO_2e) in 2015 (EC4, 2016). This is on target to meet the 2020 limit of 11.23 million metric tons of CO_2e in accordance with the 2014 Resilient Rhode Island Act, which outlines programs and policies the state could undertake to meet its commitment to reduce annual GHG emissions to at least 10 percent less than 1990 levels by 2020, and up to 80 percent less than 1990 levels by 2050 (EC4, 2016).

Permitting Applicability

DWSF will submit a notice of intent and then an air permit application to EPA as required by the OCS Regulations in 40 CFR 55.6. For the OCS air permit application, annual construction and O&M air emissions will be compared with new source review (NSR) permitting thresholds to determine the type of permitting needed. Decommissioning emissions, likely to occur 25-30 years in the future, would be the subject of another permit application.

There are two types of major source permitting, depending upon the attainment status of the pollutant of concern with the NAAQS: Prevention of Significant Deterioration (PSD) program for attainment pollutants and NNSR for nonattainment pollutants. If the Project emissions are less than the major source thresholds, then only minor NSR applies to the project (EPA, 2018e). As stated, EPA sets NAAQS standards for six criteria air pollutants: O_3, CO, PM, SO_2, lead, and NO_2. Every area of the United States has been designated by EPA in one of three attainment classifications based on the status of the air quality in the area:

- Attainment – Air quality is equal to or better than the level of the NAAQS.
- Nonattainment – Air quality is worse than the level of the NAAQS.
- Unclassified – There are no air quality data for the area; the area is treated as attainment.

The PSD permitting program includes the following:

- Installation of the Best Available Control Technology – Emission limitation based on the maximum degree of emission control, considering environmental, energy, and economic impacts
- An air quality analysis consisting of an air dispersion model
- Additional impacts analysis to assess impacts on air, and ground and water pollution on soils, vegetation, and visibility
- Public involvement, including a required public review and comment period

The NNSR Program includes the following:

- Installation of the Lowest Achievable Emission Rate – Emission rate that represents the most stringent emission limit in a state implementation plan (SIP) or implemented in practice for a similar source, which is technically feasible for the project
- Purchasing of Emission Offsets – To avoid or offset increases in emissions, emissions from proposed projects are balanced by equivalent or greater reductions from existing sources
- Public involvement, including a required public review and comment period

A minor NSR program includes the following, which is implemented by the states:

- Sources must comply with emission controls or limits specified by the state.
- The program must not interfere with attainment of maintenance of the NAAQS or the control strategies of the SIP.

General Conformity

The General Conformity Rule per 40 CFR 93 Subpart B and 40 CFR 51 Subpart W prescribes that federal actions comply with the NAAQS. To meet this CAA requirement, a federal agency must demonstrate that every action it undertakes, approves, permits, or supports will conform to the appropriate SIP. That is, it will not interfere with the states' plans to attain and maintain compliance with the NAAQS.

BOEM will conduct the conformity analysis for the SFWF and SFEC based on the construction, O&M, and decommissioning emissions provided in this COP. The General Conformity emissions will not include emissions that are already accounted for in the OCS air permit. General Conformity emissions will only include direct and indirect emissions outside the 25-nautical mile (46.3-km) OCS air region. A Conformity Determination is only required for emissions that exceed the *de minimus* thresholds. A list of the codified *de minimus* thresholds are included in Table 4.2-2.

Table 4.2-2. Clean Air Act Conformity *de minimus* Emission Thresholds

Emission	tpy
40 CFR 93.153(b)(1) – For purposes of paragraph (b) of this section the following rates apply in NAAs:	
Ozone (VOCs or NOx):	
Serious NAAs	50
Severe NAAs	25

Table 4.2-2. Clean Air Act Conformity *de minimus* Emission Thresholds

Emission	tpy
Extreme NAAs	10
Other ozone NAAs outside an ozone transport region	100
Other ozone NAAs inside an ozone transport region:	
VOC	50
NOx	100
CO: All maintenance areas	100
SO_2 or NO_2: All NAAs	100
PM_{10}:	
Moderate NAAs	100
Serious NAAs	70
$PM_{2.5}$ (direct emissions, SO_2, NOx, VOC, and ammonia):	
Moderate NAAs	100
Serious NAAs	70
Lead: All NAAs	25
40 CFR 93.153(b)(2) – For purposes of paragraph (b) of this section the following rates apply in maintenance areas:	
Ozone (NOx), SO_2, or NO_2: All maintenance areas	100
Ozone (VOCs):	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
CO: All maintenance areas	100
PM_{10}: All maintenance areas	100
$PM_{2.5}$ (direct emissions, SO_2, NOx, VOC, and ammonia)	100
All maintenance areas	100
Lead: All maintenance areas	25

Source: EPA, 2018d.

South Fork Wind Farm

The discussion of air quality within the SFWF applies to the offshore area where the WTGs are located and the port areas that vessels will use in support of the Project. Ambient air quality data are not available for the offshore SFWF area because there are no air monitoring stations. However, the discussion of regional air quality, as previously presented, effectively characterizes the affected environment for air resources associated with the SFWF.

South Fork Export Cable

SFEC - OCS

The discussion of air quality along the SFEC – OCS applies to the offshore area where the SFEC will be installed in federal waters from the SFWF OSS to where the SFEC crosses into New York State jurisdictional waters. Air quality data are not available for the offshore OCS waters portion of the SFEC. However, the discussion of regional air quality, as previously presented, effectively characterizes the affected environment for air resources associated with the SFEC - OCS.

SFEC - NYS and SFEC - Onshore

The discussion of air quality along the SFEC – NYS applies to the nearshore area where the SFEC traverses New York State waters, including the offshore sea-to-shore transition. The SFEC - Onshore applies to the onshore area from the upland end of the sea-to-shore transition to the SFEC - Interconnection Facility. Air quality data are not available specifically for New York State waters; however, the NYSDEC Division of Air Resources is the responsible agency for monitoring air quality and assessing compliance with the NAAQS for each of the criteria pollutants in the state. Two NYSDEC air quality monitoring stations are in relatively proximity to the SFEC in Holtsville and Riverhead, New York. New York State is in attainment with all the NAAQS criteria pollutant standards, except for ozone (EPA, 2018c), which is designated as moderate nonattainment (EPA, 2017). Trends for HAPs have generally been downward in New York over the last 10 years (NYSDEC, 2017b).

4.2.1.2 Potential Impacts

A summary of the IPFs that could result in air quality impacts is illustrated on Figure 4.2-1. IPFs that will not impact air quality are depicted with slashes through the circle. For the IPFs that could impact air but were found to be negligible in the analyses in Section 4.1, the circle is gray without a slash. The IPFs with potential for minor to major impacts to air quality are indicated by black shading and are evaluated in this section. The primary causes of potential air quality impacts from the SFWF and SFEC include emissions from vessels, vehicles, helicopters, and stationary engines. These sources were introduced in Table 3.1-6 and further categorized in the emissions inventory presented in Appendix L.

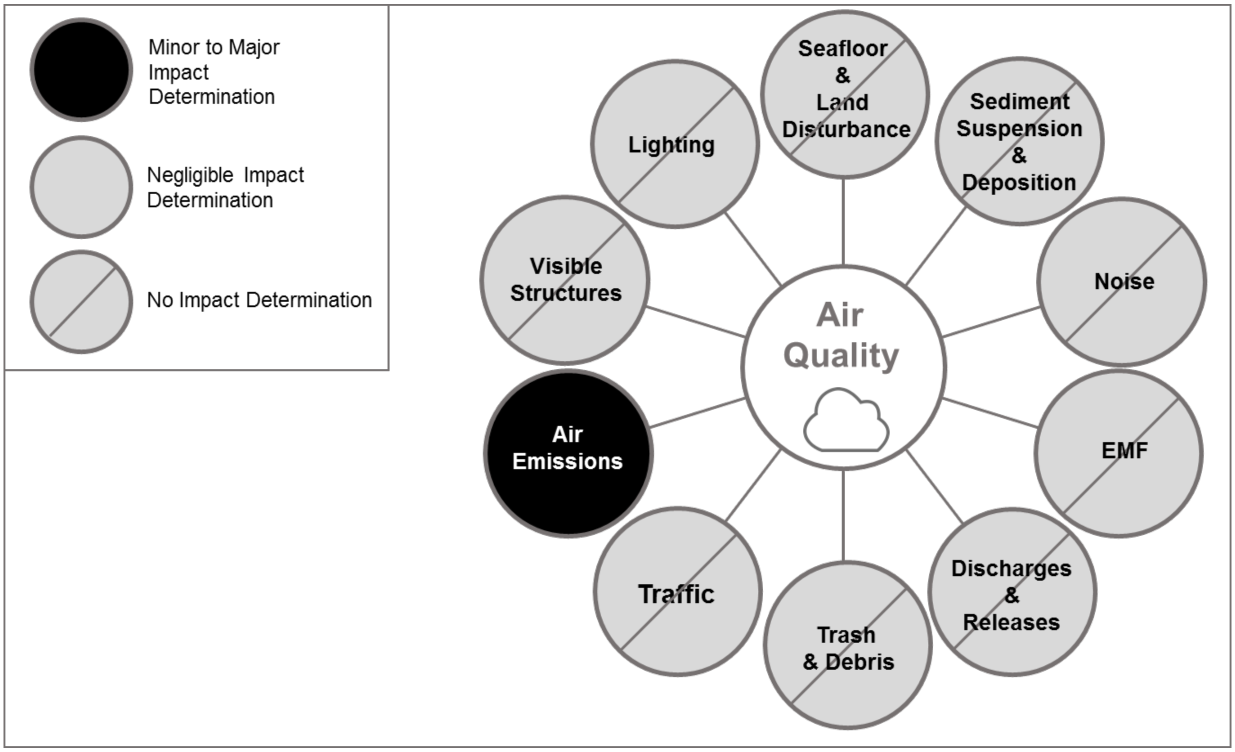

Figure 4.2-1. Impact-producing Factors on Air Quality

Project-related aircraft, vessel, vehicle, and equipment usage will generate emissions offshore and onshore, predominantly during the anticipated one-to-two-year construction phase. During the 25-year estimated O&M phase, the SFWF and SFEC will generate few emissions from infrequent use of emergency generators, equipment engines, vessels, and vehicles. O&M activities will produce relatively little emissions compared to those produced during construction. Emissions from decommissioning are estimated to be an order of magnitude less than construction emissions – though similar construction activities will be conducted to decommission Project components; the activity will be of a much shorter duration. However, decommissioning activities would occur 25 to 30 years in the future when combustion energy and pollution control technologies will be different, so it is speculative to predict emissions.

Appendix L contains the complete emissions inventory, including underlying assumptions for engine type and rating, engine use (hours), number of trips, trip destinations, and emission factors. For this COP and its related environmental review, total estimated emissions are presented by Project component (i.e., SFWF vs. SFEC) and by the three phases of the Project. This breakdown provides a comparison of potential emissions from the construction of SFWF, which will predominantly occur within the lease area during foundation installation, WTG assembly, and Inter-array Cable laying. Potential emissions from the SFEC will occur as the cable laying vessel and other support vessels follow the proposed corridor from the sea-to-shore transition at Long Island to the SFWF.

Estimated emissions also are presented as total and annual emissions, OCS permit emissions, and conformity emissions. Appendix L provides a detailed explanation and regulatory context for these categories, but they are also summarized as follows. Total emissions include all combustion sources anticipated for Project-related usage offshore and onshore. OCS permit emissions include emissions from OCS sources, vessels meeting the definition of *OCS Source* (40 CFR 55.2), and vessels traveling to and from the SFWF when within 25 nautical miles (46.3 km) of the SFWF's center (the 25-nautical mile [46.3-km] centroid or the OCS centroid).

General Conformity air emissions include emissions outside the 25-nautical mile (46.3-km) centroid and within 25 nautical miles (46.3 km) of a state's seaward boundary. Conformity emissions are apportioned to the state where the emissions will occur based on the assumptions for project vessel trips between the SFWF and ports, as well as the SFEC landfall location. Annualized emission estimates for construction and decommissioning phases are presented for the three WTG foundation options: jacket, monopile, and GBS. Emissions are presented by the pollutants identified in the BOEM *Wind Tool* and associated technical guidance (ERG, 2017).

Construction

Estimated air emissions from the proposed construction activities for the SFWF and SFEC are summarized in Table 4.2-3. As shown in the table, SFWF construction emissions vary depending on the foundation type selected. Jacket and monopile foundation construction are estimated to have emissions on a similar order of magnitude, while GBS foundation construction will result in approximately 30 percent greater emissions than the other foundation types. These higher emissions are the result of a greater anticipated number of vessels and overall duration of vessel and equipment usage to install the GBS foundations. SFEC installation results in estimated emissions within the same range of estimated emissions expected for SFWF installation.

Table 4.2-3. Comparison of Estimated Emissions from Construction for the South Fork Wind Farm and South Fork Export Cable

Project	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
SFWF											
Jacket	19,153	1.8	0.9	7.2	54.1	309.7	10.1	9.7	5.4	0.0011	10.6
Monopile	18,391	1.8	0.8	6.7	49.6	285.0	9.4	9.1	4.0	0.0011	8.7
GBS	28,394	1.8	1.3	10.5	44.2	437.8	14.4	13.9	3.8	0.0019	10.5
SFEC	20,600	0.4	0.4	3.3	85.1	229.8	7.9	7.7	21.7	0.0006	28.1

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Total, annualized OCS, and annualized Conformity emissions for the entire Project (i.e., SFWF and SFEC combined) are presented in Table 4.2-4 a - c for three construction scenarios, assuming the installation of jacket, monopile, and GBS foundation types. Appendix L breaks down construction emissions on an annual basis for OCS permitting purposes. The greater proportion of estimated emissions for jacket and monopile construction occur outside the 25-nautical miles (46.3-km) SFWF centroid (OCS emissions), representing the transiting of construction vessels between ports and the SFEC cable-laying activity.

Table 4.2-4a. Estimated OCS and Conformity Emissions (tons) for the South Fork Wind Farm and South Fork Export Cable for Jacket Foundations

Emissions Type	Year	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions		**39,753**	**2.2**	**1.3**	**10.5**	**139.3**	**539.5**	**18.0**	**17.4**	**27.1**	**0.0016**	**38.6**
OCS Emissions	1	5,070	0.3	0.2	1.8	14.5	76.2	2.5	2.4	0.8	0.0003	2.0
	2	13,457	0.9	0.6	5.3	37.0	216.2	7.2	6.9	2.4	0.0008	5.9
Conformity Emissions - New York	1	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0
	2	16,099	0.0	0.2	1.6	71.7	163.8	5.6	5.5	21.4	0.0003	26.7
Conformity Emissions - Rhode Island	1	1,469	0.2	0.0	0.4	5.6	19.2	0.6	0.6	0.8	0.0001	1.2
	2	3,658	0.7	0.2	1.4	10.5	64.2	2.1	2.0	1.7	0.0002	2.9

Notes: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Table 4.2-4b. Estimated Total, OCS, and Conformity Emissions (tons) for the South Fork Wind Farm and South Fork Export Cable for Monopile Foundations

Emissions Type	Year	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions		**38,992**	**2.2**	**1.3**	**10.1**	**134.8**	**514.7**	**17.3**	**16.8**	**25.7**	**0.0017**	**36.7**
OCS Emissions	1	6,837	0.3	0.3	2.5	16.1	104.0	3.5	3.3	0.8	0.0005	2.3
	2	11,776	0.9	0.6	4.5	32.4	184.4	6.2	6.0	1.6	0.0007	4.5
Conformity Emissions - New York	1	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0
	2	16,099	0.0	0.2	1.6	71.7	163.8	5.6	5.5	21.4	0.0003	26.7
Conformity Emissions - Rhode Island	1	1,770	0.2	0.1	0.5	6.3	23.7	0.8	0.8	0.8	0.0001	1.3
	2	2,511	0.7	0.1	0.9	8.2	38.8	1.3	1.2	1.1	0.0001	1.9

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Table 4.2-4c. Estimated Total, OCS, and Conformity Emissions (tons) for the South Fork Wind Farm and South Fork Export Cable for Gravity-base Structure Foundations

Emissions Type	Year	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions		**48,995**	**2.2**	**1.7**	**13.8**	**129.4**	**667.6**	**22.3**	**21.7**	**25.5**	**0.0024**	**38.5**
OCS Emissions	1	15,165	0.4	0.7	5.7	8.5	230.1	7.6	7.4	0.5	0.0011	3.8
	2	12,993	0.9	0.6	5.0	35.4	204.0	6.8	6.5	1.6	0.0008	4.8
Conformity Emissions - New York	1	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0
	2	16,099	0.0	0.2	1.6	71.7	163.8	5.6	5.5	21.4	0.0003	26.7
Conformity Emissions - Rhode Island	1	2,219	0.2	0.1	0.7	5.5	30.6	1.0	1.0	0.9	0.0001	1.4
	2	2,519	0.7	0.1	0.9	8.3	39.0	1.3	1.2	1.1	0.0001	1.9

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Over the one-to-two-year construction period, Project-related air emissions could have ***short-term***, ***minor*** impacts to air quality. The majority of Project emissions will occur over relatively short spans of time, and occur offshore, approximately 19 miles (30.6 km, 16.5 nm) or more from land, in the case of the SFWF, or along an approximately 26-mile (41.8-km) SFEC cable route. Impacts to air quality near populated areas is not anticipated, with the small exception of the SFEC - Onshore installation.

Operations and Maintenance

Annual total, OCS, and Conformity emissions from SFWF and SFEC O&M activities are summarized in Table 4.2-5. O&M activities for the SFWF and SFEC are described in Sections 3.1.5 and 3.2.5, respectively, and would occur over a 25- or 30-year period. Potential O&M emissions will result from the operation of crew and maintenance vessels, vehicles, and emergency generators, which are anticipated to be located on the OSS and possibly each WTG. The submarine segments of the SFEC are not expected to require routine O&M activity resulting in air emissions. However, SFEC-related emissions estimates include routine O&M activities at the SFEC – Interconnection Facility consisting of regular usage of standard pickup trucks, which are all considered Conformity emissions.

Table 4.2-5. Estimated Annual Total, OCS, and Conformity Emissions during Operations and Maintenance Period of the South Fork Wind Farm and South Fork Export Cable

Emissions Type	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total O&M Emissions	4,867	0.0	0.2	1.9	14.6	79.5	2.5	2.4	0.6	0.0003	1.7
OCS Emissions (SFWF only)	4,083	0.0	0.2	1.6	12.1	67.2	2.1	2.0	0.4	0.0003	1.4

Conformity Emissions – New York	317	0.00	0.01	0.10	1.2	4.1	0.14	0.14	0.08	0.0000	0.15
Conformity Emissions – Rhode Island	466	0.00	0.02	0.19	1.3	8.1	0.25	0.24	0.07	0.0000	0.19

Notes: All units in tpy. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Estimated air emissions from the proposed O&M activities are expected to have ***negligible*** impacts to regional air quality. The use of wind to generate electricity reduces the need for electricity generation from new traditional fossil fuel powered plants on the South Fork of Long Island that produce greenhouse gas emissions.

Potential impacts from O&M would be expected to be smaller compared to the impacts anticipated during construction activities. The only air emissions anticipated during O&M would result from maintenance vessels and crew transport vessels and would not be expected to result in a lowering of air quality within the surrounding area of the SFWF.

Decommissioning

Estimated air emissions from the conceptual decommissioning activities for the SFWF and SFEC are summarized in Table 4.2-6. These estimates are based on the conceptual approach for decommissioning the SFWF and SFEC, as explained in Sections 3.1.6 and 3.2.6, respectively. Decommissioning emissions would be an order of magnitude less than those for construction activities and would result largely from the operation of the construction equipment and vessels or aircraft. There would be no air emissions from the Project once decommissioning is complete.

Table 4.2-6. Comparison of Estimated Emissions from Decommissioning for the South Fork Wind Farm and South Fork Export Cable

Emissions Type	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
SFWF											
Jacket	3,981	0.9	0.2	1.5	11.3	64.6	2.1	2.0	1.1	0.0002	2.2
Monopile	3,282	0.9	0.1	1.2	9.3	49.8	1.6	1.6	0.8	0.0002	1.6
GBS	2,769	0.9	0.1	1.0	7.7	42.1	1.4	1.3	0.7	0.0002	1.4
SFEC	4,326	0.3	0.1	0.7	18.4	49.7	1.7	1.6	4.8	0.0001	6.1

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Estimated total, OCS, and Conformity emissions were also calculated for the decommissioning phase based on conceptual approaches and are presented in Tables 4.2-7a-4.2-7c. Appendix L breaks down decommissioning emissions on an annual basis for OCS permitting purposes.

Table 4.2-7a. Estimated Total, OCS, and Conformity Emissions during Decommissioning for the South Fork Wind Farm and South Fork Export Cable for Jacket Pile Foundations

Emissions Type	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions	**8,307**	**1.2**	**0.3**	**2.2**	**29.7**	**114.3**	**3.8**	**3.7**	**5.9**	**0.0003**	**8.3**
OCS Emissions	3,768	0.7	0.2	1.4	10.5	59.6	2.0	1.9	0.7	0.0002	1.6
Conformity Emissions – New York	3,424	0.0	0.0	0.4	15.7	36.5	1.2	1.2	4.7	0.0001	5.8
Conformity Emissions – Rhode Island	1,115	0.5	0.0	0.4	3.5	18.2	0.6	0.6	0.5	0.0001	0.9

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Table 4.2-7b. Estimated Total, OCS, and Conformity Emissions during Decommissioning for the South Fork Wind Farm and South Fork Export Cable for Monopile Foundations

Emissions Type	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions	**7,608**	**1.2**	**0.2**	**1.9**	**27.7**	**99.5**	**3.3**	**3.2**	**5.5**	**0.0003**	**7.7**
OCS Emissions	3,273	0.7	0.2	1.2	9.2	50.9	1.7	1.6	0.4	0.0002	1.2
Conformity Emissions – New York	3,424	0.0	0.0	0.3	15.4	35.1	1.2	1.2	4.7	0.0001	5.8
Conformity Emissions – Rhode Island	911	0.5	0.0	0.3	3.1	13.5	0.4	0.4	0.4	0.0000	0.7

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Table 4.2-7c. Estimated Total, OCS, and Conformity Emissions during Decommissioning for the South Fork Wind Farm and South Fork Export Cable for Gravity-base Structure Foundations

Emissions Type	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Total Emissions – GBS Foundations	7,095	1.2	0.2	1.7	26.2	91.8	3.1	3.0	5.4	0.0003	7.5
OCS Emissions	2,841	0.7	0.1	1.1	7.9	44.4	1.5	1.4	0.4	0.0002	1.0
Conformity Emissions – New York	3,424	0.0	0.0	0.3	15.4	35.1	1.2	1.2	4.7	0.0001	5.8
Conformity Emissions – Rhode Island	830	0.5	0.0	0.3	2.8	12.3	0.4	0.4	0.4	0.0000	0.6

Note: All units in tons. Black carbon is the sooty black material emitted from combustion sources and it is included because it comprises a significant portion of particulate matter or PM.

Estimated emissions anticipated during decommissioning would result largely from the operation of the construction equipment and vessels or aircraft and would not be expected to result in a lowering of air quality within the surrounding area of the SFWF. There would be no further air emissions from the SFWF once decommissioning is complete. Overall, air quality impacts from decommissioning would be considered ***negligible***.

4.2.1.3 Proposed Environmental Protection Measures

The construction activities for the SFWF and SFEC are planned and designed in a manner that will avoid, minimize, and mitigate the potential impacts to air quality.

- Vessels providing construction or maintenance services for the SFWF will use low sulfur fuel where possible.
- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements when operating within Emission Controls Areas.
- Equipment and fuel suppliers will provide equipment and fuels that comply with the applicable EPA or equivalent emission standards.
- Marine engines with a model year of 2007 or later and non-road engines complying with the Tier 3 standards (in 40 CFR 89 or 1039) or better will be used to satisfy best available control technology (BACT).

In addition, the use of wind to generate electricity reduces the need for electricity generation from new traditional fossil fuel powered plants on the South Fork of Long Island that produce greenhouse gas emissions. Table 4.2-8 presents the estimated annual avoided emissions from the operation of the SFWF. Avoided emissions were based on New York's annual nonbaseload outputs and rates. The estimated annual and lifetime (25 years) emissions were calculated based on 392,500 MW hours. The Project is expected to annually displace CO_2, NO_x, and SO_2 produced by the New York electric grid and decrease the creation of GHG in the atmosphere from these sources.

Table 4.2-8. Estimated Annual and Lifetime Avoided Emissions for the Operation of the South Fork Wind Farm over a 25-year Period

Pollutant (metric tons)	CO_2	NOx	SO_2	N_2O	CH_4	CO_2e
Annual Avoided Emissions	217,653	234	164	1,454	6	798,125
Lifetime Avoided Emissions	5,441,325	5,855	4,091	36,355	147	19,535,130

Note: All units in metric tons.

4.2.2 Water Quality and Water Resources

This section provides a description of water quality and water resource conditions in the SFWF and SFEC, as defined by several parameters including: dissolved oxygen; chlorophyll; nutrient content; seasonal variations in algae or bacterial content; upwelling conditions; contaminants in water or sediment; and turbidity or water visibility. This section also briefly discusses relevant anthropogenic activities that have in the past or currently may impact water quality, including point and nonpoint source pollution discharges, deposition and spills, and pollutants in the water or in sediment.

The description of the affected environment and assessment of potential impacts for water quality and water resources was evaluated by reviewing the revised Environmental Assessment completed as part of the BOEM NEPA review for the RI-MA WEA (BOEM, 2013) and the OSAMP (RICRMC, 2010). In addition, current public data sources related to water quality and water resources in Suffolk County and on Long Island, including local, regional, state, and federal agency-published papers and reports and published journal articles were reviewed.

4.2.2.1 Affected Environment

The SFWF and SFEC will occur in federal and state marine waters, and the SFEC - Onshore will occur near surface water (tidal waters and freshwater wetlands) and groundwater resources. This section describes the water resources in the SFWF and SFEC and the metrics used to describe their condition according to available data.

Regional Overview

The SFWF and SFEC - OCS are located in offshore marine waters where available water quality data are limited. However, the threat to marine water quality is reduced at greater distances from shore and with exposure to the movement of high water volume through oceanic circulation, causing pollutants to be dispersed, diluted, and biodegraded (BOEM, 2013).

The SFEC - NYS is located in coastal marine waters of New York State where there is also limited water quality data available. The EPA rated the quality of the nation’s coastal waters as “poor,” “fair,” and “good” for the 2010 National Coastal Condition Assessment (NCCA) (EPA, 2015) from data collected at 238 Northeast Coast sampling locations from Maine through Virginia. The NCCA used physical and chemical indicators to rate water quality, including phosphorous, nitrogen, dissolved oxygen, salinity, water clarity, pH, and chlorophyll a. The National Coastal Condition Report (NCCR) presents a summary of data collected for assessing the ecological and environmental conditions of U.S. coastal waters. Data has been collected since 1997 and summarized in four different reports. This NCCR IV presents an assessment of data collected from 2003 to 2006. The water quality of the coastal waters ranging from Maine to North Carolina, which is inclusive of the SFWF and SFEC, was rated as “good” to “fair” (EPA, 2012). This survey only included four sites located near the SFWF and SFEC: four sampling locations within Block Island Sound.

Dissolved Oxygen

Dissolved oxygen (DO) is the amount of oxygen present in water received from the atmosphere and from aquatic plants. Low levels of oxygen (hypoxia) or no oxygen levels (anoxia) can occur when excess organic material, such as large algal blooms, are decomposed by microorganisms (LICAP, 2016). Water sampling conducted at four stations in Rhode Island Sound in 2002 by the USACE found that DO concentrations both at the surface and in bottom waters remained above established levels for the "highest quality marine waters" and suggests that hypoxic and anoxic conditions do not typically occur in those areas (RICRMC, 2010).

The NCCR IV (EPA, 2012) points out that the overall condition of DO in the Northeast Coast region is fair. However, a summary of data in the NCCA shows the stations within Block Island Sound area to have good water quality conditions (EPA, 2015).

Chlorophyll a

Chlorophyll *a* is the main photosynthetic pigment in green algae. The concentration of chlorophyll gives an indication of the volume of aquatic plants present in the water column. For this reason, chlorophyll *a* is used as a metric of plant production, called "primary production" because of the ability of plants to capture energy from sunlight and is described in units of grams of carbon per meter square per day (g C m^{-2} day^{-1}). The RICRMC adapted a table (Table 4.2-9) from Hyde (2009) to compare the range of primary production throughout the year for OSAMP waters and nearby ecosystems. Primary production in the OSAMP area is comparable to other coastal systems, just slightly lower than the value ranges presented for Narragansett Bay and New York Bight.

Table 4.2-9. Comparison of the Range of Primary Production (g C m^{-2} day^{-1}).

Ecosystem	Production	Reference
OSAMP	143-204	Hyde, 2009
Narragansett Bay	160-619	Oviatt et al., 2002
Massachusetts Bay	160-570	Keller et al., 2001; Oviatt et al., 2007; Hyde et al., 2008
New York Bight	370-480	Malone and Chervin, 1979

Table adapted from RICRMC, 2010

Limited data are available on nutrient levels (e.g., silica, nitrogen, and phosphorus) in the waters south of Rhode Island and Massachusetts. Dissolved nutrients are discharged from Narragansett Bay, Long Island Sound, and Buzzards Bay; research on Block Island Sound water quality also suggests that nutrient concentrations had seasonal variation, with peaks in the autumn, and nearly undetectable levels in the late spring and early summer months (Staker and Bruno, 1977).

Water quality data collected in Northeast coastal waters indicates that concentrations of chlorophyll *a* continue to be elevated when compared to thresholds used to evaluate water quality in coastal waters; therefore, the waters are considered to represent fair water quality conditions (EPA, 2012, 2015).

Algae and Bacterial Content

Nutrients are chemical elements that all living organisms need for growth. Problems arise when too much of a nutrient is introduced into the environment through human activities. In surface waters, excess nutrients fuel algal blooms which can lead to water quality degradation. Severe or harmful algal blooms can result in the depletion of oxygen in the water that aquatic life needs for survival. Algal blooms also reduce water clarity preventing desirable plant growth, such as seagrasses, reduce the ability of aquatic life to find food, and clog fish gills. In groundwater, excess nitrogen can cause nitrate concentrations to rise to levels unsafe for drinking water (LICAP, 2016). Freshwaters are primarily affected by excess phosphorus, while in coastal waters, nitrogen is the nutrient of highest concern. In some cases, both nutrients may interact and contribute to the water pollution problem (RI DEM, 2010).

Waterborne pathogens include bacteria, viruses, and other organisms that may cause disease or health problems in native species and in humans. When pathogens are present in water at elevated concentrations, the beneficial uses of waters are adversely affected prompting restrictions (closures) at public beaches and on the harvest of shellfish.

The SFWF and SFEC is located in waters that are considered temperate and therefore, subject to highly seasonal variation in temperature, stratification, and productivity. There is little information on the algal and bacteria dynamics in either Block Island or Rhode Island Sounds. According to RICRMC (2010), there were no documented reports of harmful algal blooms or waterborne pathogen outbreaks in the waters of either Block Island or Rhode Island Sounds as of 2010.

Upwelling/Currents

The physical oceanographic and meteorological conditions of the SFWF and SFEC are described in Section 4.2.4.

Contaminants in Water or Sediment

Data on water-column contaminant levels in Rhode Island Sound are limited. Organic contaminants (polychlorinated biphenyls [PCBs] and pesticides) measured in 2001 and 2002 were generally below method detection limits (USACE, 2004). For example, total PCB concentrations were less than 46 parts per trillion, and total dichlorodiphenyltrichloroethanes (DDTs) were less than 4 parts per trillion. Water-column dissolved metals concentrations in Rhode Island Sound were also low, with concentrations generally less than 1 part per billion. Dissolved metal concentrations appeared similar throughout the year and throughout Rhode Island Sound. Metals, PCBs, and pesticide concentrations measured in the water column within the OSAMP area in 2002 were well below ambient RI DEM water quality criteria for toxic pollutants (RICRMC, 2010).

DWSF completed chemical analyses of geotechnical sediment samples from the SFEC - NYS, and completed testing for the following contaminants: arsenic; cadmium; copper; lead; mercury; benzene; total benzene, toluene, ethylbenzene, and xylenes (BTEX); total PAH; Sum of DDT + dichlorodiphenyldichloroethene (DDE)+ dichlorodiphenyldichloroethane (DDD); mirex; chlordane; dieldrin; PCBs (sum of aroclors); dioxin (Toxic Equivalency Total); grain size; and total organic carbon. The methods used for this sampling procedure and the results are described in the following section on water quality in the SFEC - NYS, and in greater detail in Appendix H.

Toxicity testing at dredged materials disposal sites in Rhode Island Sound indicates that the constituents do not appear to pose a significant threat to water quality in the Rhode Island Sound area (RICRMC, 2010).

Turbidity

Turbidity is the measure of cloudiness or haziness in water caused by suspended solids (e.g., sediments or algae). Ocean waters beyond 3 miles (4.8 km) offshore typically have very low concentrations of suspended particles and low turbidity. Turbidity in Rhode Island Sound from five studies cited in USACE (2004) ranged from 0.1 to 7.4 mg/L TSS. Bottom currents may re-suspend silt and fine-grained sands, causing higher suspended particle levels in benthic waters. Storm events, particularly frequent intense wintertime storms, may also cause a short-term increase in suspended sediment loads. (BOEM, 2013)

Additional information on turbidity impacts (TSS and deposition) resulting from construction activities in the SFWF and SFEC are described further in the Sediment Transport Analysis report in Appendix I.

Anthropogenic Activities

Current anthropogenic activities that are sources of water quality degradation include point source pollution and nonpoint source pollution. Point source pollutants, which enter waterways at well-defined locations, such as pipe or sewer outflows are the most common sources of water pollution. There are no direct municipal wastewater or industrial point sources for pollution into or within the SFWF and SFEC.

Nonpoint source pollutants, however, are considered the largest contributors to water pollution and water quality degradation. Various human land-use practices, such as agriculture, construction activities, urban runoff, and deposition of airborne pollutants, can introduce nutrients, bacterial and chemical contaminants, and sediments, which all can impact coastal water quality and water resources (NYSDEC, 2018). The states of New York, Connecticut, Rhode Island, and Massachusetts may contribute nonpoint source pollution to the coastal waters near the SFWF and SFEC.

There is a 1.3 square mile (3.24 km^2) site in east-central Rhode Island Sound (the Rhode Island Sound Disposal Site) that was designated in December 2004 for the disposal of dredge material, including approximately 120 million cubic feet (Mft^3; 3.4 million cubic meters [Mm^3]) of sediment from Providence River. The disposal site is located approximately 13 miles (21 km) south of Narragansett Bay, and is approximately 6 miles (9 km) northwest from the nearest part of the SFWF and SFEC (RICRMC, 2010). There are no other active open water disposal sites in federal waters near the SFWF, SFEC – OCS, and SFEC - NYS (USACE, 2018).

South Fork Wind Farm

As described previously, there is minimal available information related to offshore water quality specific to the SFWF. The movement of water and currents through the SFWF are described in Section 4.2.4. In addition, DWSF completed the geophysical and geotechnical (G&G) survey reports of the seafloor within the SFWF to categorize the geophysical and chemical properties of the sediment for the purposes of improved micro-siting of the WTGs, as well as to understand the risks associated with seafloor disturbance and contaminants in the sediment at the SFWF (Appendix H).

South Fork Export Cable

This section discusses water quality and water resources that could be impacted by the SFEC - OCS, SFEC - NYS, and SFEC - Onshore.

SFEC - OCS

The SFEC - OCS extends from the SFWF passing through the OSAMP area, to the boundary of New York State waters, south of the two potential landing sites (Figure 1.1-2). As noted for the SFWF, DWSF completed testing of the seafloor along a proposed SFEC - OCS route corridor to categorize the geophysical and chemical properties of the sediment for the purposes of improved micro-siting of the cable route, as well as to understand the risks associated with seafloor disturbance and contaminants in the sediment along the path of the SFEC - OCS (Appendix H).

SFEC - NYS

The SFEC - NYS extends from where the SFEC - OCS crosses into New York State waters and connects on shore at one of the potential landing sites on the south shore of Long Island in East Hampton. These waters are categorized by the NYSDEC as a Class SA saline surface waterbody and are described as "suitable for fish, shellfish, and wildlife propagation, and survival." The best uses of Class SA waters are "shellfishing for market purposes, primary, and secondary contact recreation and fishing" (NYSDOS, 2018a).

DWSF completed a geotechnical analysis of 12 vibracores collected in New York State waters using techniques described in Appendix H (Fugro Geotechnical Data Report). Samples were analyzed along the two proposed SFEC - NYS routes and landing sites at Beach Lane and Hither Hills, with six cores collected from each approach. Sediment contaminant concentration results from these cores correspond to Class A (No Appreciable Contamination) as defined in the Sediment Quality Thresholds described in the Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999) for in-water/riparian placement.

SFEC - Onshore

Onshore surface waters found along the SFEC - Onshore route options include marine subtidal and intertidal waters, mudflats, as well as a variety of freshwater water resource types including bogs, marshes, ponds, streams, swamps, and various groundwater-influenced ditches and swales. These tidal and freshwater wetlands and waterbody features are regulated by the USACE, NYSDEC, and the town and/or the village of East Hampton. Descriptions of the tidal and freshwater wetlands and water bodies are provided in the Onshore Biological Resources Survey Report (Appendix M) and in Section 4.3.1.

Surface Waters

The fresh and marine water resources of eastern Suffolk County are diverse and abundant with coastal waters forming the county's boundaries to the north, east, and south. Most of the bays along Suffolk County's southern coast are designated as impaired; that is, they are in violation of state water quality standards. A variety of algae blooms proliferates in warmer weather. In addition to regular algae blooms, there are "harmful" algae blooms, "red tides," "rust tides" and "brown tides" comprising different types of problematic microscopic organisms, all linked to excess nitrogen pollution from wastewater-derived effluent (primarily cesspools and septic systems) and atmospheric deposition (Suffolk County Department of Health Services, 2017). These algal blooms could have adverse impacts on swimming, fishing, shellfishing, and boating.

Suffolk County's fresh surface water resources are also considered abundant and generally of sufficient quality to support multiple uses. Within the county, New York State has classified more than 200 freshwater streams and ponds and regulates over 1,050 freshwater wetlands covering nearly 24,000 acres (9,712 ha) (Suffolk County, 2015). Suffolk County surface waters are regularly monitored and their quality is assessed as part of other ongoing programs, including New York State's identification of impaired waters under Section 303(d) (NYSDEC, 2017c).

However, coastal waters throughout eastern Suffolk County are impacted to varying degrees by contaminants introduced by nonpoint sources. Nonpoint sources are considered to be the major contributors of nutrients and pathogens. Nitrogen and pathogens were identified as the parameters with the greatest impacts in terms of limiting uses and stressing the living marine resources. As of 2014, almost 30,000 acres (12,140 ha) are closed to shellfishing year-round, and approximately 9,000 acres (3,642 ha) are closed on a seasonal basis (NYSDEC, 2014; Suffolk County, 2015). Toxic contaminants along with emerging contaminants such as pharmaceuticals and personal care products also play a role in imparting stress on the living resources of Suffolk County's coastal waters.

Most of the marine surface waters in East Hampton area are classified by the NYSDEC as Class SA saline waters (NYSDEC, 2017c; Suffolk County, 2015). The NYSDEC classifies the best usages of Class SA waters are shellfishing for market purposes, primary and secondary contact recreation and fishing. These waters would be considered suitable for fish propagation and survival. Freshwater classifications for waterbodies in the SFEC - Onshore are classified by the NYSDEC as Class C or Class D waters. Class C waters are for fishing. These waters are also suitable for fish propagation and survival. The water quality of Class C waters is suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes. The best usage of Class D waters is fishing. The NYSDEC states that natural conditions, such as intermittency of flow, water conditions are not conducive to propagation of game fishery, or stream bed conditions; therefore, these waters generally would not support fish propagation. The Class D waters would be suitable for fish survival. The water quality also would be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes (NYSDEC, 2017c).

Groundwaters
Long Island is considered a sole source aquifer region, which means that groundwater is the single water supply source. Most of Long Island's drinking water is from groundwater with surface water an insignificant contributor. There are four primary formations which are layered, and make up the Long Island aquifer system: Upper Glacial Aquifer, Magothy Aquifer, Raritan Clay, and Lloyd Aquifer. The three most important Long Island aquifers are the Upper Glacial Aquifer, the Magothy Aquifer, and the Lloyd Aquifer (USGS, 2017; NYSDEC, 2017d). Most of the private groundwater wells and the wells that provide water to farms, golf courses, and industry tap the Upper Glacial Aquifer. Because the population is less dense and the threat of contamination in the aquifer is reduced, public supply wells in eastern Suffolk County also take water from the Upper Glacial Aquifer (LICAP, 2016).

Groundwater throughout most of eastern Suffolk County is of generally high quality (NYSDOH, 2003). All freshwater groundwater in New York State is Class GA, a source for potable water supply (NYSDOS, 2018b) With rare exceptions, potable water supplied by community water systems in Suffolk County meet all drinking water quality standards.

However, according to Suffolk County, median groundwater nitrogen levels in the Upper Glacial Aquifer have risen 40 percent to 3.58 mg/L, and the Magothy Aquifer has seen a 93 percent increase in nitrogen levels to 1.76 mg/L since 1987. While nitrogen levels are generally below the drinking water standard, there are some areas that now exceed the 10 mg/L limit. These aquifers, of course, are recharged through surface water and subsurface wastewater infiltration.

Groundwater along the SFEC – Onshore corridor and at the SFEC – Interconnection Facility generally flows both downward and horizontally to the south, toward the Atlantic Ocean, and ranges from a depth of zero feet below ground surface (bgs) at the Beach Lane and Hither Hills landing sites to approximately 40 feet (12 m) bgs at the proposed SFEC – Interconnection Facility.

The Beach Lane and Hither Hill landing sites are underlain by the Upper Glacial and Magothy aquifers. The area is vulnerable to saltwater intrusion from over-pumping of groundwater (Nemickas and Koszalka, 1982). Groundwater depths to the Upper Glacial Aquifer at the potential landing sites are estimated to be less than 11 feet (3.4 m) from the ground surface (USGS, 2017), but typical groundwater depths along the south coastline of eastern Suffolk County have been shown to be to depths ranging from approximately 4 to 5 feet (1.2 to 1.5 m) bgs (GZA, 2018).

4.2.2.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to impact water quality and water resources, as discussed in the following sections. All impacts are anticipated to be short-term and not result in permanent or long-term impacts to water quality or water resources. An overview of the potential IPFs and their potential impacts to water quality and water resources associated with the SFWF and SFEC is presented in Figure 4.2-2.

The IPFs that may impact water quality and water resources include seafloor and land disturbance, sediment suspension and deposition, discharges and releases, and trash and debris. Supporting information on the ***negligible*** level of impact from the trash and debris IPF is provided in Section 4.1. An evaluation of the remaining IPFs that may impact water quality are presented in the following sections.

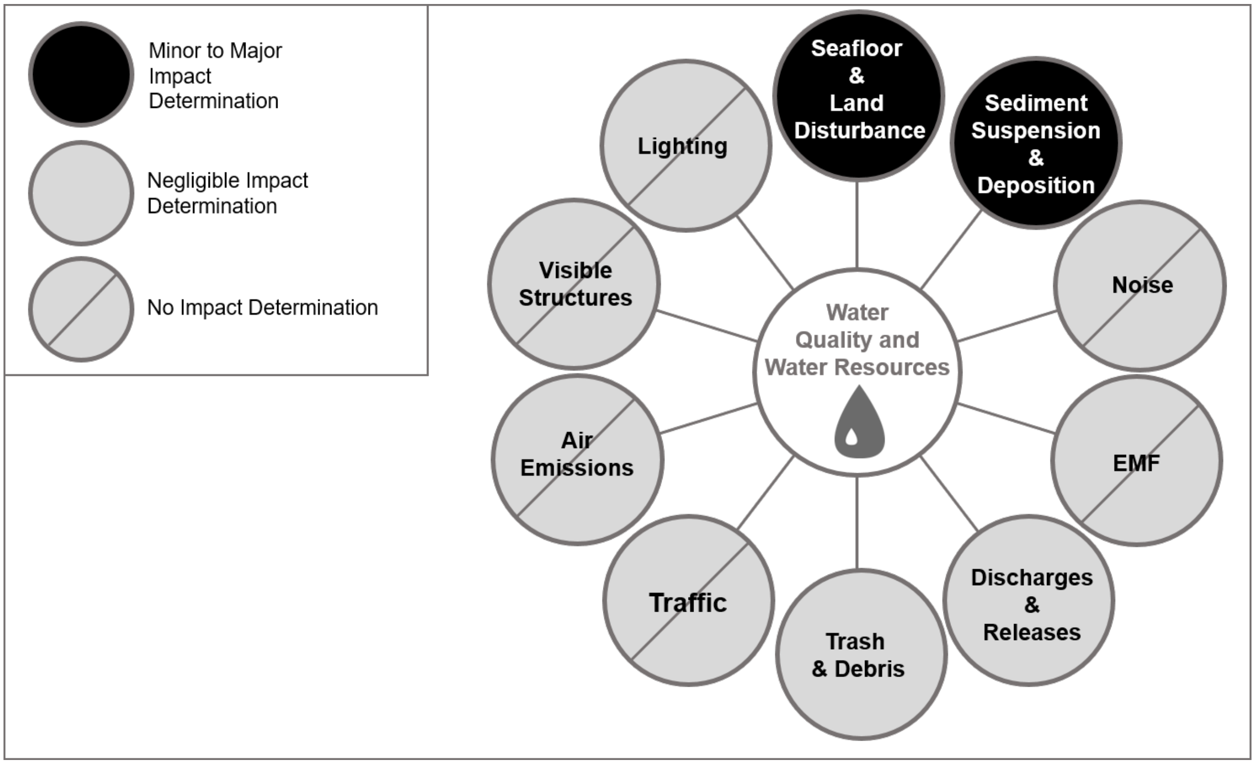

Figure 4.2-2. Impact-producing Factors on Water Quality and Water Resources

South Fork Wind Farm

Construction

Seafloor Disturbance
Impacts to marine water quality resulting from seafloor disturbance activities during the construction of the SFWF are expected to be ***minor*** and ***short-term*.** Sediment disturbance from pile-driving, foundation placement, cable-laying, and the positioning of jack-up barges and vessel anchors. would result in a ***short-term*** and ***localized*** increase in suspended sediment concentrations at the seafloor, as addressed below.

Sediment Suspension and Deposition
All seafloor-disturbing construction activities including foundation work, installation of the inter-array cable using a mechanical/hydro-jet plow, positioning of jack-up barges, and positioning of vessel anchors will result in short-term and localized suspension of sediment in the water column. The magnitude of these impacts depends on the sediment grain size, the volume and rate of sediment suspended, and the currents transporting the sediment. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For mechanical/hydro-jet plow activity, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from mechanical/hydro-jet plow installation of the inter-array cable (Appendix I).

A modeling simulation was conducted on a representative section of the inter-array cable which estimated that the maximum modeled TSS concentration from SFWF inter-array cable installation is 100 mg/L. Water column concentrations of 100 mg/L are predicted to extend up to 131 feet (40 m) horizontally from the mechanical/hydro-jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) within 18 minutes (0.3 hour) from the conclusion of mechanical/hydro-jet plow trenching. Modeling also indicates that elevated TSS concentrations are expected to remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the mechanical/hydro-jet plow at any time during the simulation. These localized impacts to marine water quality would be ***short-term*** and ***negligible*** and should not impact DO, chlorophyll *a*, or nutrient balance in the region. In addition, the sediment in the SFWF is not expected to contain contaminants; therefore, water quality will be affected primarily by the short-term physical suspension of sediments.

Discharges and Releases

Multiple vessels will be used during the construction of the SFWF, as addressed in Section 3.1.3.1. Vessels will comply with regulatory requirements for management of onboard fluids and fuels, including prevention and control of discharges and accidental spills. Vessels will be navigated by trained, licensed vessel operators who will adhere to navigational rules and regulations, and vessels will be equipped with spill handling materials. Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D). The likelihood of discharges and releases is expected to be low and impacts to water quality are unlikely and considered ***negligible***.

Some liquid wastes are allowed to be discharged to marine waters during the construction phase of the SFWF. These discharges include domestic water, deck drainage, treated sump drainage, uncontaminated ballast water, and uncontaminated bilge water, as described in Appendix F. These discharges are not expected to pose a water quality impact to marine water, because these releases would quickly disperse, dilute, and biodegrade (BOEM, 2013). All project vessels will comply with USCG standards in U.S. territorial waters to legally discharge uncontaminated ballast and bilge water, and standards regarding ballast water management.

Other liquid wastes such as sewage, chemicals, solvents, and oils and greases from equipment, vessels, or facilities will be stored and properly disposed on land. A list of chemicals to be utilized during the project is provided as required by 30 CFR 585.626 in Appendix F.

Operations and Maintenance

Seafloor Disturbance

Seafloor disturbance during O&M is expected to only occur if the inter-array cable or scour protection around the WTGs require maintenance that exposes the inter-array cable or disturbs the area around the scour protection. These maintenance activities are considered nonroutine events and are not expected to occur with any regularity. Impacts associated with exposing the inter-array cable or disturbing the scour protection may be similar to, but less frequent than, those described for the construction phase for the SFWF.

In addition, vessels are not expected to anchor during O&M activities unless the inter-array cable or WTGs require maintenance. Impacts associated with potential vessel anchoring during operation are expected to be similar to those discussed in the construction phase for the SFWF.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M would primarily result from vessel anchoring and any maintenance activities associated with a repair of the inter-array cable. These activities are expected to be nonroutine events and not expected to occur with any regularity. If maintenance or an emergency repair of the inter-array cable is required, impacts on water quality would only include local increases in turbidity and resuspension of sediments. Sediment suspension and deposition impacts resulting from vessel activity or maintenance and repair during SFWF O&M are expected to be similar, or less than sediment suspension and deposition impacts described for the construction phase.

Discharges and Releases
There may be a small, temporary diesel generator at each WTG location on the work deck of the foundation. If present, the generator will have a 50-gallon diesel tank with secondary containment. The OSS may also include a small permanent diesel generator with a 500-gallon diesel tank with secondary containment.

The operation of the SFWF is not anticipated to generate any sources of pollutants to the marine environment. To make sure that no discharges of fluids (oil, hydraulic, cooling, etc.) occur even under abnormal circumstances, the WTG and the OSS will be designed for secondary levels of containment as described in more detail in Section 3.1 and in Appendix F. Most maintenance would occur inside the WTGs, thereby reducing the risk of a spill, and no oils or other waste is expected to be discharged during service events. Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D). The original coating system on the towers is designed to last the lifetime of the structure; therefore, no painting is anticipated during the life of the turbines other than to repair minor surface damage. As a result, impacts to surface water quality during O&M is expected to be ***negligible***.

As with vessels associated with construction, any vessels used for O&M activities will comply with USCG regulations and applicable spill prevention, control, and countermeasure (SPCC) plans; therefore, potential impacts from spills are considered unlikely resulting in ***negligible impacts*** to water quality.

The proposed inter-array cable and SFEC do not contain any fluid. There will be no risk to the environment if they are disturbed by anchors or keels because no fluids or materials will be released.

Decommissioning

Decommissioning of the SFWF is expected to have similar impacts to water quality as construction of the WTGs, OSS, and inter-array cable.

SFEC – OCS

Construction

Seafloor Disturbance
Impacts to marine water quality resulting from seafloor disturbance activities during the installation of the SFEC - OCS are expected to be ***minor*** and ***short-term***, consisting of sediment disturbance from cable-laying and the positioning of vessel anchors. These seafloor disturbance activities will result in a ***short-term*** and ***localized*** increase in suspended sediment concentrations, which is described in more detail in the next subsection.

Sediment Suspension and Deposition
Installation of the SFEC - OCS using a mechanical/hydro-jet plow and positioning of vessel anchors will result in short-term and localized suspension of sediment in the water column. The magnitude of these impacts depends on the sediment grain size, the volume and rate of sediment suspended, and the currents transporting the sediment. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For mechanical/hydro-jet plow activity, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport,

and resulting sediment deposition that may result from mechanical/hydro-jet plow installation of the SFEC - OCS (Appendix I).

A modeling simulation was conducted along the SFEC - OCS which indicated that the maximum modeled TSS concentration from SFEC - OCS installation is 1,347 mg/L. The highest TSS concentrations are predicted to occur in locations where the hydro-jet plow passes over pockets of finer sediments (e.g., between VC-217 and VC-220, and again between VC-235 and the end of the route – see Appendix H), but concentrations above 30 mg/L otherwise remain within approximately 328 feet (100 m) of the source during the simulation. For the maximum predicted TSS concentrations, water column concentrations of 100 mg/L or greater are predicted to extend up to 1,115 feet (340 m) horizontally from the mechanical/hydro-jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.4 hours after the conclusion of mechanical/hydro-jet plow trenching. Modeling also indicates that elevated TSS concentrations are expected to remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the mechanical/hydro-jet plow at any time during the simulation. These localized impacts to marine water quality would be ***short-term*** and ***negligible*** and are not anticipated to affect DO, chlorophyll *a*, or nutrient balance in the region. In addition, the sediment in the SFEC - OCS is not expected to contain contaminants; therefore, water quality will be affected primarily by the short-term physical suspension of sediments**.**

Discharges and Releases
Impacts associated with discharges and releases during construction of the SFEC - OCS are expected to be similar to those described for the SFWF inter-array cable.

Operations and Maintenance

Seafloor Disturbance
Seafloor disturbance during O&M would only occur if the SFEC - OCS requires maintenance or repair. Maintenance or repair of the SFEC - OCS is considered a nonroutine event and is not expected to occur with any regularity. Impacts associated with exposing the SFEC - OCS are expected to be similar to but less frequent than those described for the construction phase.

In addition, vessels are not expected to anchor during O&M activities unless the SFEC - OCS requires maintenance. Impacts associated with potential vessel anchoring during operation are expected to be similar to those discussed in the construction phase for the SFWF.

Sediment Suspension and Deposition
Impacts associated with sediment suspension and deposition during O&M of the SFEC - OCS are expected to be similar to those described for O&M of the SFWF inter-array cable.

Discharges and Releases
Impacts associated with discharges and releases during O&M of the SFEC - OCS are expected to be similar to those described for O&M of the SFWF inter-array cable.

Decommissioning

Decommissioning of the SFEC - OCS would have similar impacts as construction

SFEC - NYS

Construction

Seafloor Disturbance
Impacts to marine water quality resulting from seafloor disturbance activities during the installation of the SFEC - NYS would be ***minor*** and ***short-term***, consisting of sediment

disturbance from cable-laying, the temporary cofferdam, and the positioning of vessel anchors. Sediments disturbed during these activities are not expected to introduce contaminants into the water column based on results of vibracores collected along the SFEC - NYS as presented in Appendix G of the Fugro Geotechnical Data Report (Appendix H). These seafloor disturbance activities will result in a short-term and localized increase in suspended sediment concentrations which is described in more detail in the next subsection.

HDD will avoid disturbance to inter-tidal zone, beach, and dunes. For the HDD landing, spoils from the trench excavation will be stored and returned to the trench after the SFEC is installed. Based on the composition of the surficial materials surrounding the boreholes, it is unlikely the drilling mud will penetrate more than 3 feet (0.9 m) of the aquifer (GZA, 2018).

The slurry used for the drilling process is comprised of bentonite clay and water; bentonite is a natural clay that is mined from the earth, and similar to the clay minerals that are present in the drilling location. No impacts to chemistry or hydrogeology are anticipated at any depths.

HDD operations are not expected to threaten private, residential wells because they will occur at safe distances. For example, at areas near the Beach Lane landing site, water pumped from residential wells draw from approximately 5 feet (1.5 m) away from the intake around the well site.

Sediment Suspension and Deposition

Installation of the SFEC - NYS using a mechanical/hydro-jet plow, positioning of vessel anchors, and sediment disturbance during installation of the temporary cofferdam will result in short-term and localized suspension of sediment in the water column. The magnitude of these impacts depends on the sediment grain size, the volume and rate of sediment suspended, and the currents transporting the sediment. For mechanical/hydro-jet plow activity and excavation in the temporary cofferdam, a sediment transport study was completed that estimated the suspended solids concentrations, sediment transport, and resulting sediment deposition that may result from mechanical/hydro-jet plow installation of the SFEC - NYS and temporary cofferdam construction (Appendix I).

The results of the project-specific sediment sampling of vibracores collected along the SFEC - NYS were compared against the sediment quality thresholds for in-water/riparian placement in the Technical Guidance for Screening Contaminated Sediments (NYSDEC-DFWMR, 1999) and determined to correspond to Class A – No Appreciable Contamination. The results of the sediment sampling and chemical analysis are summarized in Appendix G of the Geotechnical Data Report included in Appendix H.

A modeling simulation was conducted along the SFEC - NYS which indicated that the maximum modeled TSS concentration from SFEC - NYS installation is 578 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 394 feet (120 m) horizontally from the mechanical/hydro-jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.3 hours after the conclusion of mechanical/hydro-jet plow trenching. Modeling also indicates that elevated TSS concentrations are expected to remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the mechanical/hydro-jet plow at any time during the simulation.

A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore was also conducted. The maximum predicted TSS concentration from suction dredging at the HDD site is 562 mg/L. Water column concentrations of 100 mg/L are predicted to extend up to 476 feet (145 m) horizontally from the source and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.1 hours after the conclusion of suction dredging.

These localized impacts to marine water quality would be ***short-term*** and ***negligible*** and are not anticipated to affect DO, chlorophyll *a*, or nutrient balance in the region. In addition, based on project-specific vibracore sampling results (Appendix H), the sediment in the SFEC - NYS is not expected to contain contaminants; therefore, water quality will be affected primarily by the short-term physical suspension of sediments.

Discharges and Releases

Impacts associated with discharges and releases during construction of the SFEC - NYS are expected to be similar to those described for the SFWF. However, additional water quality impacts could occur during HDD operations, described as follows.

Both HDD landing site alternatives will require the use of HDD drilling fluid, which typically consists of a water and bentonite mud mixture or another nontoxic drilling fluid. Bentonite is a natural clay that is mined from the earth, and similar to the clay minerals that are present in the drilling location. While the mixture is not anticipated to significantly impact water quality if released, DWSF will implement BMPs during construction to minimize potential release for a frac-out of the drilling fluid associated with HDD activities.

A frac-out occurs when the drilling fluids migrate unpredictably to the surface through fractures, fissures, or other conduits in the underlying rock or unconsolidated sediments. A frac-out could potentially increase turbidity and possibly impact marine and coastal habitats. Because DWSF has avoided sensitive habitats in selection of the cable landing sites, a potential frac-out will result in only **minor** and localized impacts to water quality in the shallow marine and freshwater environments along the SFEC route. In addition, DWSF will develop a HDD frac-out contingency plan for the inadvertent releases of drilling fluid before construction to further minimize the potential risks associated with a frac-out.

Operations and Maintenance

Seafloor Disturbance

Impacts associated with seafloor disturbance during O&M of the SFEC - NYS are expected to be similar to those described for the SFEC - OCS.

Sediment Suspension and Deposition

Impacts associated with sediment suspension and deposition during O&M of the SFEC - NYS are expected to be similar to those described for O&M of the SFEC - OCS.

Discharges and Releases

Impacts associated with discharges and releases during O&M of the SFEC - NYS are expected to be similar to those described for O&M of the SFEC - OCS.

Decommissioning

Decommissioning of the SFEC - NYS will have similar impacts as construction.

SFEC – Onshore

Construction

The activities that could impact water quality and water resources in the SFEC – Onshore include the installation of the underground transition vault at the Beach Lane or Hither Hills landing sites, installation of the underground SFEC – Onshore route, and construction of the SFEC – Interconnection Facility. However, the SFEC – Onshore would be located underground within public roadways and MTA-owned LIRR ROW, or along roadway corridors that are characterized as impervious road surfaces or railroad beds.

Land Disturbance

The underground transition vault will be installed above mean high water, several hundred feet the MHWL within paved roadway or a parking lot and will have a manhole cover at the ground surface. The onshore transition vault will be located outside wetlands and other waterbodies. ***No impacts*** in the intertidal areas from construction at the landing sites are anticipated due to subsurface installation techniques proposed (i.e., HDD) to connect the SFEC – NYS to the SFEC - Onshore transition vault. The transition vault is located within an area identified as an "adjacent area" to a NYSDEC-regulated tidal wetland. However, as discussed in Section 4.3.1, the transition vault and HDD work area will be located within paved surfaces, and erosion and sedimentation controls will be utilized. Therefore, impacts, if they occur, to surface water quality or to surface water resources from construction activities would be ***short-term*** and ***negligible***.

Wetland resources located in the vicinity of the potential routes for the SFEC – Onshore include both freshwater and tidal wetlands. Potential impacts to wetland resources are discussed further in Section 4.3.1 – Coastal and Terrestrial Habitat.

The SFEC – Interconnection Facility will be located adjacent to and on the same parcel as the existing LIPA East Hampton substation on Cove Hollow Road. ***Negligible, short-term impacts*** to water quality and water resources are expected from increased erosion and sedimentation during land clearing and construction for the SFEC – Interconnection Facility. Similarly, impacts to water quality and water resources from erosion of disturbed soils and transport by stormwater during construction of the onshore cable duct bank and the SFEC – Interconnection Facility would be expected to be ***negligible*** and ***short-term***. All earth disturbances from onshore construction activities will be conducted in compliance with the SPDES General Permit and an approved SWPPP.

Discharges and Releases

Although ***no impacts*** from discharges and releases are anticipated during routine construction activities, some spills and accidental releases of fuels, lubricants, and hydraulic fluids may occur. These non-routine spills or accidental releases may result in ***negligible*** and ***short-term impacts*** stormwater quality. However, pollution of local wetlands and waterbodies will be avoided and minimized through the implementation of an SPCC.

Operations and Maintenance

The SFEC – Onshore has no maintenance needs unless a fault or failure occurs. Therefore, O&M of the SFEC - Onshore is not expected to generate sources of pollutants that would impact water quality and water resources.

Land Disturbance

Given that no maintenance needs are anticipated for the SFEC – Onshore, ***no impacts*** to water quality or water resources are expected from land disturbance activities. In the event of a fault or failure, impacts are expected to be similar to those described for the SFEC - Onshore construction phase.

Discharges and Releases

No impacts associated with discharges and releases during O&M of the SFEC – Onshore are expected; however, in the event there is a fault or failure, the impacts are expected to be similar to those described for construction of the SFEC – Onshore construction.

Decommissioning

Decommissioning of the SFEC – Onshore would have similar impacts as construction.

4.2.2.3 Proposed Environmental Protection Measures

The protection of water quality in marine and onshore environments is incorporated into many facets of the SFWF and SFEC design and construction. Site selection and routing, installation techniques and equipment technologies have been selected to avoid and minimize potential impacts to the environment, including water quality.

Several environmental protection measures will reduce potential impacts to water quality.

- Installation of the SFWF inter-array cable and SFEC - Offshore will occur via the mechanical/hydro-jet plow. Compared to open cut dredging/trenching, this method will minimize sediment disturbance and alteration and reduce associated turbidity and TSS.
- Vessels will comply with regulatory requirements related to the prevention and control of discharges and accidental spills.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).
- At the onshore HDD work area for the SFEC, drilling fluids will be managed within a contained system to be collected for reuse as necessary
- An HDD Inadvertent Release Plan will minimize the potential risks associated with release of drilling fluids or a frac-out.
- A SWPPP, including erosion and sedimentation control measures, and a Spill Prevention, Control, and Countermeasures Plan, will minimize potential impacts to water quality during construction of the SFEC - Onshore.

4.2.3 Geological Resources

An overview of the regional geological setting and characterization of the potentially affected environment is provided in this section. These descriptions provide the basis for an evaluation of potential Project-related impacts to geological resources. In accordance with 30 CFR 585.626, G&G survey was conducted for the SFWF and SFEC route, including the two potential landing sites. These surveys collected data for characterizing shallow hazards, geological conditions, geotechnical characteristics, and to provide data for marine archaeological resource assessment and benthic studies. The results of the G&G survey work are summarized below and discussed in detail in a series of G&G reports included in Appendix H. The SFWF and SFEC was evaluated on how Project-related and non-project-related activities could impact geological resources. In addition, geological hazards that could affect SFWF and SFEC siting and development are discussed. Related assessments, such as the characterization of the benthic and shellfish resources anticipated within the SFWF and along the SFEC as well as an assessment of the potential Project-related impacts are found in Section 4.3.2 and Appendix N.

4.2.3.1 Affected Environment

Regional Overview

Regional geology and geomorphology is a product of glacial action and post-glacial coastal processes. The continental ice sheet advanced and retreated several times over the area, leaving behind a wide range of glacial deposits and outwash, depending on the location of the edge of the ice sheet at any given time. The geomorphology of the ocean bottom, shorelines, and island masses in this area are all products of glacial processes. In general, deposits range from fine-grained clays to sand, gravel, and interlaying boulders as evidenced on the exposed erosional cliffs of the offshore islands, such as Block Island (RICRMC, 2010).

The surficial expression of Rhode Island Sound was formed during the advance and retreat of the last continental ice sheet in the northeastern United States, part of the Laurentide glaciation, and the subsequent erosion and reworking of the glacial deposits during the Holocene (10,000 years ago to the present) sea-level rise. Characteristic glacial deposits are moraine and outwash. Glacial moraines are formed at the leading edge of an ice sheet when it is no longer advancing and melting has begun. Typically, moraine includes poorly sorted, fine-grained to gravel sediments with boulders, which can be called glacial till deposits. Glacial outwash (also referred to as glacial drift) is well-sorted material, formed from meltwater within glaciers or from drainage off the front of a glacier across an outwash plain. These can be thick deposits of primarily sandy material and may include incised channels where meltwater drained. Following the glacial period, the shoreline transgressed across the area to its current location, leaving behind fine-grained to sandy fluvial-estuarine deposits (RICRMC, 2010).

In the Atlantic OCS, glacial deposits on top of shallower shelfs resulted in the formation of Block Island, Martha's Vineyard, and Long Island. The shelfs surrounding the island masses, received post-glacial sediments from erosion of the islands.

The sounds in this area – Block Island Sound and Rhode Island Sound – were formed by the presence of the glacial features Block Island, Martha's Vineyard and Long Island, and the Rhode Island and Massachusetts shorelines. Other major geologic characteristics of the area from the SFWF, along the proposed SFEC route to the southern shore of Long Island, are illustrated in Figure 4.2-3 and listed as follows:

- **Cox Ledge**. The SFWF is in an area identified as Cox Ledge on the southern side of Rhode Island Sound. Bottom geology is expected to be sandy with varying amounts of coarser material, including boulders.
- **Rhode Island Sound Channel.** Cox Ledge is bound to the west by a glacial/post glacial drainage channel incised into the ledge. The channel may contain soft fine or sandy sediments, depending on the water current velocities within the channel feature.
- **Block Island Platform and Slope** is located west of the Rhode Island Sound channel and contains glacial deposits which could include boulder zones.
- **Block Island Sound Channel** is located between Block Island and the coast of mainland Rhode Island and appears to have steep side slopes and may contain sandy to soft deposits.
- **Endeavor Shoals (Montauk Point Shoals)** is a shallow platform of glacial deposits extending off Montauk Point. Bottom deposits include sand and gravel, with possible boulders. Actively migrating sand waves up to 16 feet (5 m) tall have been mapped here.
- **Nearshore along Southern Shoreline of Long Island to Wainscott Area** is a medium- to high-energy wave environment, resulting in sandy deposits along the beach front and near shore. Varying amounts of gravel and larger material up to boulders may also be present.

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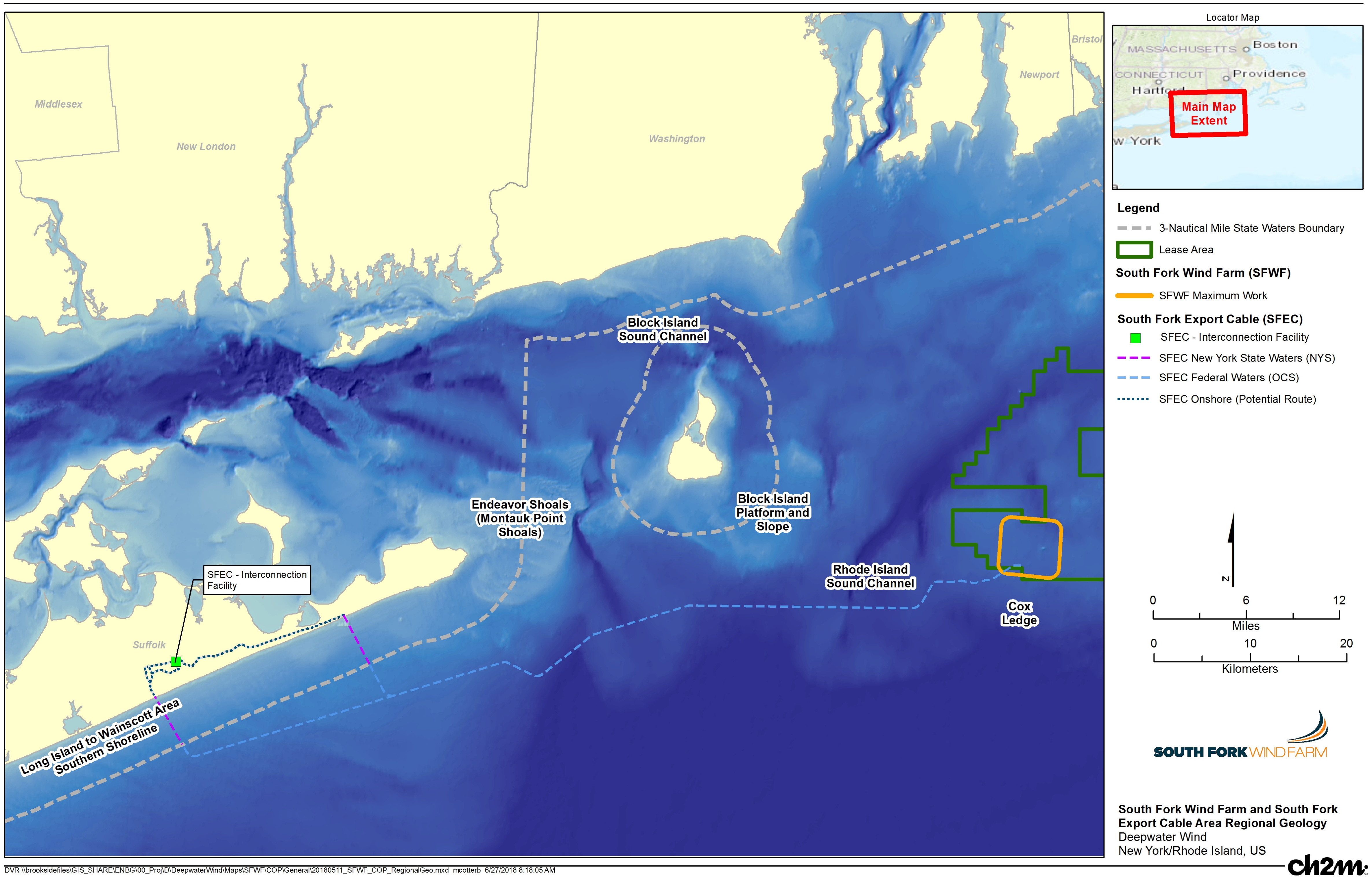

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Figure 4.2-3. South Fork Wind Farm and South Fork Export Cable Area Regional Geology

A site characterization report was developed from the Project-specific survey work completed over the fall and early winter of 2017. This report is incorporated into this section by reference as Appendix H. The regional stratigraphy of the area consists of Cenozoic-aged geologic units that were generally deposited in marine or fluvial environments that formed in response to the cyclic rise and fall of the sea level. Cenozoic aged deposits generally thicken and dip gently seaward. As mentioned earlier, glacial and post-glacial processes during the Quaternary period dramatically shaped the geology of the region encompassing the SFWF and SFEC. In descending order, the site is inferred to be underlain by Quaternary, Tertiary, Cretaceous, and Paleozoic age strata with the youngest marine deposits comprising the uppermost strata as described as follows:

- **Recent – Marine Deposits:** Marine deposits cover much of the seafloor and are comprised of sand to silty sand where moderate to strong currents are present and silt to clay in deeper, quiet water areas.
- **Holocene age – Transgressive Deposits:** As the Laurentide ice sheet melted, sea level rose and the shoreline transgressed across the continental shelf. As the area transitioned into a submerged environment, Holocene age sediments were deposited over the Late Pleistocene surface. The transgressive deposits typically exhibit a fining-upward sequence that commonly consist of gravel and basal sand deposits that transition into silt and clay. The materials may be interbedded or predominantly sand or fine-grained. These deposits are presumed to be thicker where they have filled glacial drainages cut into old surface strata (Appendix H).
- **Pleistocene age – Glacial Drift and Post-Glacial Deposits:** During the Pleistocene, glaciers advanced into region and then retreated as they melted. This depositional environment resulted in a wide variety of materials that were deposited. Glacial deposits underlying the site most likely include tills, moraine (stratified and unstratified), and/or outwash deposits (Veeger et al., 1996). The glacial outwash or ice-contact stratified drift can be characterized as acoustically well-layered sequences although some glacial moraine deposits may result in a more chaotic seismic character (signal) and with numerous indicators of glacial erratics (boulders) (O'Hara and Oldale, 1980).
- **Late Cretaceous/Tertiary age – Coastal Plain Deposits:** The seaward extension of the Atlantic Coastal Plain is likely made up of late Cretaceous to possibly Tertiary age deposits overlaying basement bedrock. These deposits are inferred to be primarily of marine origin with generally parallel strata that dip gently seaward. Limited information is available about the physical properties of the Coastal Plain deposits that underlie the survey area. However, they are inferred to be comprised of semi-consolidated to unconsolidated sand, silt, clay, and gravel deposits (Appendix H).
- **Bedrock:** Consolidated sediments and crystalline bedrock in the region is thought to be comprised of Paleozoic and Proterozoic rock units. Metasedimentary, metavolcanics and plutonic rocks of Proterzoic and early Paleozoic age outcrop along the southern Massachusetts coast and southeastern Rhode Island (Quinn, 1971).

The site characterization report provides a categorization of the area's soil/geomorphic provinces. These regional soil provinces include moraine zones, moraine flank, glacial outwash plain and proximal fan, Pleistocene tunnel valley channel complex, and Holocene channel complex. Characteristics of these provinces are summarized as follows and further explained in Appendix H.

- **Moraine:** Moraine zone sediments are comprised predominantly of dense to very dense sand and gravel. Abundant boulders and cobbles are observed across the seafloor in the side scan sonar and multibeam echo sounder (MBES) bathymetry data (Appendix H). Boulders are the dominant features on within the moraine zone and are generally most exposed between buried paleo-channels in the central and western margin of the SFWF. Diffractions in the seismic data within the glacial unit suggest abundant buried boulders may also be present. Boulders may extend from the seafloor up to approximately 98 feet (30 m) depth. Overall, moraine sediments vary from coarse sands to gravel, cobbles, and boulders – some of which could be greater than 32 feet (10 m) in diameter. Overlying marine and transgressive deposits can range from 0 (missing) to greater than 9.8 feet (3 m) in these areas. The thicker overlying sediment may mask the presence of boulders on the seafloor (Appendix H).
- **Moraine Flank:** The moraine flank zone marks a transition between the boulder-dominant moraine to the glacial outwash plain, where surficial boulders become less prevalent. In general, thicknesses of marine and transgressive sediments are similar to those found in the moraine zone; however, dense glacial outwash sands begin to accumulate in this zone. The thickness of the glacial outwash sands ranges from less than 3.3 feet (1 m) to approximately 8 feet (2.5 m) depth. Exposed and buried boulders are still considered a significant hazard with respect to cable route and burial in this area (Appendix H).
- **Glacial Outwash Plain and Proximal Fan:** The glacial outwash plain extends from the moraine flank near the SFWF to the shore of Long Island, New York. The USGS mapped a proximal outwash fan along the Long Island coast in 1999 extending from the shore landing of the SFEC route (Appendix H). The glacial outwash plain and proximal fan zones are distinguished from other glacial units by a paucity of boulders detected in side scan sonar and bathymetric data. Despite a decrease in the density of surficial boulders in this zone, boulders are likely still present in the subsurface (Appendix H).
- **Pleistocene Tunnel Valley Channel Complex:** It is interpreted that tunnel valley channels formed beneath the terminal glacier lobes across the SFWF and SFEC. These channels partly split the ice and eroded underlying strata to drain subglacial water (Hanson, 2000). A channel complex was identified in the SFWF buried approximately 19.6 to 65.6 feet (6 to 20 m) below the seafloor (Appendix H).
- **Holocene Channel Complex:** A second generation of channels formed post-glaciation as sea-level began to rise. These fluvial channels are filled with re-worked glacial sands and capped by younger marine sediments. Generally, these channels formed in the same location as the older Pleistocene channels; however, the drainage direction reversed as glaciers retreated, with a gradient indicating southward flow. Holocene channel zones are identified in the SFWF and SFEC route (Appendix H).

Seismic activity and other potential hazards are summarized as follows and further detailed in Appendix H. Seismic activity was documented from a review of the Northeast States Emergency Consortium (NESEC) data. NESEC states that approximately 40 to 50 earthquakes are detected annually in the Northeast, which includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont (NESEC, 2017a). Regionally, there has been one occurrence of seismic activity of a magnitude or intensity 4 or greater since 1965, recorded in East Hampton, New York, in March 1992 (NESEC, 2017b).

Potential geological hazards within the region were identified per 30 CFR 585.626. Geologic hazards are considered any significant geological features that can pose a significant hazard with respect to cable route and burial in the SFWF and SFEC. Boulders are the predominant geohazard in the region and may occur anywhere throughout the area based on the glacial history of the region. Sharp topographic features may also pose a hazard. Sand waves up to 16 feet (5 m) tall, have been identified mainly between Block Island and the Montauk Shelf (RICRMC, 2010). Although, sand waves more commonly encountered in the region can be up to 1.6 feet (0.5 m) high and display a wavelength (peak-to-peak) ranging from approximately 65.6 to 164 feet (20 to 50 m) (Appendix H). Geological hazards within the SFWF and along the SFEC are discussed further in the sections below and in the G&G reports included in Appendix H.

South Fork Wind Farm

The SFWF is located approximately 19 miles (31 km) southeast of Block Island, Rhode Island near Cox Ledge, in Rhode Island Sound on the Atlantic OCS. The SFWF is located on a terminal glacial moraine which is defined as a high boulder hazard area (Appendix H). The G&G survey in Appendix H confirmed a high-density of boulders mainly located in the western and central portion of the SFWF. Sources for boulders typically include moraine deposits, glacial outwash, and glacial erratics transported by ice rafts in front of the glaciers and were deposited when the ice rafts melted.

Seafloor and shallowly buried boulders with seafloor expression are observed throughout the SFWF. Seafloor boulders mapped from MBES bathymetry data estimated the diameter of boulders based on the assumption that the most common expression of a surface boulder is circular. After correcting for this assumption, boulder size generally measures 1.5 to 32 feet (0.5 to 10 m) across (Lundblad et al., 2006; Appendix H). The highest density area of seafloor boulders is in the western and central portions of the SFWF and interpreted to represent Ronkonkoma and Harbor Hill moraine deposits observed onshore. Generally, within the SFWF, the areas of fewer seafloor boulders corresponds to the extents of mapped buried paleo-channels. It is inferred that these south-southeast to north-northwest trending paleo-channels eroded and downcut into the glacial moraine deposit and removed boulders in that area. Surficial boulders rise less than 3.5 feet (1 m) to approximately 11.5 feet (3.5 m) above the seafloor, with an unknown number of boulders remaining buried. Slope angles along the flanks of seafloor boulders range from about 3 to over 30 degrees, and some flanks show clear signs of scouring. Unidentified shallowly buried boulders may be present below the widespread seafloor sand waves. (Appendix H)

Sand waves occur across the SFWF. Sand waves are migrating depositional features, generally understood to form from sediments that are transported and redeposited by bottom currents (Wynn and Stow, 2002). Sand wave crests generally trend north – south to northeast – southwest. The sand waves can be up to 1 to 2 feet (0.3 to 0.5 m) high and display a wavelength (peak-to-peak) ranging from approximately 65.6 to 164 feet (20 to 50 m). Mobility assessments (e.g., migration rate and direction) of sand waves across the SFWF area could not be determined based on the available datasets. Lower MBES backscatter intensity (blues and greens) indicate that the sand waves are most likely fine-grained sands to sandy-silts overlain on denser reworked glacial till and/or glacial moraine (yellow and reds). (Appendix H)

Ripples were identified in relative lows between sand wave bodies. The ripples are approximately 0.4 to 1.9 inches (1 to 5 cm) high (trough-to-peak) and display a wavelength (peak-to-peak) ranging from approximately 3.2 to 6.5 feet (1 to 2 m). The crests of the ripples display highly variable trends. The mobility of the ripples could not be estimated with the current data. (Appendix H)

Soil provinces delineated within the SFWF include Moraine zone sediments, moraine flank, glacial outwash plain, Pleistocene tunnel valley channel complex, and Holocene channel complex. (Appendix H)

A Pleistocene Tunnel Valley Channel Complex was identified in high resolution geophysical seismic data in the SFWF area as large valleys buried approximately 65.6 feet (6 to 20 m) below the sea floor. The base of this complex is characterized by high-amplitude reflector that corresponds to harder material composing the valley beds. The walls and base of these channels likely contain reworked glacial material, including boulders, cobbles, and gravel pavement (i.e., dense material that would cause high positive impedance contrast with overlying outwash sand infill). Channel floor elevation may vary greatly within tunnel valleys, preserving drumlins, eskers, and transverse ridges. This undulating base is generally attributed to the water flowing under hydrostatic pressure in enclosed conduits. (Appendix H)

Three channels transect the SFWF survey area – the Western Channel, Central Channel, and Eastern Channel. Despite elevation variation of the channel base, overall each channel deepens to the north, suggesting glacial drainage to the north. The Western Channel trends north-south and generally underlies the planned locations for the western-most column of WTGs. This is the smallest tunnel valley channel in the complex, measuring approximately 2,624 feet (800 m) across. Thickness of infilled sediment varies from approximately 13 to 65.6 feet (4 to 20 m). The southern extent of the Central Channel is divided into thin fingers approximately 328 to 984 feet (100 to 300 m) wide. These fingers are shallow and only cut approximately 16.4 feet (5 m) into the underlying strata. They join to create a single channel (approximately 5,905 feet [1,800 m] across) that incises to the underlying moraine approximately 49 to 65.6 feet (15 to 20 m). Channel geomorphology changes again to the north of the SFWF as the Central Channel splits into two fingers.

The Eastern Channel exhibits a dramatically different morphology than the other two. This tunnel valley formed over deformation within the underlying unit, which is inferred to have been caused by glacial loading (Hanson, 2000). Compressional deformation thickened and folded the underlying strata, while also creating a preferential pathway for subglacial water to drain to the north. This preferential drainage pattern formed the deepest and widest of the three channels. This channel cuts at an oblique angle to the other two Pleistocene channels. Like the other two channels, channel bed morphology varies significantly in the Eastern Channel, ranging from about 19 to 82 feet (6 to 25 m) of sediment infill. However, the Eastern Channel is generally straighter than the other two channels, likely because of a flow constraint caused by deformation. It is the widest channel in the tunnel valley channel complex, measuring approximately 7,545 feet (2,300 m) wide and contains a southward branching segment composed primarily of fine-grained sediment. (Appendix H)

Compared to the Pleistocene-aged complex, Holocene-aged channels are narrower and generally contain less than 3.2 feet (1 m) of sediment. Presence of Holocene Western and Central Channels in the SFWF span approximately 1,312 to 1,640 feet (400 to 500 m) and 1,640 to 2,624 feet (500 to 800 m), respectively. The branches of the two channels join in the southern extent of the survey area. Morphology of the Holocene Eastern Channel is drastically different than the underlying Pleistocene-aged channel. The channel branches from a single segment approximately 3,280 feet (1,000 m) wide into two smaller segments to the southeast. Each branch measures about 984 feet (300 m). (Appendix H)

The seafloor also includes fine-grained to coarse-grained sediments. Underneath the seafloor surface, a layer of sand with gravels was encountered, with a nominal thickness between approximately 3.2 to 6.6 feet (1 to 2 m) with some interbedded fine soil content, and below a layer of low plastic clays with sand and gravel. Other geological resource characteristics at the SFWF are summarized further in the Geotechnical Data Report and the Sediment Profile Imaging and Benthic Survey Report included as Appendix H.

South Fork Export Cable

The eastern end of the SFEC – OCS route starting at the SFWF until the bend in the route as represented between mile marker 3 to mile marker 13, shown on Figure 4.2-4, had a high proportion of gravel, cobbles, and boulders on the upper surface. Underneath fine-grained sands and clay were present. Westward between mile markers 6 and 31 along the SFEC – OCS route the surface was generally fine sand overlaying layers of either clayey sand or silty sand. Further west along the SFEC corridor, the gradation increases and generally includes various percentages of fine, medium, and coarse sand and gravel.

The highest density areas of observed seafloor boulders are located from mile marker 0 to mile marker 13 and mile marker 47 to mile marker 58. Glacial deposits encountered in the SFEC route were outwash plain/proximal fan. The outwash plain consists of dense to very dense sands of varying particle size with seams and lenses of fine gravels. Mean tip resistance calculated from cone penetration testing (CPT) in the outwash plain is 17.7 megaPascals (MPa) with a standard deviation of 7.9 MPa. Outwash sand thickness is estimated to be greater than the penetration of the longest geotechnical exploration in this zone: CPT C-300 at 35.37 feet (10.78 m). All vibracores and CPTs in the outwash plain terminated in this unit. (Appendix H)

A proximal outwash fan exists along the Long Island Coast from the shore landing of the SFEC at Beach Lane and terminates near Hither Hills (Foster et al., 1999). Mapping conducted as part of the Site Characterization Report (Appendix H), indicates that the glacial outwash extends beyond this initial mapped outwash fan, approximately 12.4 miles (20 km) further to the northeast along the proposed SFEC route. The general thickness of marine deposits, transgressive sediments, and glacial outwash sand increase with distance from the east, except for a rocky outcrop area long the proposed cable route between mile marker 47 and mile marker 58. The proposed SFEC route was deviated around this area to avoid the surficial boulders and rocky outcrops and to improve cable burial feasibility.

Pleistocene channel complexes are identified along the SFEC route between mile markers 13 and 39, mile markers 43 and 54, and mile markers 77 and 80 (Appendix H).

Holocene channel zones are identified along the SFEC route between mile markers 14 and 23, mile markers 27 and 30, mile markers 33 and 47, and mile markers 71 and 79 (Appendix H).

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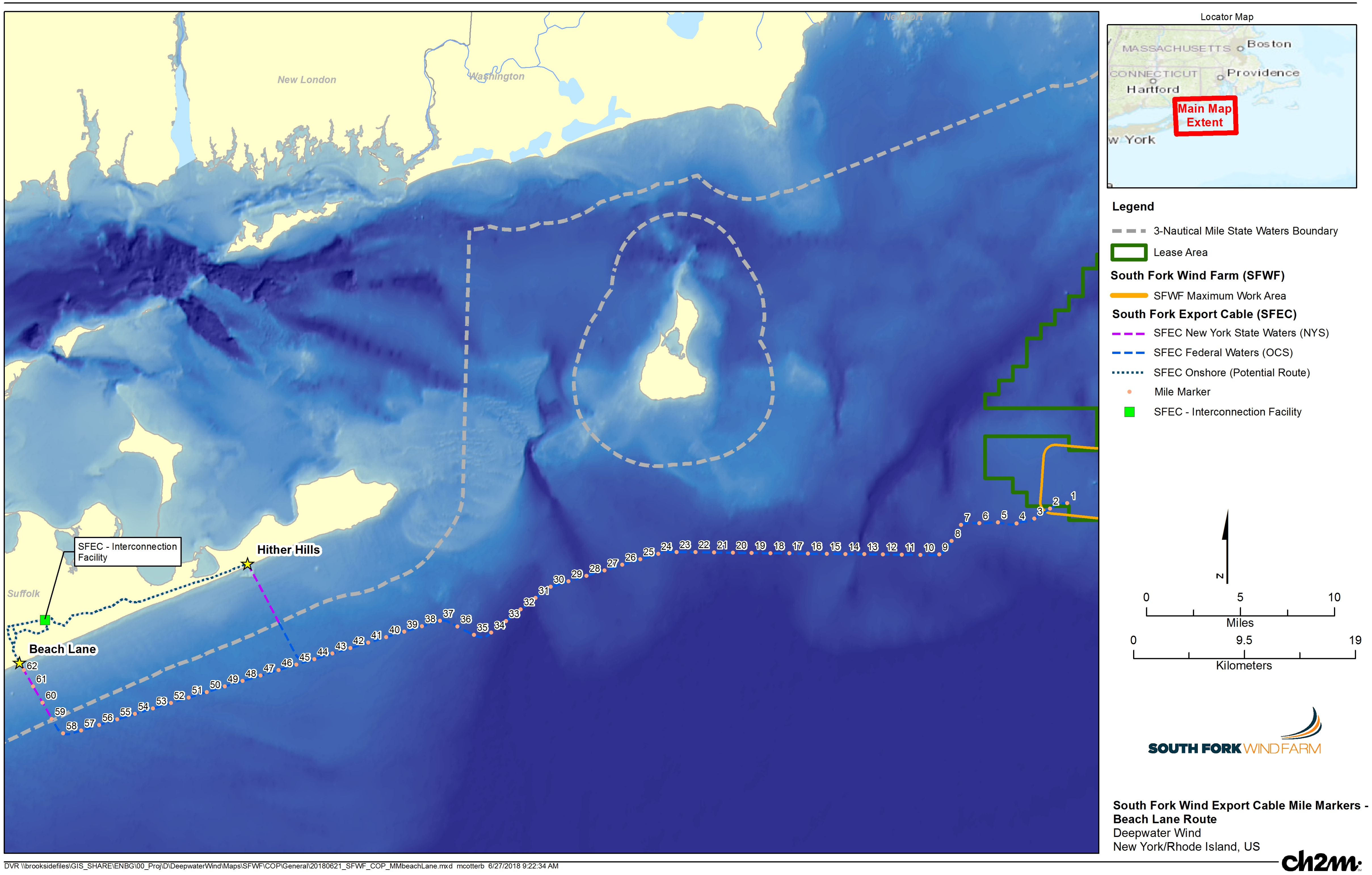

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Figure 4.2-4. South Fork Wind Export Cable Mile Markers - Beach Lane Route

SFEC – OCS and SFEC – NYS

Geology along the SFEC route on the OCS is characterized by recent fine marine surficial sediments, with underlying glacial drift, and the possibility of boulders and other coarser materials occurring in the subsurface and at the surface. As shown in Figure 4.2-4, the SFEC route crosses the southern ends of the Rhode Island Sound and Block Island Sound paleochannels and may encounter shallow representations of these features.

As the SFEC route enters shallower New York State waters, the surface layer of re-worked glacial deposits may become increasingly coarser sands, with the continuing possibility of boulders. The SFEC landing site approach at either potential Beach Lane or Hither Hills locations consists of similar glacial outwash deposits.

SFEC – Onshore

The land mass of Long Island is also a product of glacial and post-glacial processes. The Wisconsin epoch is predominantly responsible for the surficial geology of the modern Long Island region. During the Wisconsin glacial stage, an ice sheet moved to approximately the center of Suffolk County, New York and stopped, leaving before it two terminal moraines, which are now known as the Ronkonkoma moraine and the Harbor Hills moraine. After the ice sheet reached its southern limits in Suffolk County, it began to melt. The melted water flowed into streams and carried a large volume of sand and gravel farther south. This sand and gravel was deposited in two relatively flat outwash plains; one between the Ronkonkoma moraine and the Atlantic Ocean, where the South Fork of Long Island and the town of East Hampton are located, and the other between the Harbor Hill moraine, which extends from the western edge of Nassau County, along the north shore of Long Island, to its easternmost point at Fisher’s Island, and the Ronkonkoma moraine. (USDA, 1975)

The Ronkonkoma moraine and the Harbor Hills moraine are parallel in the western half of Long Island but diverge near Peconic Bay. The Harbor Hill moraine and the Ronkonkoma moraine are comprised primarily of poorly sorted till, including sand, pebbles, rocks, and boulders, while the outwash plains located between the moraines, and south of the Ronkonkoma moraine, include varying amounts of well sorted sand and gravel. The Ronkonkoma moraine was deposited as a terminal moraine at the end of a glacial lobe and forms the spine of Long Island (Sanders and Merguerian, 1994). Streams draining southward at the edge of the glacier deposited an outwash plain of sandy material that is now the southern Long Island coastal zone and shore. In general, at low ground elevations near the shore, the groundwater table is encountered at shallow depths (Como et al., 2015). At higher ground elevations along the SFEC onshore route, the groundwater table may occur at deeper depths.

The bedrock under Suffolk County varies in depth from approximately 400 feet (121 m) bgs along the northern coastline of the town of Southold, to approximately 2,000 feet (609 m) bgs along the central part of the southern coastline of Fire Island (i.e., an outer barrier island parallel to the south shore of Long Island). Depth to bedrock, proximate to the SFEC – Onshore, ranges from approximately 1,400 feet (426 m) bgs at the Beach Lane landing site to approximately 1,300 feet (396 m) bgs at the point of the SFEC – Onshore intersection with the LIRR ROW (USGS, 1995).

The soils along the SFEC – Onshore and at the SFEC – Interconnection Facility were characterized in accordance to the Soil Survey of Suffolk County, New York (USDA, 1975) (the “Soil Survey”), in which soils were classified according to distinct characteristics and placed accordingly into series and mapping units. A series is a group of mapping units formed from partly disintegrated and partly weathered rocks that lie approximately parallel to the surface and that are similar in arrangement and differentiating characteristics, such as color, structure, reaction, consistency, mineralogical composition, and chemical composition. Mapping units differ from each other according to slope and may differ according to characteristics, such as texture (USDA, 1975). The predominant soil series found along the SFEC – Onshore and at the SFEC – Interconnection Facility include Bridgehampton, Carver, and Plymouth series (USDA, 1975).

The landing sites and surrounding areas are underlain by beach deposits, consisting of beach sand and gravel, and dune sand, that range from less than 5 feet (1.5 m) to approximately 20 feet (6 m) in thickness (USDA, 1975). The beach deposits are underlain by glacial deposits consisting of clay, silt, clayey and silty sand, sand, and gravel, that comprise the upper glacial aquifer, which ranges up to approximately 200 feet (60.9) in thickness below the landing sites and is one of the principal water sources of Suffolk County. According to data from the USGS, depth to groundwater around the landing sites typically ranges from approximately 4 to 5 feet (1.2 to 1.5 m) bgs (GZA, 2017).

4.2.3.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to cause both direct and indirect impacts on geological resources, as discussed in the following sections. IPFs associated with the construction, O&M, and decommissioning phases for the SFWF and SFEC are described in Section 4.1.

An overview of the potential impacts to geological resources associated with the SFWF and SFEC is presented on Figure 4.2-5. IPFs not expected to impact geological resources are depicted with slashes through the circle. For the IPFs that could impact geological resources, but were found to be negligible in the analyses in Section 4.1, the circle is gray without a slash. The IPFs with potential to impact geological resources are indicated by gray shading.

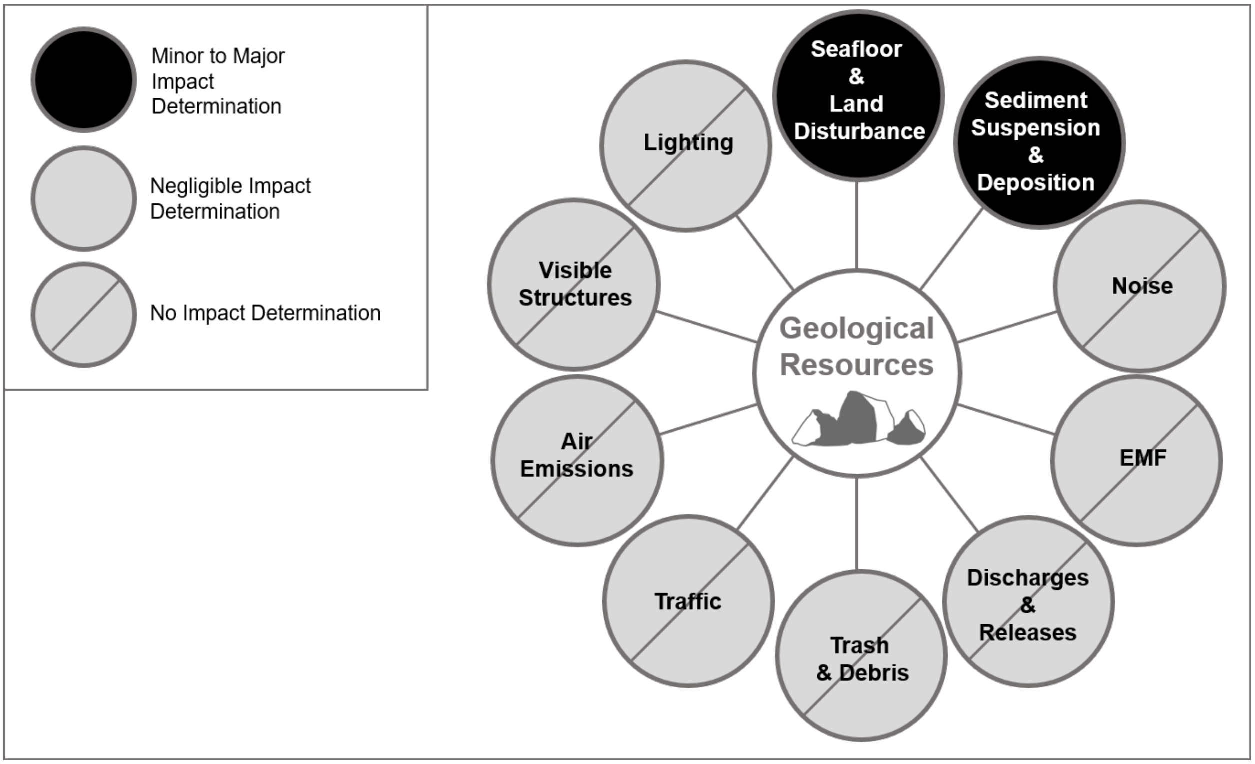


Figure 4.2-5. Impact-producing Factors on Geological Resources

South Fork Wind Farm

Construction

Seafloor Disturbance

Seafloor disturbance from foundation installation, inter-array cable installation, and anchoring would impact geologic resources. Mainly surficial and subsurface geological resources at specific installation locations would be impacted from penetration (i.e., pile driving), mechanical and hydraulic cable embedment, and anchoring. If monopile or jacket foundations are installed, subsurface impacts may extend up to 197 feet (60 m) into the seabed while gravity base foundations will penetrate approximately 10 feet (3.1 m) into the seabed. Alteration of the strata by the installation of the foundations will occur at each pile point but would not result in a broader scale impact to the geologic setting of the area. Impacts from seafloor disturbances during construction described above would be ***short-term localized*** and ***minor***. The presence of boulders on the seafloor within the SFWF are the primary geologic hazards identified by pre-construction assessments, as described in the Site Characterization Report included in Appendix H. The siting of the SFWF areas avoided shallow hazards to the extent practicable. However, where construction activities result in the movement of boulders or depositional features (e.g., ripples, sand waves) impacts would be ***short-term***, ***localized*** and ***minor***.

Sediment Suspension and Deposition

Surficial geological resources, mostly comprised of (recent) Holocene pre-transgressive and transgressive marine sediments, would be impacted mainly because of sediment suspension/deposition from inter-array cable installation resulting in localized changes to surficial geology and bottom topography. Installation of the inter-array cable using the mechanical/hydro-jet plow is expected to result in the disturbance and temporary suspension and re-deposition of these deposits, as described in the Hydrodynamic and Sediment Transport Modeling Results Report included in Appendix I. Recent marine deposits would also be disturbed during foundation installation. Sedimentation resulting from the installation of the inter-array cable would be limited to the area immediately adjacent to the burial route. These impacts are considered to be s***hort-term, localized***, and ***minor*** because of the limited extent of sedimentation predicted by the model and highly dynamic nature of the marine sediments in the SFWF.

As explained above in the discussion of seafloor disturbance, the presence of boulders and topographic features (channels and sand waves) on the seafloor within the SFWF are the primary geologic hazards identified by pre-construction assessments, as described in the Site Characterization Report included in Appendix H. The siting of the SFWF inter-array cable avoids these hazard areas to the extent practicable. However, where construction activities result in the movement of boulders or depositional features (e.g., ripples, sand waves) impacts would be ***short-term***, ***localized*** and ***minor***.

Operations and Maintenance

Seafloor Disturbance
Once the SFWF is constructed and operational, no impacts to geologic resources are anticipated except for vessel anchoring during planned and unplanned maintenance, and the very low likelihood that the inter-array cable requires replacement, relocation, or additional armoring. In the very rare circumstances that seafloor disturbances occur during the O&M phase, impacts would be similar to those discussed for construction of the SFWF.

Sediment Suspension and Deposition
Scour at the base of the WTG foundations will locally impact surficial geology during the O&M phase. Scour protection, if required, will be placed at the base of each WTG foundation and on top of the segments of the inter-array cables where they emerge from the trench and connect into the WTG. ***Negligible impacts*** to Holocene marine deposits from sediment suspension and deposition around the artificial structures are expected during O&M, but broad-scale geologic resources impacts are unlikely.

Decommissioning

Impacts to geologic resources from seafloor disturbance and sediment suspension and deposition would be similar to those impacts described for construction if removal of the SFWF components takes place using similar equipment and methods.

SFEC – OCS and SFEC – NYS

Construction

Seafloor Disturbance
Impacts to geologic resources during construction of the SFEC in OCS waters would be limited to the mechanical/hydro-jet plowing of the seafloor during cable installation, vibratory pile driving for sheet pile cofferdam, or gravity cell installation for the sea-to-shore transition. Similar to the seafloor disturbance described above for the SFWF foundations and inter-array cable, trenching and sheet pile installation would result in ***short-term*** and ***minor impacts*** to localized geologic resources such as marine deposits (sediments) and near-surface stratigraphy. Broad-scale geologic features would not be measurably impacted.

In New York State waters, SFEC installation impacts to Holocene deposits consisting of medium to coarse sand with some gravel resources would be from the SFEC sea-to-shore transition (e.g., HDD) Impacts to the Holocene sediment layers at this depth would be ***minor*** *because the cable will be installed within the conduit.* This technique will minimize impacts, compared to an open trench installation. Also, measurable impacts to geologic resources from the SFEC cable installation, including the HDD process, would be ***negligible*** to the overall geologic resources and processes in the area. The temporary cofferdam installed nearshore would result in ***short-term, localized,*** and ***minor impacts*** to Holocene sediments but ***no permanent*** or ***long-term impact*** to geologic resources are expected.

Sediment Suspension and Deposition
According to the modeling in the Sediment Transport Analyses report in Appendix I, sediment will be disturbed and temporarily suspended during installation of the SFEC using mechanical/hydro-jet plow techniques and during suction dredging of the cofferdam for the offshore sea-to-shore transition. The model predicted that sediment suspension and deposition resulting from installation of the SFEC – OCS and SFEC – NYS will be limited to the area immediately adjacent to the burial route. Localized impacts to marine deposits would be ***short-term*** and ***minor***.

Sediment suspension and deposition from suction dredging at the sea-to-shore transition were predicted to occur within a very small radius of the activity without the confinement of the steel sheetpile or gravity cell cofferdam. Any localized impacts to marine deposits would be ***short-term*** and ***minor***.

Operations and Maintenance

Seafloor Disturbance
No impacts to geological resources from SFEC operations are anticipated. If mechanical damage to the SFEC – Offshore should occur, repair of the cable may result in disturbance to the seafloor from maintenance vessels and activities. Localized impacts to marine deposits would be ***short-term*** and ***minor***.

Sediment Suspension and Deposition
No impacts to geological resources from SFEC operations are anticipated. If mechanical damage to the SFEC – Offshore should occur, repair of the cable may result in sediment suspension and deposition from maintenance vessels and activities. Localized impacts to marine deposits would be ***short-term*** and ***minor***.

Decommissioning

Impacts to geologic resources from seafloor disturbance and sediment suspension and deposition would be similar to those impacts described for construction if removal of the SFEC takes place using similar equipment and methods.

SFEC – Onshore

Construction

Land Disturbance
HDD will be used to connect the SFEC – NYS with the SFEC – Onshore in the sea-to-shore transition area resulting in ***long-term minor impacts*** to the subsurface geology along the cable alignment. No impacts to the geomorphology of the beach and adjacent coastal area will occur because of the subsurface installation technique.

Previously disturbed areas within and along roadways and railways will be excavated and trenched for burial of the SFEC – Onshore. The upper layers of soil in these areas will be reconfigured. Following installation all trenches will be back-filled and surface grades will be returned to pre-construction conditions where practicable. Overall, impacts to geological resources would be ***short-term*** and ***negligible***.

Sediment Suspension and Deposition
Sediment suspension and deposition along the SFEC – Onshore would have ***negligible impacts*** to surficial geology because all earth disturbances from onshore construction activities will be conducted in compliance with the SPDES General Permit and an approved SWPPP.

Operations and Maintenance

Land Disturbance
Negligible impacts to geological resources could occur during the O&M phase in the unlikely event that SFEC - Onshore requires repair or replacement.

Decommissioning

Impacts to would be similar to impacts described for construction.

4.2.3.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to geological resources.

- The SFWF and SFEC - Offshore will avoid, to the extent practicable, identified shallow hazards.
- Installation of the SFWF inter-array cable and SFEC - Offshore will occur via the mechanical/hydro-jet plow. Compared to open cut dredging/trenching, this method will minimize impacts to surficial geology.
- Use of DPV for cable installation for the SFWF inter-array cable and SFEC - Offshore will minimize impacts to surficial geology, as compared to use of a vessel relying on multiple-anchors.
- A plan for vessels will be developed prior to construction to identify no-anchor areas inside the MWA to protect sensitive areas or other areas to be avoided.
- The SFEC sea-to-shore transition will be installed via HDD to avoid impacts to the dunes, beach, and near-shore zone. SFEC - Onshore is sited within previously disturbed existing ROWs.

4.2.4 Physical Oceanography and Meteorology

The physical oceanographic and meteorological conditions within the SFWF and SFEC are described in this section. Physical oceanographic conditions include circulation, currents, and water column stratification by temperature and salinity. Meteorological conditions include wind speed and direction, and occurrence of storms. This section is intended to provide an overview of conditions to form the basis of evaluating potential impacts of the Project construction, operation, and decommissioning on physical processes. These topics will be assessed in greater detail during the FDR and Fabrication and Installation Report (FIR) phases in accordance with 30 CFR 585.700-702.

4.2.4.1 Affected Environment

The following are key sources of oceanographic and meteorological information on the SFWF and SFEC reviewed in the support of the development of this COP section:

- *Rhode Island Ocean Special Area Management Plan* (OSAMP) (RICRMC, 2010).
- Environmental Assessment prepared by BOEM for the RI-MA WEA, Appendix C: *Additional Resource Information: Geology and Physical Oceanography* (BOEM, 2013).

- Wind speed and directional data obtained from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) product for 2001-2010 (Saha et al., 2010) and from Environmental Assessment prepared by BOEM for the RI-MA WEA (BOEM, 2013).
- Data on regional current and circulation data for the area was obtained from the HYbrid Coordinate Ocean Model (HYCOM) hindcast reanalysis performed by the U.S. Naval Research Laboratory (Chassignet et al., 2007).
- The National Aeronautics and Space Administration (NASA) Global Modeling and Assimilation Office project, the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) provides wind data from 1980 to the present (Gelaro et al., 2017).
- The Integrated Ocean Waves for Geophysical and Other Applications (IOWAGA), funded by the European Commission, provides wave-related information through a model that simulates sea state conditions from 1996 to 2016.
- NOAA's National Data Buoy Center (NDBC) manages a U.S. data buoy network to collect meteorological and environmental data and includes buoys and a Coastal-Marine Automated Network (C-MAN) (NOAA, 2018; Appendix X).
- Current and water level data was also extracted from a Global Tide Model included in a model package created by IOWAGA called MIKE 21 (Appendix X).
- A time series of sea-level data was obtained from Oregon State University's (OSU) Tidal Inversion Software model that assimilated tide gauges along the East coast.
- Tidal elevations information was obtained from the Admiralty Total Tide (ATT) software (Appendix X).
- Tropical cyclone track data was obtained from the International Best Tracks for Climate Stewardship (IBTrACS) database (version IBTrACS v03r09), which is a historical global dataset of tropical cyclones.

Regional Overview

The SFWF is located at the southern end of Rhode Island Sound, which is bounded by Block Island to the west, mainland Rhode Island to the north, Martha's Vineyard to the east, and is open to the Atlantic Ocean to the south. The SFWF and a portion of the SFEC are at the southern end of the OSAMP study area. Block Island Sound lies to the west of Block Island and extends to Long Island Sound, as depicted in Figure 1.1-2 in Section 1. The SFEC - OCS and SFEC - NYS occupy waters south of Block Island and Montauk until the cable makes landfall.

Circulation

Circulation patterns are influenced by winds, tides, differences in water density (dependent on temperature and salinity), and geomorphology (bathymetry and land masses). Overall, net transport of water from Rhode Island Sound moves toward the southwest and west. However, bottom water may flow toward the north, particularly during the winter. Circulation patterns are influenced by water moving in from Block Island Sound and the colder water coming in from the Gulf of Maine. Also, "warm core rings" split off from the northward flowing Gulf Stream could move into Rhode Island Sound, bringing entrained warm water biota. (RICRMC, 2010)

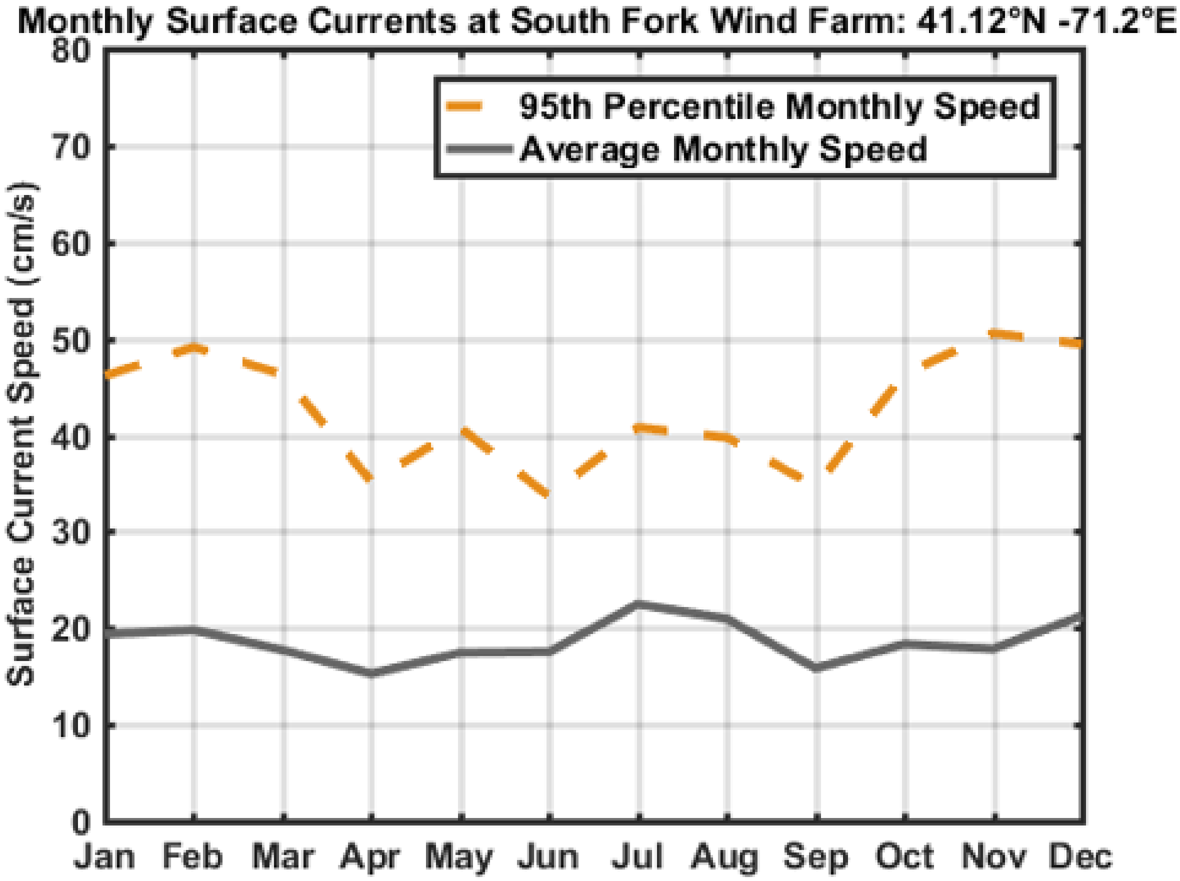
Regionally, currents from Rhode Island Sound meet outflow from Block Island Sound off Montauk Point and flow towards the southwest below Long Island. Although current flow south of Long Island follows the overall southwestern movement, nearshore currents flow towards the east. (RICRMC, 2010)

Waves generally move across the area from the south and are on average between 3.3 and 9.8 feet (1 and 3 m). Highest storm waves are up to 30 feet (9 m). Under normal conditions, wave action results in little disturbance to bottom waters or sediments. Semi-diurnal (i.e., twice daily) tides come in from the southeast, with an average tidal range of 3.2 feet (1.0 m) across Block Island and Rhode Island Sounds. (RICRMC, 2010)

Evaluation of Available Data Sets for Circulation

As a preliminary assessment of ocean currents within the SFWF and SFEC, statistics were generated based on modeled hindcast reanalysis of inputs for the years 2001 to 2010, from the HYCOM 1/12-degree global simulation assimilated with Navy Coupled Ocean Data Assimilation (NCODA) from the U.S. Naval Research Laboratory (Halliwell, 2004). The 2001 to 2010 data period was chosen as the most recent 10 years of re-analysis data for HYCOM currents and its matching wind CFSR that is available.

The study area for this assessment was centered on the SFWF, but spatial coverage extended to the SFEC route. At the SFWF, average surface current speeds were consistently about 8 inches per second (in./s; 20 centimeters per second [cm/s]) throughout the year, with the strongest currents of 20 in./s (50 cm/s; as the 95th percentile) in late fall and early spring, as depicted in Figure 4.2-6. Estimated average currents at depth of 98.4 feet (30 meters) range between approximately 2.8 in./s (7 cm/s) as the mean, to 6.7 in./s (17 cm/s) as the 95th percentile. Currents show directional variability from the surface to the bottom depth, changing from easterly in the surface to north-easterly/west-south-westerly at depth. Differences between surface currents and seabed currents can be attributed partly to the influence of wind effect on the surface layer and bathymetric features around the study area on the bottom layer, as depicted on Figure 4.2-7.



Sources: Halliwell, 2004; Chassignet et al., 2007

Figure 4.2-6. HYCOM Monthly Current Speed Statistics Near the SFWF and SFEC Study Area from January 2001 to December 2010

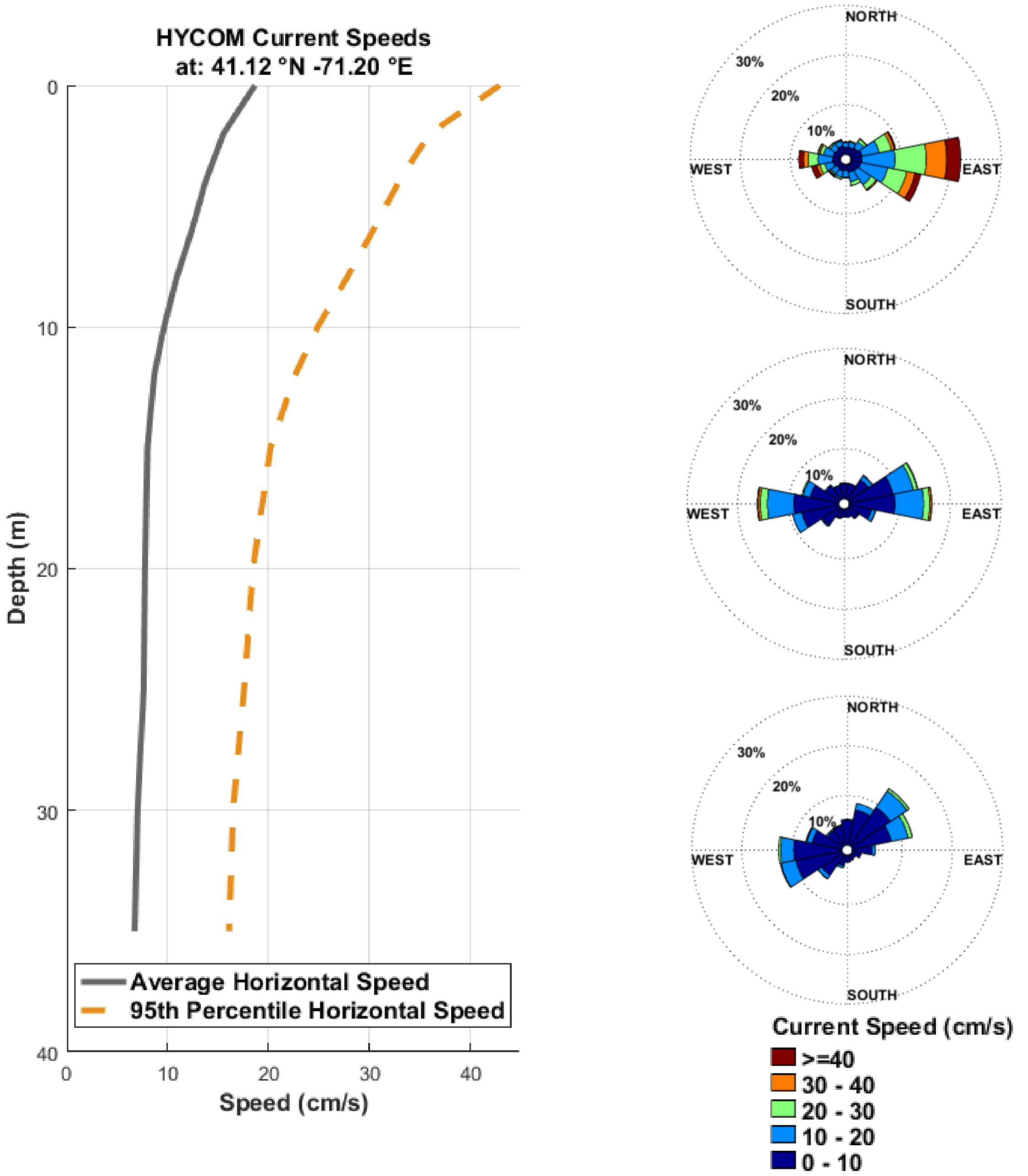
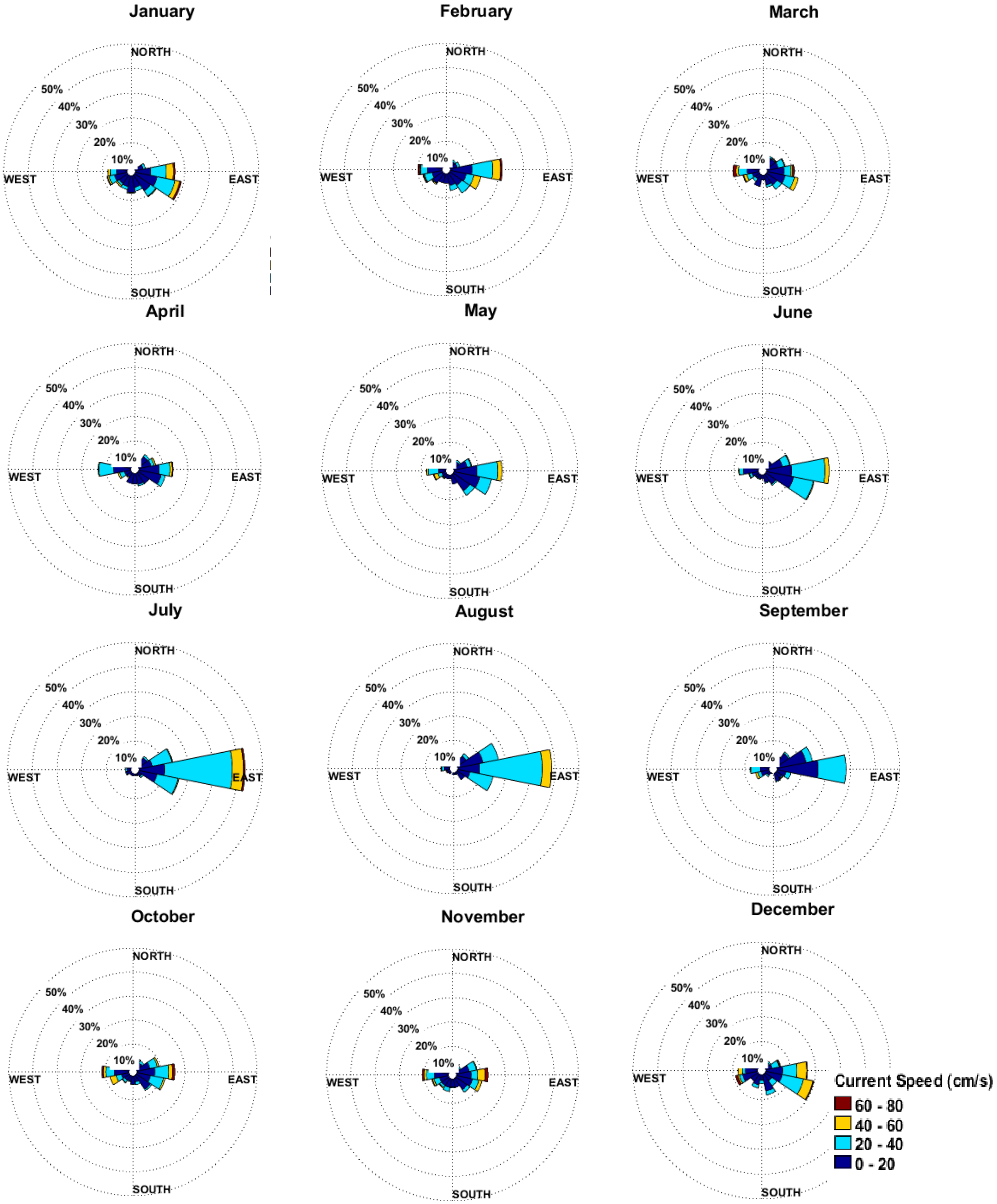


Figure 4.2-7. Vertical Profile of the HYCOM 2001-2010 Horizontal Current Speed (cm/S) Dataset

Figure depicts average and 95th percentile speed and variation with depth near the study area. Current roses of annual current are from the surface, 15 m and 30 m water depths. Current roses show the direction to which the current is flowing.

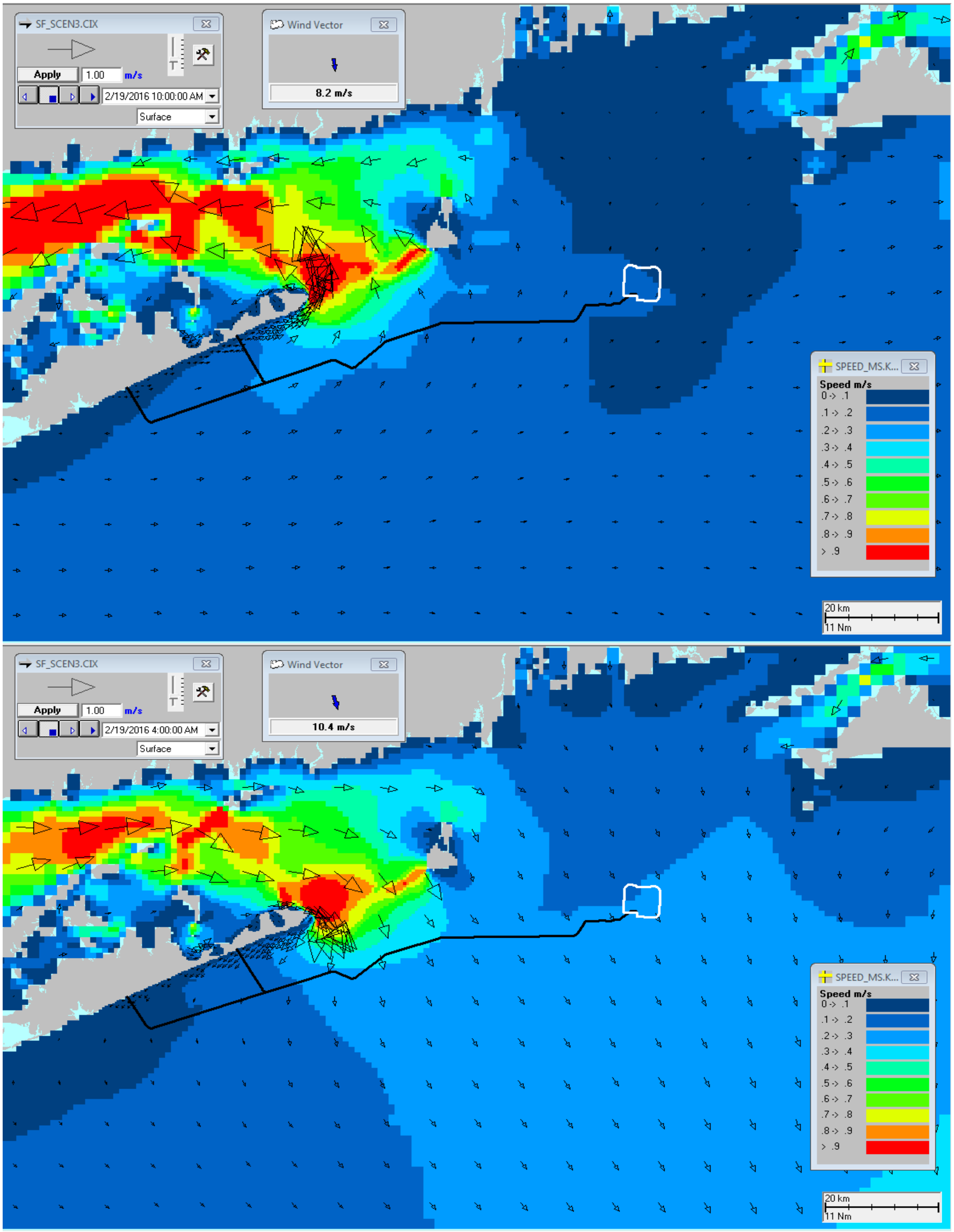
Figure 4.2-8 illustrates that surface currents consistently move toward the east. The direction of flow shifts westerly as depth increases. Currents moving along the southern Long Island shoreline near the SFEC – Offshore had higher average velocities, up to 9.8 in./s (25 cm/s). A map of surface currents in Figure 4.2-9 indicates flow direction at peak flood and peak ebb. Based on this preliminary assessment of currents at the SFWF, it appears that the SFWF may be located outside the zone of regional southwestward surface current flow from Block Island and Rhode Island Sounds.



Note: Direction convention is standard (i.e., direction currents are headed).

Source: Saha et al., 2010

Figure 4.2-8. Monthly Averaged HYCOM Surface Currents near the Study Area from January 2001 to December 2010



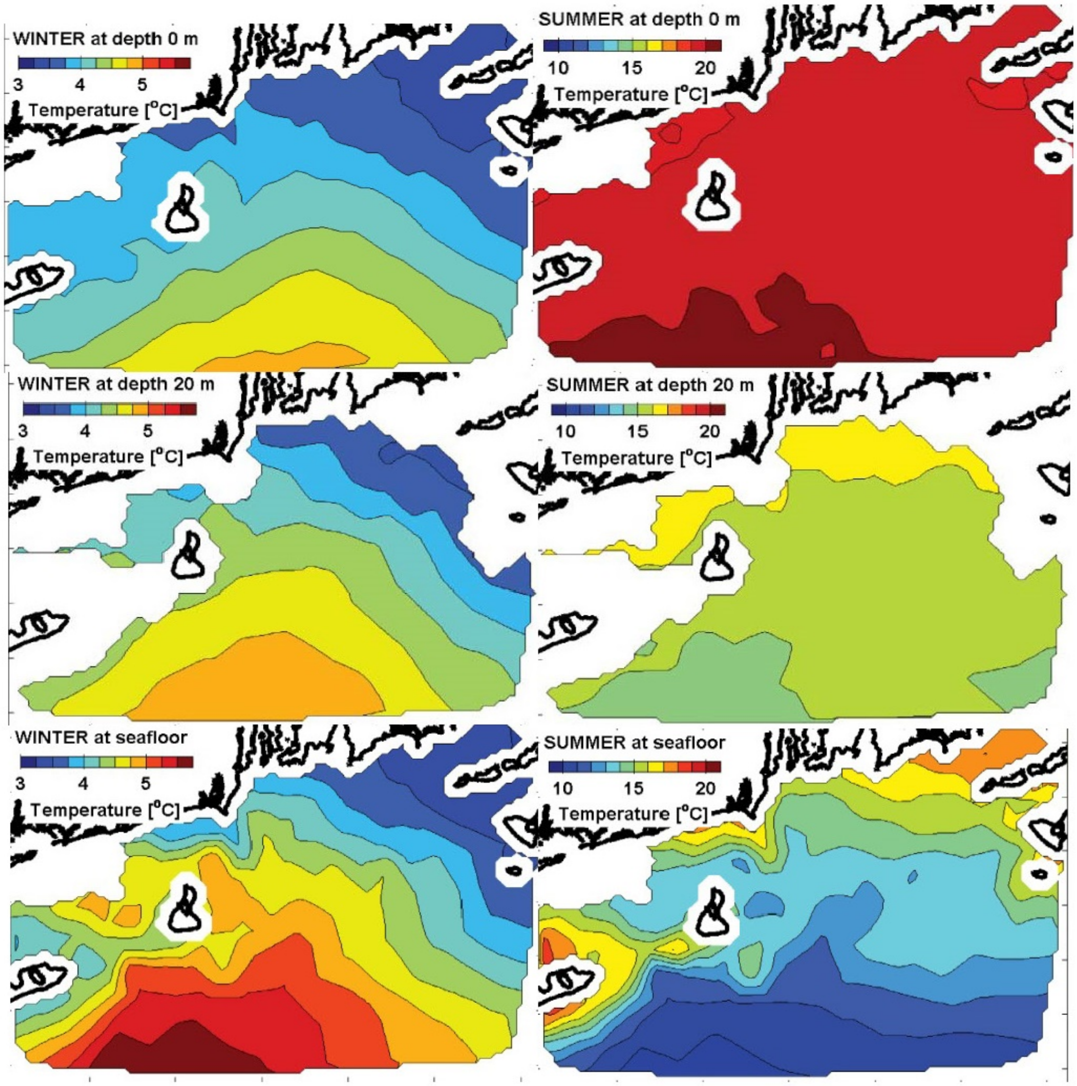
Source: Appendix I

Figure 4.2-9. Surface Currents with Flow Direction Indicated at Peak Flow and Peak Ebb Tides

Water Column Stratification

In general, the heating of water and increased salinity during the late summer and early fall results in a stratified water column that is subjected to mixing in the fall from upwelling bottom waters and storm action. The temperature and salinity trends described below contribute to this seasonal stratification.

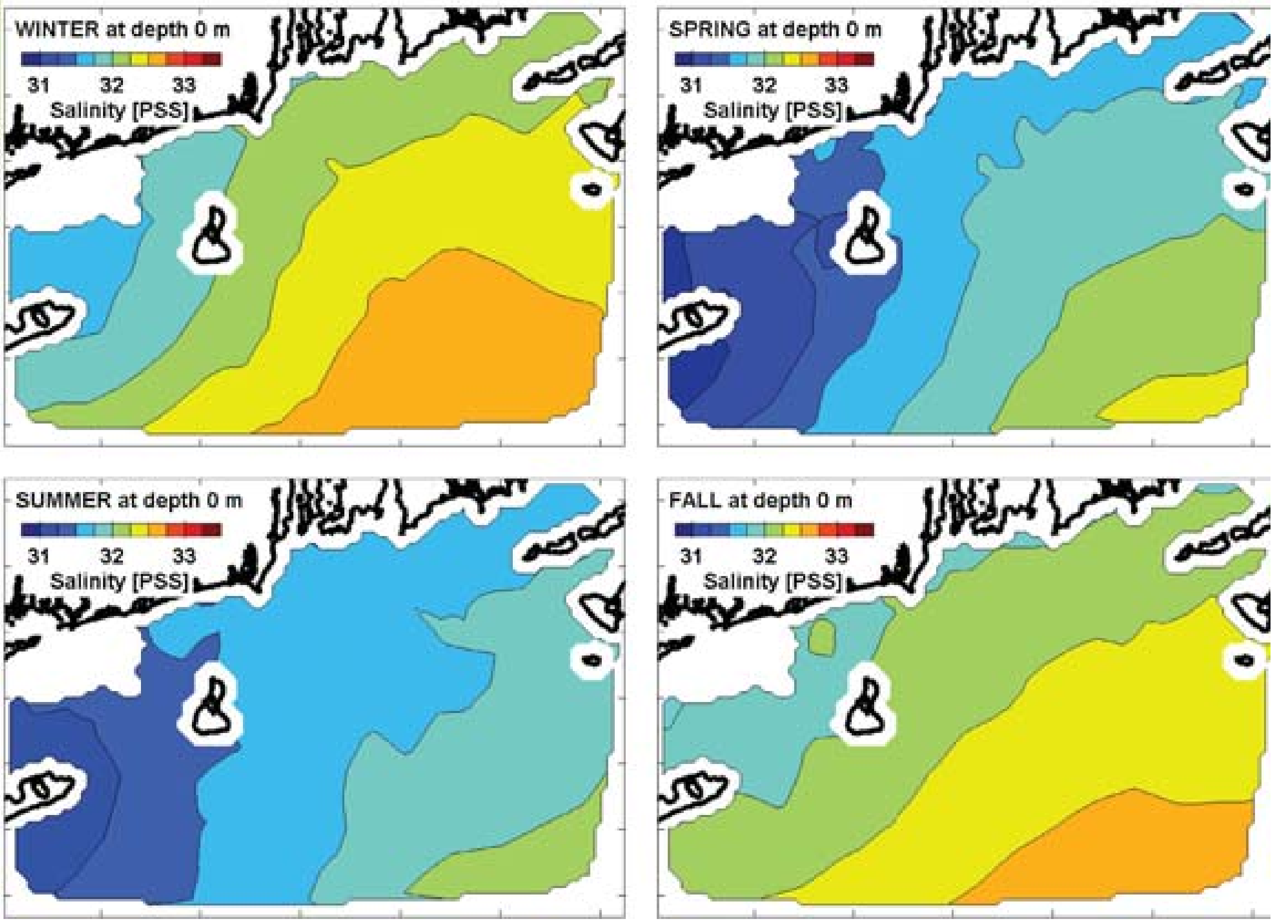
Averages of seasonal water temperature data collected by the RICRMC between 1980 and 2007 are depicted on Figure 4.2-10 (RICRMC, 2010). Surface water temperatures fluctuate up to 59 degrees Fahrenheit (°F) (15 degrees Celsius [°C]) seasonally, and as expected, bottom waters have smaller seasonal temperature fluctuation of approximately 41°F (5°C). Water temperatures are highest in July/August when the water column becomes stratified; surface water temperatures are close to 68°F (20°C), with bottom waters in the SFWF area of about 50°F (10°C). During the winter, average surface water temperatures range from approximately 39 to 41°F (4 to 5°C), with bottom waters staying slightly warmer at the southern edge of Rhode Island Sound in the SFWF.



Source: RICRMC, 2010

Figure 4.2-10. Seasonal Water Temperature Based on Data Collected Between 1980 and 2007

Surface water salinity decreases in the spring with fresh water inflows from ice melts and spring rains, and increases with temperature in the summer, with highest surface water salinities in the fall and winter. Bottom water salinities are higher than surface water salinities throughout the year, setting up for the stratification described above. Highest salinities within Rhode Island Sound (approximately 33 Practical Salinity Scale [PSS]) are bottom waters at the southern end of the Sound, near the SFWF. Seasonal water salinities at the sea surface in Rhode Island Sound are shown in Figure 4.2-11.

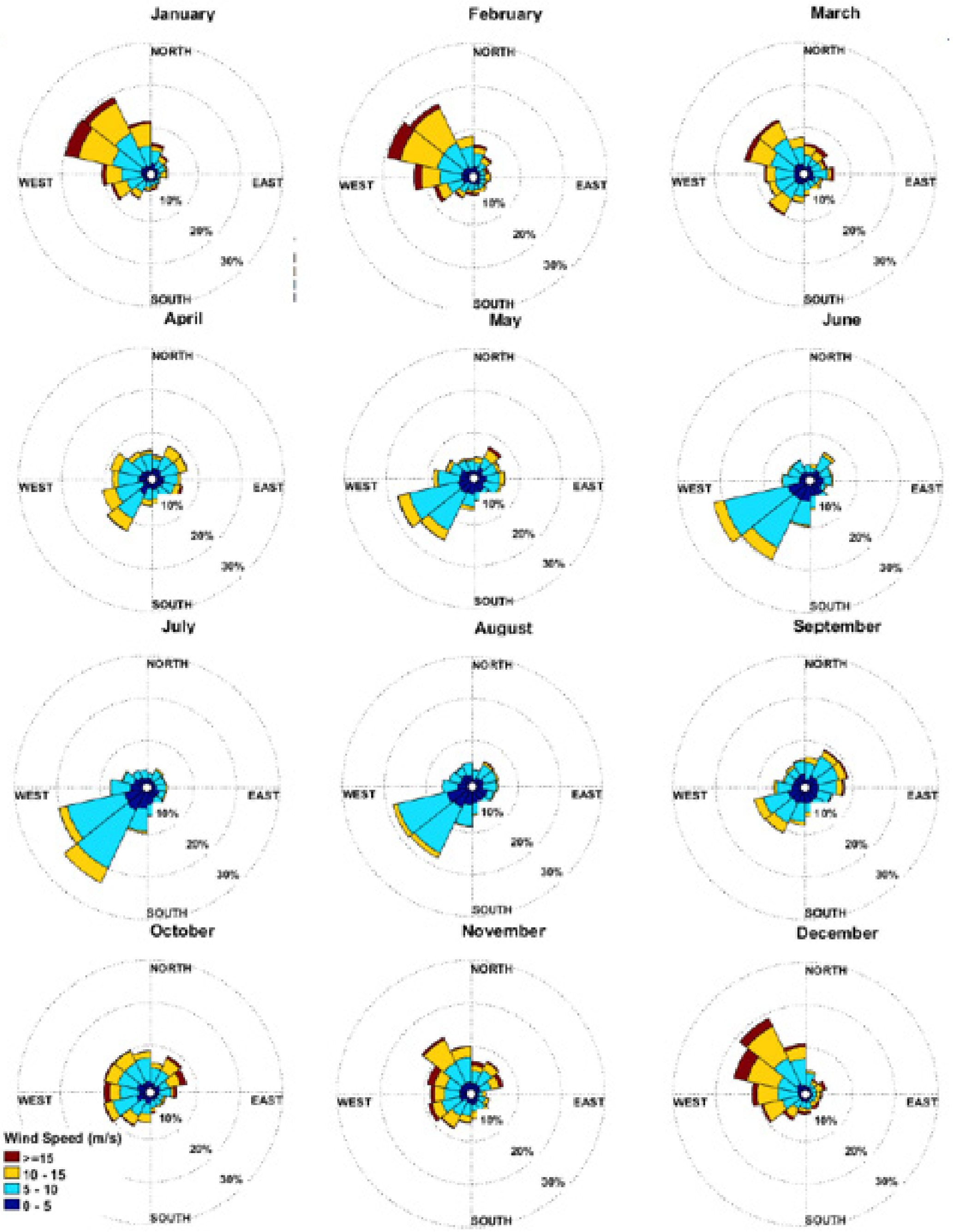


Source: RICRMC, 2010

Figure 4.2-11. Seasonal Water Salinities at Sea Surface (Depth 0 m), Based on Archived Conductivity, Temperature, and Depth Data Collected Between 1980 and 2007

Wind

Wind data was obtained from the NCEP CFSR product for 2001 through 2010 to provide a preliminary evaluation of wind direction and speed. Predominant wind direction is from the southwest during the summer months, and from the northwest during the winter when wind speeds are higher. Monthly wind direction and speed at a representative point within the Rhode Island Sound are depicted in Figure 4.2-12.

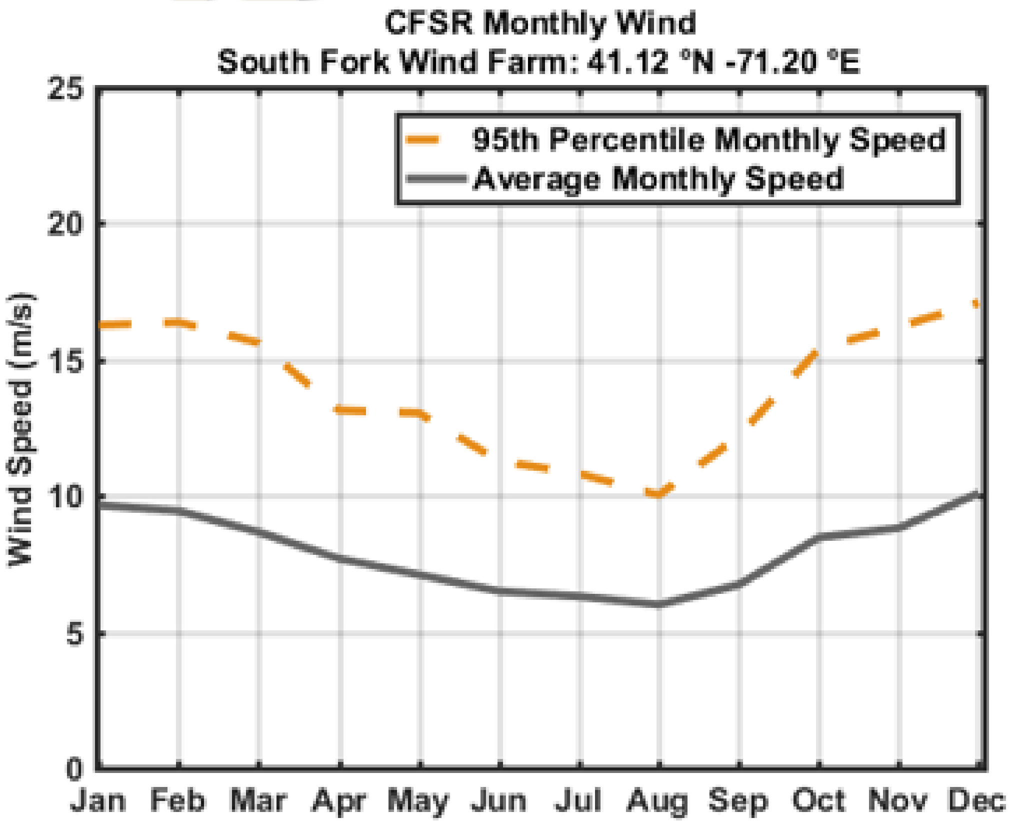


Note: Wind speeds are in m/s. using meteorological convention (i.e., direction from which wind is coming.

Source: Saha et al., 2010

Figure 4.2-12. Monthly Wind Roses for the CFSR Grid Point Nearest to the SFWF

Average monthly wind speeds and strongest winds (represented by the 95th percentile) are depicted on Figure 4.2-13 for the years 2001 through 2010. Average wind speeds are between 16 and 32 feet per second (ft/s) (5 and 10 meters per second [m/s]), with stronger wind in the winter. The occurrence of stronger winds from the northwest during winter is seen by the 95th percentile curve that reaches over 49 ft/s (15 m/s). According to wind measurements from meteorological measurement sites in Massachusetts and Rhode Island, the wind rose figures show the predominant winds for Block Island, Martha’s Vineyard, and Nantucket during the years 2003 through 2012 are from the southwest through northerly directions and the average speeds are between 12.5 and 20.3 ft/s (3.8 and 6.2 m/s).



Source: Halliwell, 2004; Chassignet et al. 2007

Figure 4.2-13. Monthly Wind Speed Statistics for the CFSR Grid Point Nearest to the SFWF

Storms

Regional data reports indicating the magnitude of wind events within the NOAA National Centers for Environmental Information Storm Events Database, provides a characterization of recently recorded wind events in the general vicinity of the project. Table 4.2-10 includes the high wind events for Barnstable and Nantucket Counties in Massachusetts between January 2017 and March 2018. Few hurricanes pass through New England, but the area is subjected to frequent Nor'easters that form offshore between Georgia and New Jersey, and typically reach maximum intensity in New England. These storms are usually characterized by winds from the northeast, and can bring heavy precipitation, wind, storm surges, and rough seas. They primarily occur between September and April but can form any time of the year. Although hurricanes are relatively infrequent in New England, wave heights up to 30 feet (9 m) were recorded south of Block Island (Scripps Buoy 44097) during Hurricane Sandy in 2012 (NOAA, 2012).

Table 4.2-10. Recorded High Wind Speeds for Barnstable and Nantucket Counties, Massachusetts for January 2017 to March 2018

Date of Measurement	Magnitude (knots)	Magnitude (m/s)	Measured (MG) or Estimated (EG)
23-Jan-17	51	26.2	MG
13-Feb-17	50	25.7	EG
2-Mar-17	50	25.7	MG
14-Mar-17	69	35.5	MG
14-Mar-17	51	26.2	MG
19-Mar-17	52	26.8	MG
1-Apr-17	54	27.8	MG
1-Apr-17	56	28.8	MG
25-Oct-17	50	25.7	MG
29-Oct-17	81	41.7	MG
30-Oct-17	61	31.4	MG
25-Dec-17	57	29.3	MG
25-Dec-17	66	34.0	EG
4-Jan-18	65	33.4	EG
4-Jan-18	53	27.3	MG
12-Jan-18	57	29.3	EG
30-Jan-18	36	18.5	MS
2-Mar-18	84	43.2	EG
2-Mar-18	78	40.1	EG
5-Mar-18	35	18.0	MS
13-Mar-18	67	34.5	EG

Cyclones

The IBTrACS project contains the most complete global set of historical tropical cyclones available. It combines information from numerous tropical cyclone datasets, simplifying interagency comparisons by providing storm data from multiple sources in one place. As part of the IBTrACS project the quality of storm inventories, positions, pressures, and wind speeds are checked and information about the quality of the data is passed on to the user. The version of the database that has been used is IBTrACS v03r09, which contains cyclone data from 1848 up to 2015 and was released in September 2016. Figure 4.2-14 illustrates the track of cyclones having passed within 5 degrees of the SFWF project area between 1971 and 2015.

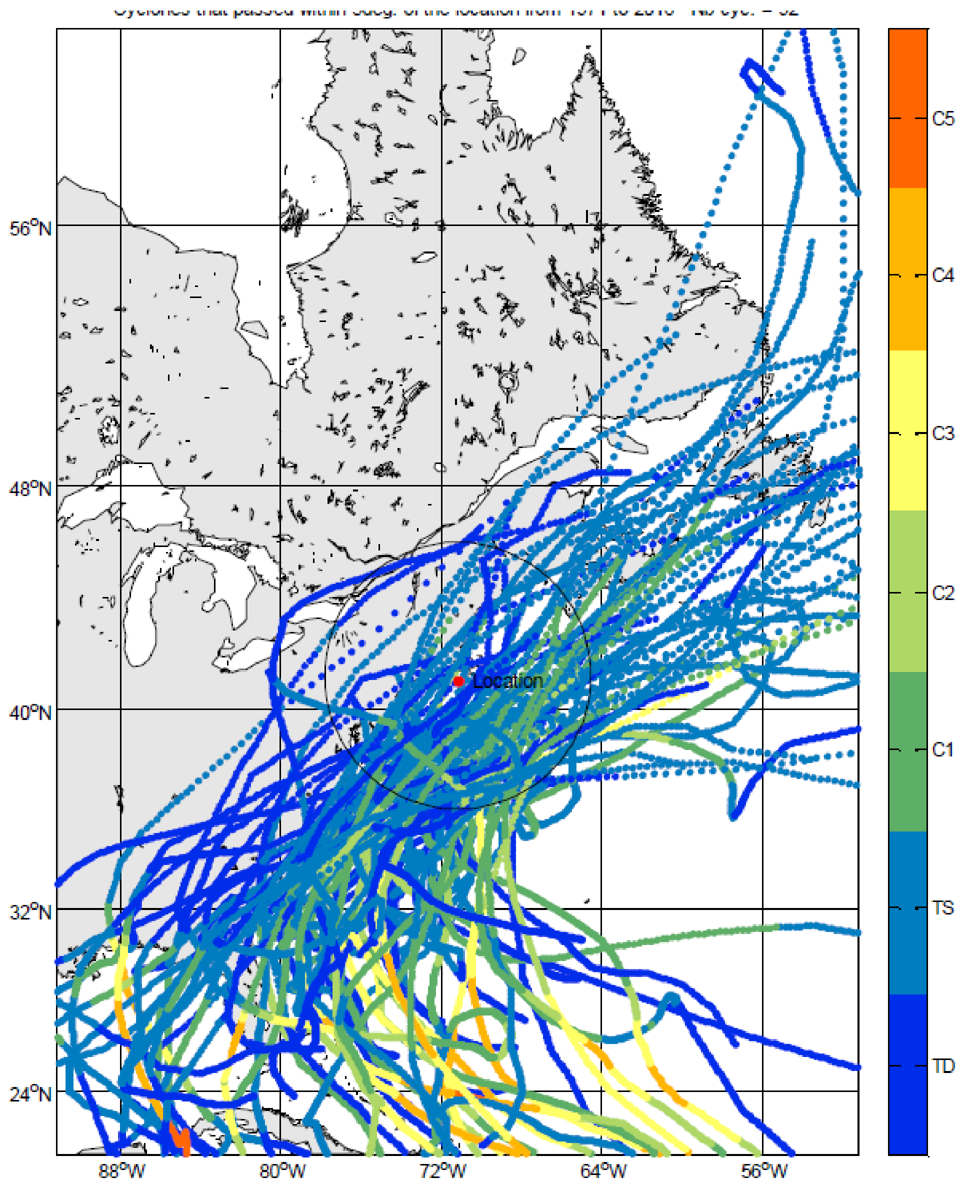
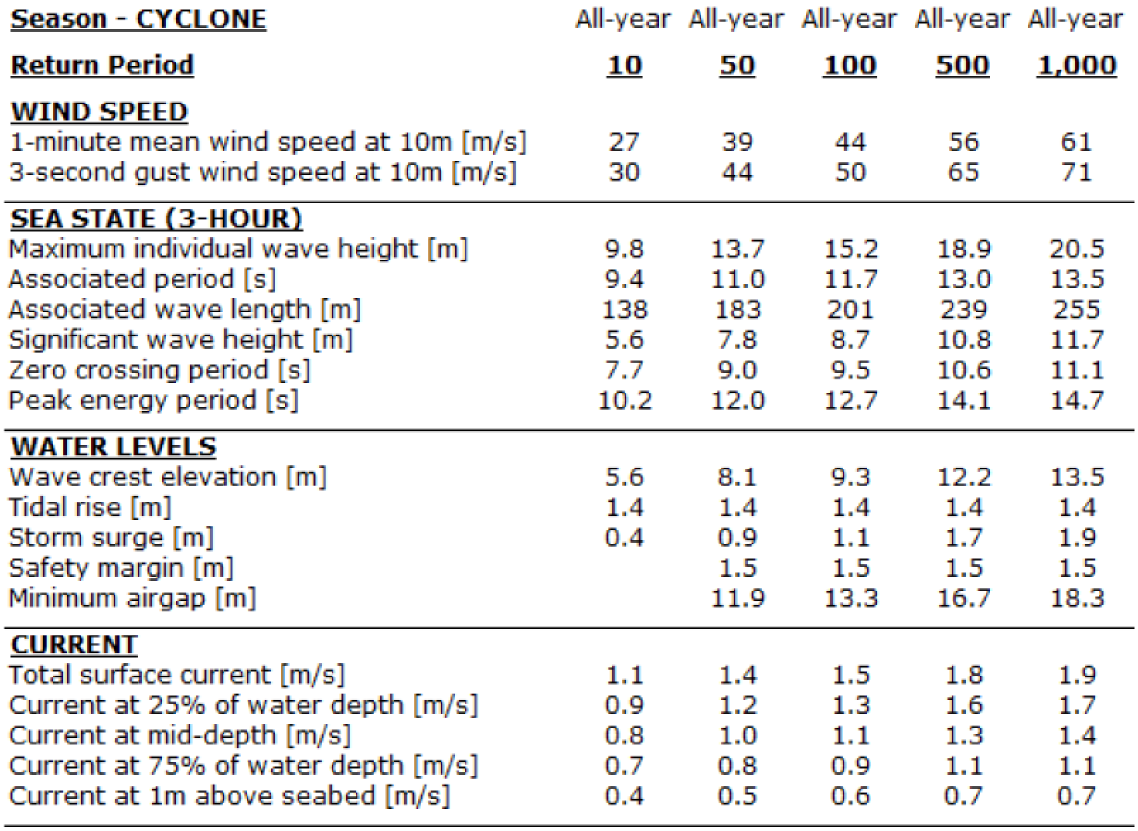


Figure 4.2-14. Cyclone Tracks having passed within 5 degrees of the SFWF between 1971 and 2015 (NOAA IBTrACS 2010)

Available data for all cyclones passing within a certain radius (e.g., 270 NM) of the SFWF were examined using the IBTrACS data. For each of those cyclones, the DWSF team employed a parametric wind model to identify the maximum wind speed caused at the location due to the passing of the cyclone. An extreme value analysis was then undertaken on the distribution of maximum wind speeds caused by all cyclones within the 270-NM radius in order to determine the extreme wind speeds with a given return period. A number of different locations along the cyclone tracks were included and the analysis was applied to those locations with the highest cyclone risk. Appendix Z includes the technical report for a meteorological and oceanographic study of the SFWF area (SFWF MetOcean Conditions Report). Table 4.2-11 is excerpted from Appendix Z and provides predicted cyclonic conditions near the SFWF based on previously recorded events. The results presented are omni-directional so that predominant wind or wave directions are not indicated.

Table 4.2-11 Possible Cyclone Conditions, including Omni-directional Extremes, within the SFWF Area for 10, 50, 100, 500 and 1,000 Year Model Return Periods



Season - CYCLONE	All-year	All-year	All-year	All-year	All-year
Return Period	**10**	**50**	**100**	**500**	**1,000**
WIND SPEED					
1-minute mean wind speed at 10m [m/s]	27	39	44	56	61
3-second gust wind speed at 10m [m/s]	30	44	50	65	71
SEA STATE (3-HOUR)					
Maximum individual wave height [m]	9.8	13.7	15.2	18.9	20.5
Associated period [s]	9.4	11.0	11.7	13.0	13.5
Associated wave length [m]	138	183	201	239	255
Significant wave height [m]	5.6	7.8	8.7	10.8	11.7
Zero crossing period [s]	7.7	9.0	9.5	10.6	11.1
Peak energy period [s]	10.2	12.0	12.7	14.1	14.7
WATER LEVELS					
Wave crest elevation [m]	5.6	8.1	9.3	12.2	13.5
Tidal rise [m]	1.4	1.4	1.4	1.4	1.4
Storm surge [m]	0.4	0.9	1.1	1.7	1.9
Safety margin [m]		1.5	1.5	1.5	1.5
Minimum airgap [m]		11.9	13.3	16.7	18.3
CURRENT					
Total surface current [m/s]	1.1	1.4	1.5	1.8	1.9
Current at 25% of water depth [m/s]	0.9	1.2	1.3	1.6	1.7
Current at mid-depth [m/s]	0.8	1.0	1.1	1.3	1.4
Current at 75% of water depth [m/s]	0.7	0.8	0.9	1.1	1.1
Current at 1m above seabed [m/s]	0.4	0.5	0.6	0.7	0.7

Icing and Fog

Given the cold air temperatures experienced during many New England winters, there is potential for icing of equipment and vessels above the water line in the SFWF and SFEC. To evaluate the potential for icing and fog conditions within the OSAMP, Merrill (2010) assessed data from two locations: the Buzzard's Bay Tower (west of the Elizabeth Islands) and the Martha's Vineyard Coastal Observatory (1.9 miles [3 km] offshore). Results of the data analysis indicate the highest potential for fog development during the summer, with 10 potential days in June, compared to 1 to 4 potential days during each of the winter months. As expected, days with potential for icing conditions were limited to November through March, with the highest number of days (9) in January.

4.2.4.2 Potential Impacts

IPFs that could result in impacts to physical oceanography and meteorology are depicted in Figure 4.2-15. IPFs which would not impact physical oceanography and meteorology are shown as circles with a slash. IPFs that could impact physical oceanography and meteorology but were found to be negligible in the analyses in Section 4.1, are shown as gray circles without a slash.

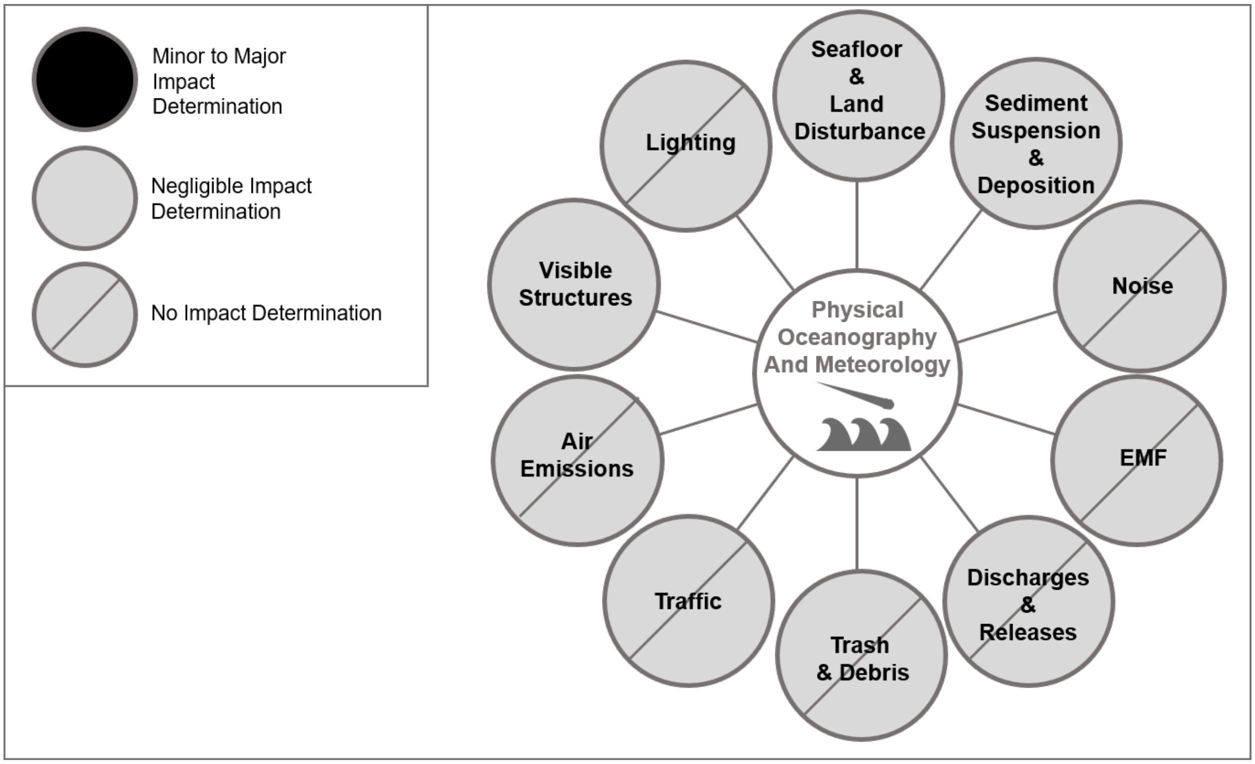


Figure 4.2-15. Impact-producing Factors on Physical Oceanography and Meteorology

Three, inter-related IPFs were identified that will result in ***negligible impacts*** to physical oceanographic processes and conditions or meteorological conditions. Seafloor and Land Disturbance, Sediment Suspension and Deposition, and Visible Structures from the construction activity and physical presence of the SFWF and SFEC will affect water and wind currents as well as seafloor topography that, on a small scale, impact oceanographic and meteorological conditions but not to a degree to alter these conditions or processes. Because of the inter-related nature of these IPFs and consequent impacts, they are addressed together below.

Meteorological and oceanographic conditions could potentially affect all phases of the SFWF and SFEC, including construction, operations, and decommissioning. The SFWF and SFEC will be designed to address risks that the identified oceanographic and meteorological factors pose. The design will be reviewed by BOEM during the FDR in accordance with 30 CFR 585.700-702.

South Fork Wind Farm

Construction

Seafloor and Land Disturbance/Sediment Suspension and Deposition

Disturbance of the seafloor and increases in sediment suspension and deposition during construction of the SFWF may result in ***short-term, localized,*** and ***negligible impacts*** to physical oceanographic conditions because of relative small and isolated changes to currents and seafloor topography.

Operations and Maintenance

Seafloor and Land Disturbance/Sediment Suspension and Deposition/Visible Structures

Over the operational period, the presence of the SFWF foundations will result in relatively small and isolated changes to bottom current patterns, sediment scour, suspension, and transport.

However, only appreciable changes in sediment distribution patterns are expected and would result in ***localized, negligible impacts*** to oceanographic conditions. However, because the foundations would be spaced, on average, approximately 0.8 to 1.0 miles (1.3 to 1.6 km, 0.69 to 0.86 nm) apart and given the small footprint of the SFWF relative to the oceanic current systems, currents would likely not be affected by the presence of the foundations, and impacts are considered ***negligible***.

Similarly, the presence and operation of the WTGs has the potential to create turbulence in the immediate vicinity of the tower, nacelle, and blades. However, impacts to air flow would be ***localized*** and are considered ***negligible***.

Decommissioning

Impacts to physical oceanographic and meteorological conditions would be similar to those described above, ***short-term, localized,*** and ***negligible.***

SFEC – OCS

Construction

Seafloor and Land Disturbance/Sediment Suspension and Deposition
Disturbance of the seafloor resulting in increases in sediment suspension and deposition during construction of the SFEC - OCS would result in ***short-term, localized,*** and ***negligible impacts*** to physical oceanographic conditions in the installation because of effects on currents and seafloor topography.

Operations and Maintenance

Seafloor Disturbance
No disturbance to physical oceanographic conditions are expected during routine operations because there is no routine maintenance of the SFEC – OCS requiring work on the seafloor. Should there be a need for construction-related maintenance of the SFEC - OCS, vessels similar in size to the cable lay barge spread or smaller would likely be used for the repair. Therefore, routine operations of the SFEC - OCS are expected to result in ***no impact*** to physical oceanographic conditions with the potential for ***localized, negligible impacts*** if a repair is needed.

Sediment Suspension and Deposition
The physical presence of the SFEC - OCS would have ***no impacts*** to currents because the cables will be buried beneath the seabed except in some areas of the SFEC - OCS that require protective armoring which could have the potential to affect currents. However, because of the small acreage associated with this protective armoring relative to the greater oceanic current systems in the region, this potential SFEC – OCS O&M impact is expected to be ***localized*** and ***negligible***.

Decommissioning

Impacts to physical oceanographic and meteorological conditions would be similar to those described above, ***short-term, localized,*** and ***negligible.***

SFEC – NYS

Construction

Seafloor Disturbance/Sediment Suspension and Deposition
Similar to the SFEC - OCS, construction of the SFEC - NYS has the potential to result in ***short-term, localized,*** and ***negligible impacts*** to physical oceanographic conditions from seafloor

disturbance and related sediment suspension and deposition because of small, isolate changes to currents and seafloor topography. The onshore segments of the SFEC - NYS will not impact physical oceanographic and meteorological conditions.

Operations and Maintenance

Seafloor and Land Disturbance/Sediment Suspension and Deposition
Impacts associated with seafloor disturbance during O&M of the SFEC - NYS are expected to be similar to those described for the SFEC - OCS.

Decommissioning

Impacts to physical oceanographic and meteorological conditions would be similar to those described above, ***short-term, localized,*** and ***negligible.***

4.2.4.3 Proposed Environmental Protection Measures

DWSF has designed the Project to account for site-specific oceanographic and meteorological conditions within the Project Area; therefore, no additional measures are necessary.

4.3 Biological Resources

4.3.1 Coastal and Terrestrial Habitat

This section describes the affected environment and to provides an assessment and discussion of potential impacts for existing coastal and terrestrial habitats, including sensitive habitats, during construction, O&M, and decommissioning of the SFWF and SFEC. The coastal and terrestrial habitats considered are along the Long Island south coastline in the vicinity of the two potential landing sites and inland along the SFEC – Onshore cable routes. Other habitats, such as benthic and shellfish habitats and essential fish habitat (EFH) are discussed separately in Sections 4.3.2 and 4.3.3, respectively.

To characterize existing coastal and terrestrial habitats within the vicinity of the various SFEC – Onshore components, information in this section was assembled from desktop research, agency consultations, and field surveys of biological resources. The following resources informed the description of the affected environment:

- Current public data sources related to coastal and terrestrial habitats in the town of East Hampton, village of East Hampton East Hampton, Suffolk County, and in Montauk Peninsula area on eastern Long Island including the Town of East Hampton Local Waterfront Revitalization Program (Town of East Hampton, 2008).
- State and federal agency published reports including BOEM (2013), USFWS (1997), U.S. Department of Interior, Minerals Management Service (DOI-MMS; 2007), and NYSDEC.
- Project-specific studies included field surveys of onshore biological resources to aid in the characterization of the affected environment for coastal and terrestrial habitats (Appendix M). The field surveys included classification of observed habitats, delineations of freshwater and tidal wetlands, identification of plant and wildlife species, observations of rare and protected species and communities, and delineation of invasive species occurrences within the locations of the potential landing sites and routes for the SFEC – Onshore.

4.3.1.1 Affected Environment

Regional Overview

The SFWF and much of the SFEC will be located on the southern New England OCS and on the northern end of the Mid-Atlantic Bight. A portion of the SFEC will be located within New York State (SFEC – NYS) waters and onshore in the town or village of East Hampton on Long Island, New York.

Eastern Long Island's coastal and terrestrial environment varies widely and consists of a diversity of habitats. These range from exposed rocky shores and exposed bedrock, sandy coastal beaches, dunes, freshwater and brackish bays and ponds, and salt marshes fringing the shore of sheltered embayments to intertidal mud- and sandflats (BOEM, 2013). The sandy, coastal beaches along the southeastern coastline of Long Island are characterized by four zones: nearshore bottom (submerged areas below mean low water to 29.5 feet [9 m]); foreshore (intertidal areas between mean low water to the high tide zone); backshore (exposed sandflats above high tide line to dunes, but occasionally submerged during storms or exceptionally high tides); and dunes (areas of wind-blown sand ridges or mounds above the highest tide line and exposed to wind action) (USFWS, 1997).

These coastal and terrestrial habitats are constantly changing because of wave action and tidal currents that cause sediment transport (DOI-MMS, 2007). Eroding beaches and sand shoals on the inner continental shelf are the primary sources of sand that are deposited on and maintain the sand beaches (BOEM, 2013). In addition, small, sheltered beaches between rocky headlands are the predominant shoreline type for Long Island Sound, Rhode Island, and Massachusetts coastlines (DOI-MMS, 2007).

The vegetated habitat areas along the coastal beaches of eastern Long Island are generally found from the high tide line inland to the mainland. The backshore of the beach (high tide line to dunes) is usually sparsely vegetated. Just inland, at the toe of the dune, American beachgrass (*Ammophila breviligulata*) occurs along with dusty miller (*Artemesia steleriana*), beach pea (*Lathyrus japonica*), and saltwort (*Salsoli kali*). On the primary dunes, beachgrass is dominant along with seaside goldenrod (*Solidago sempervirens*); on the backside of the dunes, beach heather (*Hudsonia tomentosa*), bearberry (*Arctostaphylos uva-ursi*), and bayberry (*Myrica pensylvanica*) occur. Interdunal swales are wetlands that are formed where blowouts in the dunes intersect the water table and typical wetland plants such as sedges, rushes, herbs, and low shrubs become established. Characteristic species of these swale wetlands include purple gerardia (*Agalinis purpurea*), sundews (*Drosera* spp.), cranberry (*Vaccinium macrocarpon*), highbush blueberry (*Vaccinium corymbosum*), and bayberry. The upland transition zone along the south coastline of eastern Long Island has stands of shrublands/woodlands dominated by bayberry, arrowwoods (*Viburnum spp*.), and pitch pine (*Pinus rigida*). (USFWS, 1997)

South Fork Wind Farm

The SFWF is located offshore and therefore does not include coastal or terrestrial habitat. Marine habitats in the SFWF are discussed in Section 4.3.2 and EFH are discussed in Section 4.3.3. Water quality in the SFWF is described in Section 4.2.2.

South Fork Export Cable

SFEC - OCS and SFEC - NYS

Much of the SFEC –OCS, including off the coast of Long Island and the SFEC – NYS approaching the coastline of Long Island supports coastal subtidal marine habitats not coastal and terrestrial habitats. Subtidal coastal marine habitats, such as submerged aquatic vegetation (SAV), macroalgal assemblages, hard bottom habitat, microbenthic and macrobenthic communities, soft bottom habitat, and shellfish resources are discussed in Section 4.3.2and in Section 4.3.3.

SFEC – Onshore

The coastal and terrestrial habitats associated with the SFEC – Onshore would include those habitats in the vicinity of the landing sites, along the SFEC – Onshore cable routes, and at the SFEC – Interconnection Facility.

The coastal habitats in the SFEC – Onshore include the area from the ocean inland to the mainland, including the foreshore, backshore, dunes, and interdunal areas. Habitats could include nesting and feeding areas for beach-nesting birds, rare beach and interdunal swale communities and plants, and wintering waterfowl habitat.

Wetland habitats in the region are shown on Figures 4.3-1 and 4.3-2 and consist of fresh, brackish, and salt marshes and mudflats. Salt marshes and mudflats occur in the intertidal zones. Estuaries, which are shallow semi-enclosed areas where stream or river inflows mix with marine waters, include a range of intertidal and subtidal habitats from fresh to brackish and saline. Coastal wetlands and estuaries are highly productive, yet fragile, environments that support a great diversity of fish and wildlife species (DOI-MMS, 2007). The Peconic Bay Estuary, Narragansett Bay Estuary, and Long Island Sound are major estuaries in the region. Subtidal habitats such as seagrass beds occur offshore in shallow water and are addressed in Section 4.3.2.

New York State Significant Coastal Fish and Wildlife Habitats (SCFWH) are shown on Figure 4.3-2, *South Fork Wind Farm Project Location and New York State Significant Coastal Fish and Wildlife Boundaries* (NYSDOS, 2018). New York State SCFWH are NYSDEC-designated special coastal and terrestrial habitat areas that are mapped along with a technical narrative providing site-specific information. The habitat narrative constitutes a record of the basis for the SCFWH's designation and provides specific information regarding the fish and wildlife resources that depend on this area.

The coastal and terrestrial habitats along the SFEC – Onshore cable routes are described below and summarized in Table 4.3-1. The habitats along the routes generally include a successional shrubland community located adjacent to the various roadways ROWs and the LIRR ROW. The vegetated cover types observed adjacent to the SFEC – Onshore cable routes include various upland and wetland plant communities (Appendix M).

- The landing sites consist of the marine intertidal gravel/sand beach and maritime beach communities as classified by the New York Natural Heritage Program (NYNHP) Ecological Communities of New York State (ECNYS) publication (Edinger et al., 2014; Town of East Hampton, 2008).
- The SFEC – Onshore cable routes traverse the following NYNHP-identified Significant Natural Communities: marine intertidal gravel/sand beach, maritime dunes, maritime heathland, maritime pitch pine dune woodland, maritime freshwater interdunal swales, high salt marsh, low salt marsh, salt shrub, brackish meadow, highbush blueberry bog thicket, coastal oak-heath forest, coastal oak-hickory forest, and pitch pine-oak forest (Edinger et al., 2014; Town of East Hampton, 2008). Neither of the proposed SFEC – Onshore route landing sites (Beach Lane and Hither Hills) is within a NYSDEC-designated SCFWH. However, the SFEC – Onshore cable route from the Hither Hills landing site would traverse three of the NYSDEC-designated SCFWH.

- The SFEC – Interconnection Facility consists of some ECNYS communities, including paved road path, unpaved road/path, and urban structure exterior, as well as a disturbed example of the coastal oak hickory forest community and a successional shrubland community (Edinger et al., 2014; Town of East Hampton, 2008).

Field surveys and desktop research for areas along the SFEC – Onshore cable routes identified habitat for a variety of birds, terrestrial mammals, and reptiles and amphibians, including species commonly associated with tidal, intertidal, and freshwater wetlands, freshwater surface waters, forests, successional habitats, agricultural fields, and developed areas. Observed avian, terrestrial mammal, and reptiles and amphibians documented near the SFEC – Onshore routes are described in Appendix M.

Wetland resources located in the vicinity of the SFEC – Onshore are illustrated on Figures 4.3-1 (Beach Lane) and 4.3-2 (Hither Hills). These include National Wetlands Inventory (NWI) and NYSDEC freshwater and tidal wetlands and adjacent areas. Figure 4.3-2 also shows the NYSDEC-designated SCFWH areas that would be traversed along the Hither Hills SFEC - Onshore route. Wetland delineation and results are presented in Appendix M, including a summary in Table 2 and maps in Appendix A (of Appendix M), Figure 4 (Sheets – 1-127).

The locations of rare and protected species and species habitats were observed during the field surveys of the SFEC – Onshore routes. Observed species documented near the SFEC – Onshore routes are described further in Appendix M.

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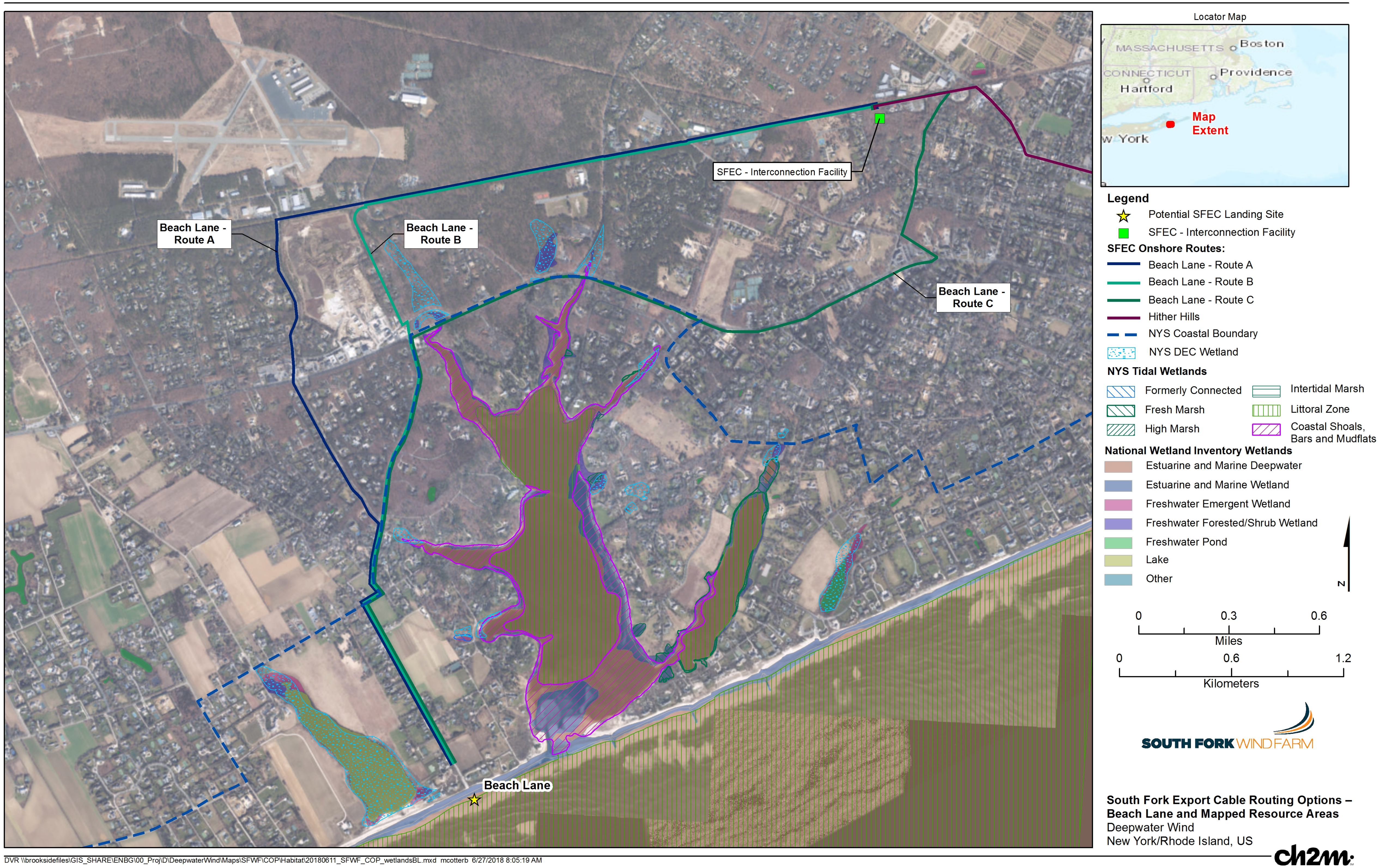

Figure 4.3-1. South Fork Export Cable Routing Options – Beach Lane and Mapped Resource Areas

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Figure 4.3-2. South Fork Export Cable Routing Options – Hither Hills and Mapped Resource Areas

Table 4.3-1. Summary of Coastal and Terrestrial Habitats Observed for the SFEC - Onshore

Environmental Considerations and Onshore Habitats

Project Component	NLCD Developed Land Cover Types (percent)	Delineated Wetlands and Wetland Adjacent Areas (number/ acres [ha])	Rare/Protected Species Observation (Number)	Invasive Species Occurrences (number)
SFEC – ONSHORE (BEACH LANE)				
Beach Lane Landing Site	91	0 / 0	2	2
Beach Lane – Route A	70.89	0 / 0	0	26
Beach Lane – Route B	70.57	2 / 0.02 (0.008)	2	40
Beach Lane – Route C	94.82	5 / 0.90 (0.36)	1	58
SFEC – ONSHORE (HITHER HILLS)				
Hither Hills Landing Site	41	TBD	0	0
Hither Hills – Route A	86.14	57 / 10.85 (4.39)	17	123
Hither Hills – Route C	97.18	50 / 13.34 (5.39)	49	83
SFEC – Interconnection facility				
SFEC – Interconnection Facility Site	0	0/0	0	1

4.3.1.2 Potential Impacts

Project-related IPFs that could potentially result in impacts to coastal and terrestrial habitats during the construction, O&M, and decommissioning phases of the SFWF and SFEC are described in this section. Impacts to benthic habitats are discussed in Section 4.3.2 and EFH is discussed in Section 4.3.3. The IPFs that are discussed in this section that may impact coastal and terrestrial habitats are seafloor and land disturbance and sediment suspension and deposition IPFs. IPFs like discharges and releases and trash and debris could have indirect impacts on some of the coastal and terrestrial habitats included in this chapter but given the lack of direct impact with project activities, these IPFs are dismissed as no impact for the remainder of this discussion. A summary of IPFs and the potential impacts to coastal and terrestrial habitats associated with the SFWF and SFEC is presented in Figure 4.3-3.

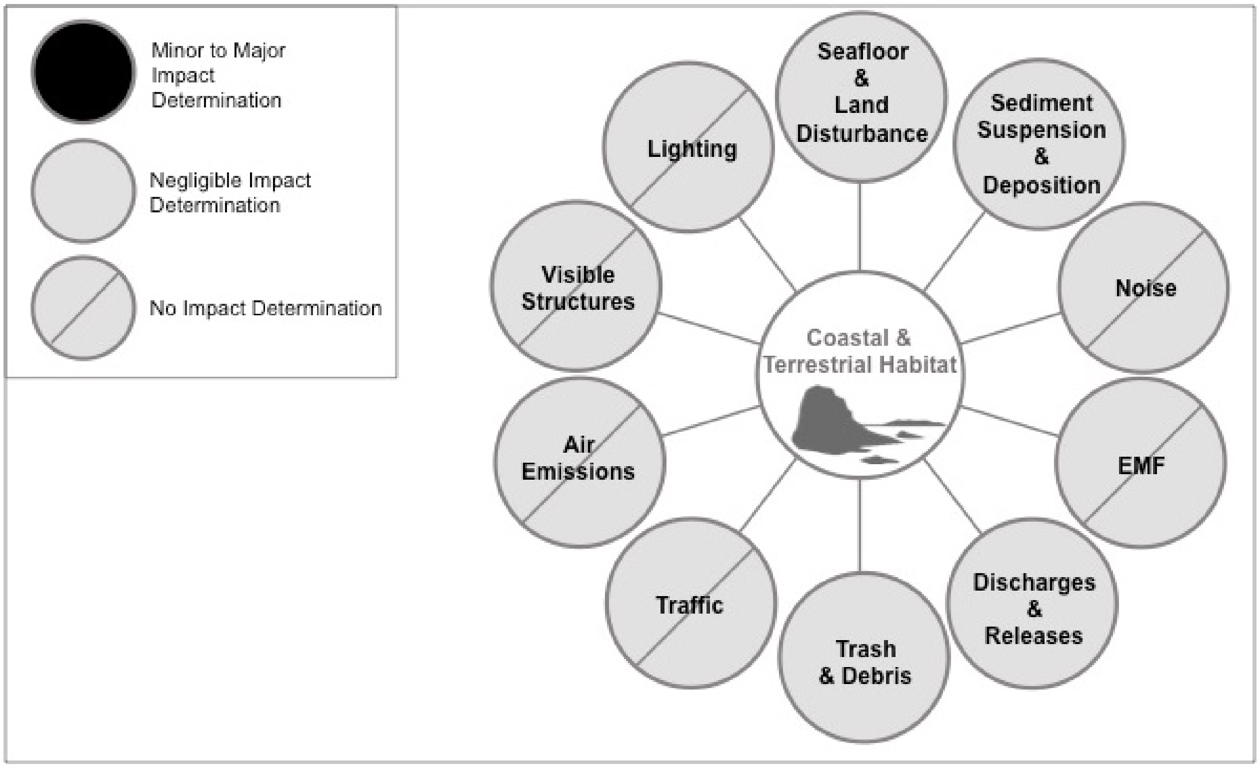


Figure 4.3-3. Impact-producing Factors on Coastal and Terrestrial Habitat

South Fork Wind Farm

The focus of the coastal and terrestrial habitat section is on evaluating the present of sensitive habitats that may be present along the Long Island coast and marginally inland where the SFEC route is being considered; therefore, the SFWF is not expected to have an impact on coastal and terrestrial habitats during construction, O&M, or decommissioning. Offshore benthic habitats and EFH are the marine habitats that could be impacted during construction, O&M, or decommissioning of the SFWF. Benthic habitats are discussed in Section 4.3.2 and EFH is discussed in Section 4.3.3.

South Fork Export Cable

Impacts to coastal and terrestrial habitats that are anticipated to occur from activities associated with the SFEC – OCS and SFEC - NYS are discussed in Section 4.3.2 and in Section 4.3.3, respectively. Activities associated with the SFEC – Onshore could impact onshore coastal and terrestrial habitats during construction, O&M, and decommissioning. Onshore coastal and terrestrial habitats may experience ***short-term*** and ***negligible impacts*** from construction activities, including HDD operations, trenching, equipment, and supplies laydown, and SFEC – Interconnection Facility construction.

Table 4.3-2 summarizes the level of impacts expected to occur to coastal and terrestrial habitat during the construction, O&M, and decommissioning phases of the SFEC. Additional details on potential impacts to coastal and terrestrial habitat from the various IPFs of the SFEC during construction are described in the following sections.

Table 4.3-2. IPFs and Potential Levels of Impact on Coastal and Terrestrial Habitat at the SFEC

IPF	Potential Impact	Maximum Level of Impact
Seafloor/Land Disturbance	Land Disturbance	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized
Discharges and Releases		Negligible indirect
Trash and Debris		Negligible indirect

SFEC-OCS and SFEC-NYS

Construction, Operations, and Decommissioning

Seafloor and Land Disturbance
Offshore, benthic habitats and EFH are the coastal and terrestrial habitats that could be impacted during construction, O&M, or decommissioning in the SFEC – OCS and SFEC – NYS. Benthic habitats are discussed in Section 4.3.2 and EFH is discussed in Section 4.3.3.

SFEC-Onshore

Construction

Land Disturbance
Coastal and terrestrial habitat between the landing sites and SFEC – Interconnection Facility may experience ***direct, negligible,*** and ***short-term impacts*** from land disturbance during onshore construction activities.

Within the sea-to-shore transition, impacts to intertidal wetlands within the sea-to-shore transition area would be avoided, by using HDD technology. Impacts to the marine intertidal gravel/sand beach and maritime beach communities near the landing sites and sea-to-shore transition area would be avoided by locating the sea-to-shore transition vault within the roadway by using HDD technology to bury the cable beneath the beach and dune.

No wetlands were delineated within the site proposed for the SFEC – Interconnection Facility.

During construction, there may be ***short-term, localized,*** and ***negligible impacts*** to coastal and terrestrial habitats along the SFEC – Onshore routes, including wetlands, from land disturbance, as described in Table 4.3-1. HDD technology may be used in locations along the cable routes, as needed, to avoid or minimize impacts to sensitive areas, such as wetlands, surface water crossings, or parklands. No long-term impacts resulting in habitat loss or alteration are anticipated. ***Long-term*** and ***negligible*** impacts are expected to result from the clearing at the SFEC – Interconnection Facility site.

In addition, depending on the route selected, construction of the SFEC – Onshore cable routes may result in ***short-term, negligible impacts*** to NYSDEC-regulated Freshwater Wetlands and 100-foot (30-m) Adjacent Area, NYSDEC-regulated Tidal Wetlands and 300-foot (91-m) Adjacent Area, and USFWS NWI Wetland coastal and terrestrial habitats, as described in Appendix M. Very limited sections of the SFEC – Onshore will be located in existing roads that intersect with FEMA-mapped 100-year or 500-year floodplains. Impacts to coastal and terrestrial habitats would be minimized along the alignment of and in the vicinity of the SFEC – Onshore cable routes because the cable will be located underground in previously disturbed areas, such as roadways and LIRR ROW.

Sediment Suspension and Deposition

Construction-related impacts to water quality from suspended sediment are discussed in Section 4.2.2, Water Quality and Water Resources. Indirect impacts to coastal and terrestrial habitat from ***short-term, localized*** decreases in water quality during SFEC – Onshore construction or decommissioning activities may occur, but they are considered ***negligible***. The risk of erosion and sedimentation will be managed according to federal, state, and local regulations through the implementation of the SWPPP.

Operations and Maintenance

Regular O&M activities would not be expected to cause further habitat alteration or involve activities that have potential to cause impacts. However, when cable inspection or repairs require excavation, resulting in land disturbance, there may be ***negligible, short-term,*** and ***localized impacts*** to coastal and terrestrial habitats from these O&M activities.

Decommissioning

Impacts to coastal and terrestrial habitats would be expected to be similar to the construction impacts, and the area is expected to return to pre-project conditions.

4.3.1.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to coastal and terrestrial habitat.

- SFEC - Onshore is sited within previously disturbed existing ROWs.
- The SFEC sea-to-shore transition will be installed via HDD to avoid impacts to the dunes, beach, and near-shore zone. Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).
- A SWPPP, including erosion and sedimentation control measures, and a SPCC Plan, will minimize potential impacts to water quality during construction of the SFEC - Onshore.

4.3.2 Benthic and Shellfish Resources

The description of the affected environment and assessment of potential impacts for benthic and shellfish resources were determined by reviewing public data sources and conducting project-specific studies. Sources reviewed included state and federal agency-published papers and databases (McMullen et al., 2009; RICRMC, 2010; LaFrance et al., 2010; Poppe et al., 2014a; Collie and King, 2016; Siemann and Smolowitz, 2017), published journal articles (McMaster, 1960), online data portals and mapping databases (Northeast Ocean Data, 2017; USGS, 2017), academic theses (Malek, 2015), and correspondence and consultation with federal and state agencies. Project-specific studies conducted to aid in the characterization of the affected environment and to address BOEM Benthic Habitat Guidelines (2013) for benthic and shellfish resources included:

- G&G Surveys, completed by Fugro on December 30, 2017, characterized and evaluated seafloor conditions (Appendix H).
- Benthic Habitat Surveys, conducted by INSPIRE Environmental (INSPIRE) on November 11–15, 2017, identified and confirmed dominant benthic macrofaunal and macrofloral communities (Appendix N).

Benthic and shellfish resources are described in the following subsections in terms of benthic habitat types and commonly associated taxa, including SAV, macroalgal assemblages, and micro- and macrobenthic communities. A brief discussion of ecologically and economically important shellfish species is also included. These descriptions and discussion of habitat distribution within the SFWF and along the SFEC are followed by an evaluation of potential project-related impacts.

4.3.2.1 Affected Environment

Regional Overview

The RI-MA WEA is located offshore on the northeastern Atlantic continental shelf in Rhode Island Sound. The waters in the vicinity of the SFWF and SFEC are transitional waters that separate Narragansett Bay and Long Island Sound from the OCS. Benthic communities in these areas are adapted to survive in this dynamic environment. In general, the benthic communities of the OCS areas are diverse, with lower densities of organisms than in the northern portion of the Mid-Atlantic Bight and in deeper areas of the OCS (DOI-MMS, 2007).

The area is composed of a mix of soft and hard bottom environments defined by dominant sediment grain size and composition. The U.S. Geological Survey (USGS) conducted sediment studies in the vicinity of Block Island and in Rhode Island Sound. These areas were found to have sandy sediments that ranged from very fine to medium sand; very fine sands were prevalent in deeper, lower energy areas, while coarser sediments were found in shallower and higher energy areas (McMullen et al., 2007a, 2007b, 2008; Poppe et al., 2011, 2014a, 2014b, 2014c). The USGS data and other data available for the SFWF area (RICRMC 2010; Malek et al., 2014; USGS, 2017; Collie and King, 2016; BOEM, 2017) suggest that surface sediment cover in the SFWF and along the SFEC comprise mostly sandy sediments with some areas of coarser material (gravel or small cobble) and boulder fields, but there was very little site-specific data available (McMaster, 1960; Poppe et al., 2014; McMullen et al., 2009; LaFrance et al., 2010). This range of grain sizes is typical of OCS glacial moraine depositional environments that include Holocene marine transgressive deposits.

The OSAMP assessed sediment data collected from two areas: (1) within state waters around the southern end of Block Island, and (2) in federal waters west of Martha’s Vineyard in Rhode Island Sound (RICRMC, 2010). Some OSAMP data from the federal waters west of Martha’s Vineyard were collected from portions of the overall North Lease Area north of the SFWF. Results showed a wide range of depositional environments dominated by coarse sand and sand sheets (LaFrance et al., 2010). Sediment types found in lower areal coverages included boulder gravel concentrations, cobble gravel pavement, and sand waves.

The NYSDOS commissioned the Offshore Atlantic Ocean Study to better understand the biological and physical characteristics of the OCS waters (NYSDOS, 2013). This study, which encompassed the New York Offshore Planning Area (an area roughly the extent of the New York Bight), ended immediately west of the RI-MA WEA. However, this data set covers much of the SFEC - OCS and predicts a high likelihood of fine to coarse sand with areas of granules and pebbles (i.e., small, mobile gravels).

Marine substrata and surface sediments provide context and settings for many aquatic processes and living space for benthic biota. The Coastal and Marine Ecological Classification Standard (CMECS) (FGDC, 2012), the use of which is recommended by BOEM Benthic Habitat Survey Guidelines (2013), provides a means to categorize sediments using the Substrate Component. CMECS uses standard (Udden-Wentworth) grain size classes to define sediment types; these classes pair measurements to common terminology. For example, all grain sizes larger than 5/64 of an inch (2 mm) constitute gravels, which are further classified in order of increasing size as granules, pebbles, cobbles, and boulders. Habitats predominantly composed of larger gravels constitute hard bottom habitats, along with rock outcrops and rocky reefs. These habitats are considered stable and are not readily moveable by currents and wave energy. In contrast, soft bottom habitats composed of sands, silts, and clays are readily moved by such hydrodynamic forces. Sand is further divided into very fine sand (0.06 to 0.125 mm), fine sand (0.125 to 0.25 mm), medium sand (0.25 to 0.5 mm), coarse sand (0.5 to 1 mm), and very coarse sand (1 to 2 mm) and is very common on the OCS. Fine-grained sediments (silts and clays, 0.002 to 0.06 mm and 0.001 to 0.002 mm, respectively) are typically found in quiescent depositional environments.

Sediment grain size influences the biological communities likely found in each habitat (Steimle, 1982), and the CMECS Biotic Component provides a useful means to examine these relationships. The Biotic Component of CMECS is a classification of the living organisms of the seabed and water column, together with their physical associations at a variety of spatial scales. The Biotic Component is organized into a branched hierarchy of five nested levels: Biotic Setting, Biotic Class, Biotic Subclass, Biotic Group, and Biotic Community. The Biotic Subclass is a key CMECS classifier that presents valuable information about the surveyed area in terms of physical habitat and the potential presence of sensitive taxa. Although Biotic Subclasses are not directly based on sediment grain size distributions, they reflect those distributions at the scale of relevance to the dominant fauna present, thus integrating physical and biological characteristics of the seafloor. CMECS expressly states that "…substrate type is such a defining aspect of the Faunal Bed Subclass that CMECS Faunal Bed Subclasses are assigned as physical-biological associations involving both biota and substrate" (FGDC, 2012). Further, the Biotic Subclass is a key classifier that presents valuable information in terms of physical habitat and the potential presence of sensitive habitats.

Most relevant to the study region are the Attached Fauna and Soft Sediment Fauna Biotic Subclasses, which provide excellent broad-scale categories for seafloor habitats. The Soft Sediment Fauna Subclass in the Northwest Atlantic OCS typically includes common taxa, such as sand dollars, tube building worms, and clams, whereas the Attached Fauna Subclass indicates the dominant presence of sessile biota (macroalgae, sponges, bryozoans) living on hard bottom substrata. Attached Fauna habitats are also referred to in some documents as "live bottom." These hard bottom habitats are considered to be potentially valuable and sensitive resources for regionally important taxa, such as Atlantic cod and lobster. Hard bottom habitats are limited in regional distribution compared to sandy and soft bottom habitats (CoastalVision and Germano and Associates, 2010).

Cobble and boulder habitat can serve as a nursery ground for juvenile lobster and as preferable habitat for squid to deposit their eggs. Both lobster and squid are specific in their habitat requirements and are also economically important species in New England. For these reasons, federal and state agencies consider evidence of these taxa to indicate the presence of potentially sensitive habitats. Along with valuable hard bottom habitats, additional potentially sensitive seafloor habitats include areas with corals present and submerged aquatic vegetation beds (BOEM, 2013). Corals are not predicted to commonly occur within the SFWF or along the SFEC, as corals are more commonly found at deeper depths in the Northwest Atlantic. SAV beds are not predicted to occur within the SFWF or along the SFEC - OCS route due to depth limitations and are not predicted to be present along the SFEC - NYS primarily due to wave energy in nearshore waters.

Benthic community structure has only been inferred from studies in surrounding areas, including the OSAMP and related publications (RICRMC, 2010; LaFrance et al., 2010), studies conducted at the Block Island Wind Farm study (CoastalVision and Germano and Associates, 2010; DWW, 2012; INSPIRE, 2016), and BOEM-funded research (Collie and King, 2016; Siemann and Smolowitz, 2017). Data available from most of these studies only suggest which physical substrata and biotic communities may be present within the SFWF and SFEC; although one study, which included lobster trawls, examined the RI-MA WEA in terms of lobster habitat and confirmed the importance of the lease area as lobster habitat compared to inshore areas (Collie and King, 2016).

Benthic Habitats and Biota

Benthic Habitat Types

To better understand the site-specific benthic characteristics of the SFWF and the SFEC, DWW conducted a G&G survey (Appendix H) and a benthic habitat assessment (Appendix N) in the fall of 2017. A combined Sediment Profile and Plan View Imaging (SPI/PV) system was used to gather data to ground truth G&G data (multibeam echosounder and side scan sonar), and to provide a thorough characterization of surface sediment and biota found at the SFWF and along the SFEC. These data were used to meet BOEM Benthic Habitat Guidelines (BOEM, 2013) to characterize surface sediments; delineate and characterize hard bottom areas; identify and confirm benthic flora and fauna, including sessile and slow-moving invertebrates; identify sensitive habitats; establish preconstruction baseline benthic conditions against which postconstruction habitats can be compared; and determine the suitability of a sampled reference area to serve as a control site for future monitoring and assessment. These objectives were met, and more details are provided in the full SPI/PV reports presented as part of Appendices H and N.

Data provided by these site-specific surveys are discussed here in concert with previously existing data on surface sediments, biota, and habitat types found and likely to be found in the region. A list of species commonly associated with benthic habitats and the depth ranges found at the SFWF and the SFEC are provided in Table 4.3-3 (flora), Table 4.3-4 (fauna), and Table 4.3-5 (ecological and economically important shellfish). The depth ranges within the NYS portion of the SFEC route are shallower than along the SFEC - OCS, and differences in species distributions related to these depths and wave energy exposure in nearshore areas are discussed in the SFEC habitat distribution section.

It is important to note that most of the macroalgae species identified in Table 4.3-3 are found in shallow intertidal and subtidal waters that are not present within the SFWF or along most of the SFEC route; no living macroalgae was observed during the site-specific benthic survey (Appendix N). Similarly, the depth ranges and habitats found at the SFWF and along most of the SFEC route preclude the possibility of SAV (e.g., eelgrass, widgeon grass), which are found in quiescent habitats shallower than 20 feet (6.1 m); none were observed during the benthic survey (Appendix N). Additionally, no known invasive species (i.e., those listed by the Northeastern Aquatic Nuisance Species Panel) were observed during the benthic survey (Appendix N). Demersal (bottom-dwelling) fish species and commercially harvested shellfish and invertebrates associated with hard bottom habitats are described further in Section 4.3.3 and Appendix O.

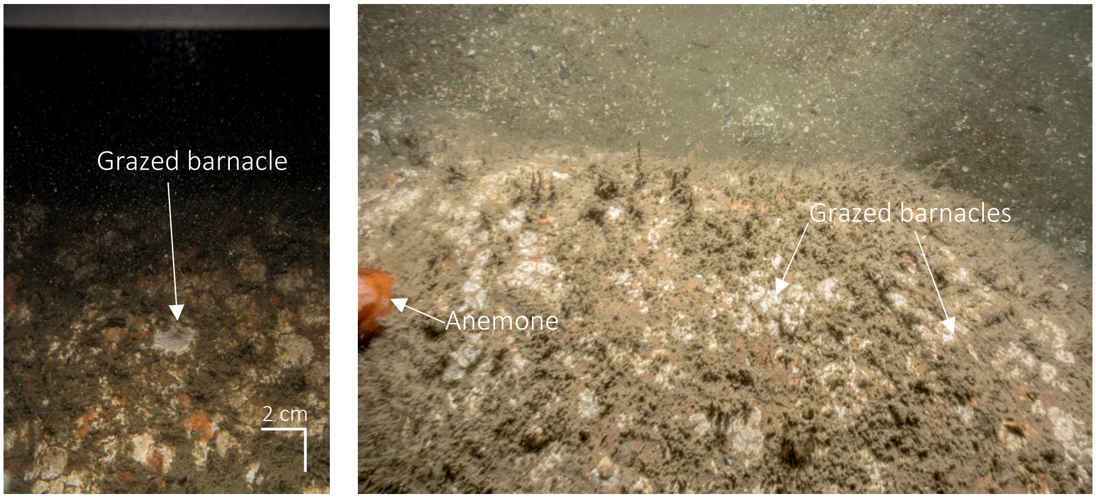
Benthic habitat types are used here as a construct to describe repeatable physical-biological associations found within the SFWF, SFEC, and reference area. These were derived from CMECS classifiers, and specific classification data for the Substrate and Biotic Component are provided in Appendices H and N. Three unique benthic habitat types were observed: patchy cobbles and boulders on sand; sand with mobile gravel, and sand sheets (Figure 4.3-4 and Appendix N). In Figure 4.3-4, images (A) and (B) represent patchy cobbles and boulders on sand with associated fauna annotated. Figure 4.3-4 image (C) represents sand with mobile gravel and image (D) represents sand sheet habitats, shown here with infaunal tubes annotated in the SPI image and sand dollars in the PV image. The species found in these types of habitats are typically described as infaunal species, those living in the sediments (e.g., polychaetes, amphipods, mollusks), and epifaunal species, those living on the seafloor surface (mobile, e.g., sea stars, sand dollars) or attached to substrates (sessile, e.g., barnacles, anemones).

(A) and (B) represent patchy cobbles and boulders on sand with associated fauna annotated. (C) represents sand with mobile gravel; (D) represents sand sheet habitats, shown here with infaunal tubes annotated in the SPI image and sand dollars in the PV image. Note: PV image width is approximately 3.2 feet (1 m), and SPI image height is approximately 7.9 inches (20 centimeters [cm]).

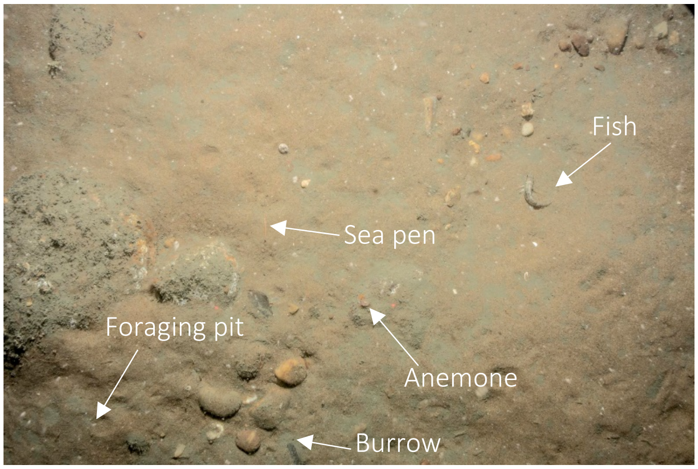
Sand, generally fine to coarse sand grain sizes, was the predominant surface sediment across all three habitat types. These sands are mobile, influenced by bottom currents that form ripples on the seafloor surface; which, in turn, influence sediment resuspension, deposition, and sorting. For example, deposition of fine sediment grains and organic material in ripple troughs is promoted by the structure of the ripple. The sand with mobile gravel habitat type has small-sized gravels (granules, pebbles, and small cobbles) that are also influenced by bottom currents (tides, storms) and are transported often enough, appearing “washed clean,” that biota are not able to attach and grow on their surfaces. In these habitats, gravel tends to gather in the troughs between sand ripples (Figure 4.3-4 and Appendix N).

The frequent hydrodynamic forcing and subsequent sediment mobility in sand sheet and sand with mobile gravel habitats creates a dynamic environment for biota. Therefore, these habitats do not include more than occasional sparse presence of attached flora or sessile attached epifauna and are, instead, inhabited by mobile epifauna, such as sand dollars, Jonah crabs, American lobster, and small tube-building and burrowing infauna (Tables 4.3-3 and 4.3-4). The dynamic nature of these environments results in high turnover of infauna, and, combined with the very low organic loads found in medium and coarse sands, limits the development of infaunal successional stages to Stage 1 and Stage 2 taxa; Stage 3 head-down deposit feeders would not be expected in these habitats (Appendix N). Because they are accustomed to a certain degree of natural disturbance, the benthic biological communities associated with these habitat types are considered generally resilient to change and quick to recover.

In CMECS terms, the dominant Biotic Subclass of these habitats is Soft Sediment Fauna; and the dominant Biotic Groups include Small Surface-Burrowing Fauna, Small Tube-Building Fauna, and Sand Dollar Beds (Appendix N). However, there is still potential that hydrozoans, anemones, and encrusting sponges will be present in low densities in sand with mobile gravel habitat, particularly when in close proximity to boulders and cobbles. Economically important species, including sea scallops, horseshoe crabs, surf clams, and the ocean quahog, are associated with these sandy habitats (Table 4.3-5).

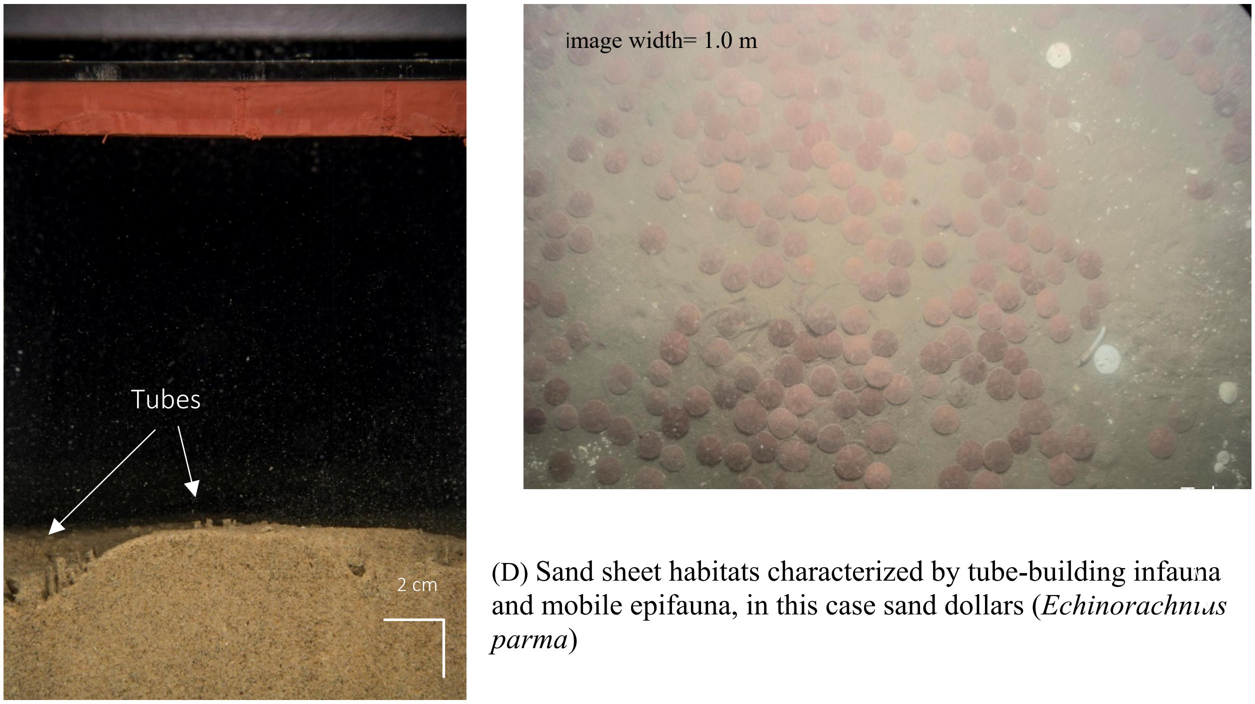


(A) The boulder is colonized by hydroids and barnacles, many of which have been grazed. A large orange anemone is attached to the boulder on the far left of the PV image.



(B) Hydroids and grazed barnacles are visible on the large cobbles and boulder. A sea pen and anemone are near the center of the image. A small unidentified fish is visible on the right side of the image. Infaunal burrows are present in the bottom center of the PV image and fish foraging pits in lower right and lower left.

(C) Small gravels washed clean by frequent water motion gather in throughs beneath ripples of mobile sand.



(D) Sand sheet habitats characterized by tube-building infauna and mobile epifauna, in this case sand dollars (*Echinorachnius parma*)

Figure 4.3-4. Representative Sediment Profile Imaging and Plan View Images for Each Habitat Type

The third benthic habitat type observed was patchy cobble and boulder on sand. These hard substrates generally support increasingly diverse epifaunal assemblages as grain sizes increase. The cobbles and boulders in these habitats provide substrate and stability on which biota can attach and grow; additionally, these habitats provide variable topography that creates complexity and additional niches for fauna to occupy. Where present, these large gravels were colonized by attached epifauna, predominantly hydroids, barnacles, and occasional anemones (Appendix N). Other attached epifauna that have the potential to be found in this habitat type include encrusting sponges, serpulid polychaetes, sea pens, and mussels, among others (Table 4.3-3). Because presence of cobbles and boulders is patchy, these areas are interspersed with sandy habitats, further increasing diversity within these areas.

Because dominant CMECS Biotic Subclasses and Biotic Groups are strongly correlated with surficial sediments, the classifications of these habitats were a mix of Soft Sediment Fauna and Attached Fauna; biota associated with sand was found in the patches of sand between the cobbles and boulders, on which the attached fauna were found (Appendix N). Within the Attached Fauna Subclass, dominant CMECS Biotic Groups included Attached Hydroids, Barnacles, Diverse Colonizers, Egg Masses, and Pennatulid Bed (Appendix N). Mobile epifauna are often associated with the Attached Fauna Subclass and include taxa such as crabs, sea stars, moon snails, and lobster (FGDC, 2012; Table 4.3-4). Macroalgae, such as foliose red algae and coralline algae, also have the potential to grow attached to cobbles and boulders in these habitats (Table 4.3-3). Economically important species, notably lobster and squid, are associated with these hard bottom habitats (Table 4.3-4).

The structure provided by the cobbles and boulders in these habitats can also serve as nursery habitat for juvenile lobster, feeding ground for fish such as cod and black sea bass, and substrate upon which squid (including longfin squid, *Loligo pealei*) lay their eggs (Table 4.3-4 and

Figure 4.3-5). Further, the presence of boulders in mixed bottom types has been noted as an important feature for understanding the distribution of lobsters (*Homarus americanus*) and Jonah crab (*Cancer borealis*) in the region of the SFWF (Collie and King, 2016; Table 4.3-5).

The distribution of habitat types within the SFWF and along the SFEC as it travels from the SFWF along the OCS south of Block Island and Montauk to the nearshore areas within NYS waters are variable and are discussed in the following sections. The likelihood of encountering the taxa listed in the tables within the SFWF or along any particular segment of the SFEC - OCS is directly related to the distribution of habitat types found in each area. Because the depths and exposure to wave energy in the nearshore portion of the SFEC in New York State waters differs from the SFWF and SFEC - OCS, there are some differences in taxa expected; these are discussed in the SFEC habitat distribution section.

Figure 4.3-5. PV image from the SFWF showing extensive coverage of squid eggs, considered indicative of sensitive taxa, likely attached to thinly buried pebbles and cobbles under sand

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Agarum cribrosum	Rocks, cobble	Subtidal to approximately 131 feet (40 m)	Single blade up to 59 inches (150 cm) with stipe attached to a holdfast	Limited potential for occurrence on boulders at the SFWF because of the depth at the site. Limited potential along the SFEC route segment near the SFWF where boulders and cobble are present.[a, b]
Coral weed (*Corallina officinalis*)	Rocks, cobble, large gravel, shells	Lower intertidal and subtidal	Coralline red algae that can encrust on rocks and shells; grows to about 4 inches (10 cm)	No potential at the SFWF and SFEC - OCS because of depth, and no potential at the SFEC - NYS because no cobble and boulder were present in the surveyed area. [c]
Coralline red algae (Order Corallinales)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal	Algal crusts	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC. [a, b]
Foliose red algae (Phylum Rhodophyta)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal	Low-growing, foliose red algae	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC, and potentially suitable habitat is present in the SFWF and the portions of the SFEC near the SFWF. [a, b]
Green Thread (*Chaetomorpha linum*)	Free floating or drifting; often entangled with other algae	Upper Intertidal, and free-floating mats	Filamentous clumps and tangles	Potential for occasional presence at the SFWF and SFEC as free-floating mat. [c]
Gut weed (*Ulva intestinalis*)	Rocks, mud, sand, tide pools, epiphyte on other algae and shells	Intertidal-Upper Intertidal and free-floating mats	Unbranched, flattened, gas-filled tubes with undulating edges to approximately 16 inches (40 cm) long	Potential for occasional presence at the SFWF and SFEC as free-floating mat. [c, d]

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Hooked red weed (*Bonnemaisonia hamifera*)	Rocks, cobble, large gravel, often epiphytic on shells and algae	Subtidal	Small, highly branched red foliose algae growing to 4 inches (10 cm)	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC, and potentially suitable habitat is present in the SFWF and the portions of the SFEC near the SFWF.[c]
Horsetail kelp (*Laminaria digitata*)	Rocks, large cobble	Subtidal in wave exposed areas	Large, wide, brown blade with central holdfast; grows to 39 inches (1 m)	Very limited potential for occurrence on boulders at the SFWF and portions of the SFEC near the SFWF because of depth, habitat, and offshore location.[c]
Irish moss (*Chondrus crispus*)	Rocks	Lower intertidal and shallow subtidal	Shrub-like, densely branched; grows to 6 inches (15 cm)	No potential at the SFWF and most of the SFEC route because they are located in waters too deep for this species. Limited potential in nearshore intertidal areas along the SFEC - NYS route if rocks or boulders are present.[c]
Kelp (*Saccharina latissimi, S. longicruris*)	Rocks, large cobble, rocky reef	Subtidal to approximately 115 feet (35 m)	Single blades with stipe that grow to 36 feet (11 m) (S. longicruris)	Very limited potential for occurrence on boulders at the SFWF and portions of the SFEC near the SFWF because of depth, habitat, and offshore location. [a, c]
Lacy red weed (*Callophyllis cristata*)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal, deeper waters	Small, highly branched red foliose algae growing to 2 inches (5 cm)	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC, and potentially suitable habitat is present at the SFWF and portion of the SFEC near the SFWF.[c]

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Sargasso weed (*Sargassum filipendula*)	Free floating	Open water and embayments	Multibranched with small, gas-filled nodules	Potential for occasional presence at the SFWF and SFEC as free-floating mat.[c]
Sea lettuce (*Ulva lactuca*)	Rocks and rocky reefs, epiphyte on other algae and shells	Intertidal-Upper Intertidal and free-floating mats	Attached via holdfast; grows to approximately 7.1 inches (18 cm) in length	Very limited potential for species to occur as free-floating mat at the SFWF and SFEC because of the distance to nearshore habitat where this species occurs. More likely to occur along the SFEC - NYS. [c, d]
Wire weed (*Ahnfeltia plicata*)	Rocks and drift	Subtidal	Branched algae attached to bottom substrate or drifting	Limited potential for species to occur as drift algae at the SFWF and SFEC because of the distance to nearshore habitat where this species occurs. More likely to occur along the SFEC - NYS. [c]

Note: No living macroalgae were observed during the SPI and PV survey (Appendix N).

[a] Vadas and Steneck, 1988

[b] McGonigle et al., 2011

[c] Van Patten and Yarish, 2009

[d] Shimada et al., 2003

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
Sand substrates	Asteroidea	Blood star	DWW, 2012
	Bivalvia	Atlantic sea scallop (*Plactopecten magellanicus*) *·, ocean quahog (*Artica islandica*), *Nucula proxima*, Waved astarte (*Astarte undata*), chestnut astarte (*A. castanea*), Atlantic surf clam (*Spisula solidissima*)	Steimle, 1982; Zajac, 1998; Fay et al., 1983; Meyer et al., 1981; Cargnelli et al., 1999a
	Cephalopoda	Squid egg masses and newly hatched larvae	Macy and Brodziak, 2001; NEFSC, 2005
	Crustacea	Tube forming amphipods: including *Ampelisca agassizi* and *A. vadorum*	Steimle, 1982; Wigley, 1968; DWW, 2012;

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
		American lobster, Atlantic rock crab, sand shrimp (*Crangon septemspinosis*), hermit crabs, Genus *Haustorid, Phoxocephalid, Leptocuma, Chiridotea, and Cancer* spp. Jonah crab (*Cancer borealis*)	Robichaud et al., 2000; Williams and Wigley, 1977; Appendix N
	Echinoidea	Sand dollar *· (*Echinarachnius parma)*	Wigley, 1968; DWW, 2012; Appendix N
	Gastropoda	Northern moon snail (*Lunatia heros*), *Nassarius* spp., channeled whelk (*Busycotypus canaliculatus*), common slipper shell	Wigley, 1968; DWW, 2012; Peemoeller and Stevens, 2013
	Ophiuroidea	Not listed	Poppe et al., 2014b
	Polychaeta	Surface feeding: *Exogone verugera, Prionospio steenstrupi, Anobothrus gracilis,* and *Paraonis gracilis* Tube forming *: *Spirorbis borealis, Ophelia bicornis,* and *Travisia carnea*	Steimle, 1982; Wigley, 1968
	Xiphosura	Horseshoe crab	ASMFC, 2010; NJDEP, 2016
Gravel/granule substrates	Asteroidea	Sea star *, blood star, common sea star	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980
	Bivalvia	Waved astarte, chestnut astarte, genus *Placopecten,* including Atlantic sea scallop *, eastern oyster (*Crassostera virginica*), ocean quahog	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Wigley, 1968; Jenkins et al., 1997; Hargis and Haven; 1999
	Cephalopoda	Squid egg masses *·, including longfin squid and newly hatched larvae	Macy and Brodziak, 2001; NEFSC, 2005; Appendix N
	Crustacea	Tube-forming Amphipods *·: *Ampelisca agassizi* and *A. vadorum* American lobster, sand shrimp *·, hermit crabs, Genus *Haustorid, Phoxocephalid, Leptocuma, Chiridotea*, and *Cancer* spp., Jonah crab (*Cancer borealis*), Atlantic rock crab	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Cobb and Wahle, 1994; Appendix N
	Gastropoda	Northern moon snail, *Nassarius* spp., channeled whelk, common slipper shell	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980
	Ophiuroidea	Genus *Ophiopholis* and *Ophiacantha*	Collie et al., 1997; Wigley, 1968

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
	Polychaeta	Tube-forming *·: *Phyllochaetopterus socialis*, *Filograna implexa, Chone infundibuliformis, Protula tubalaria* Carnivorous and omnivorous: *Nephtys incisa, Eunice norvegica* Deposit feeding: *Thelephus cincinnatus*	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Appendix N
Cobbles, boulders, rocky reef, rock outcrop	Anthozoa	Sea anemones *·, Order Alcyonacea (both gorgonians and non-gorgonians) tulacea[b.]	Poppe et al., 2011; Northeast Ocean Data, 2017; DWW, 2012; Appendix N
	Asteroidea	Blood star, common sea star, genus *Solaster* and *Crossaster*	DWW, 2012; Wigley, 1968; Collie et al., 1997
	Bivalvia	Horse mussel (*Modiolus modiolus*), eastern oyster, Atlantic sea scallop *·, waved astarte, chestnut astarte, genus *Brachiopoda, Placopecten, Anomia,* and *Musculus*	DWW, 2012; Wigley, 1968; Jenkins et al., 1997; Hargis and Haven; 1999
	Bryozoa	Not listed *·	DWW, 2012
	Cephalopoda	Squid egg masses *· and newly hatched larvae including longfin squid	Macy and Brodziak, 2001; NEFSC, 2005; Appendix N
	Chordata	Tunicates (*Boltenia* spp.)	Wigley, 1968
	Crustacea	Tube-forming Amphipods *·: *Ampelisca agassizi* and *A. vadorum* Barnacles ·(Infraclass Cirripedia and genus *Balanus*), America lobster, sand shrimp*·, hermit crabs*·, Genus *Cancer* and *Hyas**·, Jonah crab, Atlantic rock crab	DWW, 2012; Wigley, 1968; Appendix N
	Echinoidea	Green sea urchin (*Strongylocentrotus droebachiensis*)	Collie et al., 1997; Wigley, 1968
	Gastropoda	Northern moon snail, *Nassarius* spp., limpet*, channeled whelk, knobbed whelk (*Busycon carica*), whelk (*Sinistrofulgur sinistrum*), common slipper shell, genus *Neptunea, Dendronotus*, and *Doris*	Poppe et al., 2014b; Wigley, 1968, Appendix N
	Hydrozoa	Hydroids[b.], including genuses *Eudendrium, Sertularia,* and *Bougainvilia*	Poppe et al., 2011; DWW, 2012; Appendix N
	Ophiuroidea	*Ophiopholis aculeate* and *Ophiacantha* spp.	Collie et al., 1997; Wigley, 1968

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
	Polychaeta	Tube-forming and suspension feeding*: *Phyllochaetopterus socialis*, *Filograna implexa, Chone infundibuliformis, Protula tubalaria,* genus *Serpula* and *Spiorbis* Carnivorous and omnivorous: *Nephtys incisa, Eunice norvegica*	Wigley, 1968; DWW, 2012; Appendix N
	Porifera	Encrusting sponges of genus's *Halichondria, Clathria, Polymastia, Clionia, and Myxilla*	Poppe et al., 2011; DWW, 2012; Wigley, 1968

Note: The potential for each species to occur at the SFWF and along the SFEC - OCS and SFEC - NYS is related to the distribution of benthic habitat types within each area

* Indicates taxa were observed in SPI/PV imagery for the SFWF or SFEC (Appendix N).

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
American lobster (*Homarus americanus*)	All	Prefers rocky habitat, including mixed bottom types, but may burrow in featureless sand or mud habitat.	Year-round	Potential presence in the vicinity of rocky areas within the SFWF and along the SFEC near the SFWF; may seasonally pass through the SFWF, SFEC - OCS, and SFEC - NYS, including nearshore waters during migratory movements.	Collie and King 2016; ASMFC, 2015; Cobb and Wahle, 1994

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Atlantic rock crab (*Cancer irroratus*)	All	Prefers depths ranging from 20 to 1,496 feet (6 to 456 m), but most common in waters less than 65 feet (20 m) deep. Prefers rocky and gravely substrate but also occurs in sand.	Year-round	Limited potential for presence within the SFWF and along the SFEC near the SFWF because species prefers areas that are shallower than the SFWF. Potential presence in the SFEC - NYS and in nearshore waters.	Krouse, 1980; Robichaud et al., 2000; Williams and Wigley, 1977
Atlantic sea scallop (*Plactopecten magellanicus*)	All	Found on sand, gravel, shells, and other rocky habitat. Larvae settle out on gravel and rocky substrate. Found from mean low water to depths of 656 feet (200 m). This species also has designated EFH along part of the SFEC route (see Appendix O).	Year-round	Potential for presence throughout the SFWF and SFEC route.	NEFSC, 2004; Mullen and Moring, 1986
Atlantic surf clam (*Spisula solidissima*)	All	Prefers depths ranging from 26 to 216 feet (8 to 66 m) in medium-grained sand, but may also occur in finer-grained sediments. Burrows up to 3 feet (0.9 m) below the sediment-water interface. This species also has designated EFH along part of the SFEC route (see Appendix O).	Year-round	Potential for presence in sandy substrates within the SFWF and along the SFEC route.	Fay et al., 1983; Meyer et al., 1981; Cargnelli et al., 1999a

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Channeled whelk (*Busycotypus canaliculatus*)	All	Commonly found in nearshore and offshore environments, but preferred depth range is not known. Occurs in sandy and fine-grained sediments where they can bury themselves. Eggs are laid on sand in intertidal and subtidal areas.	Year-round	Potential for presence in sandy substrates within the SFWF and along the SFEC route. Potential for eggs to be laid in nearshore portions of the SFEC route.	Fisher, 2009; Peemoeller and Stevens, 2013
Eastern oyster (*Crassostera virginica*)	All	Larvae and adults can be found on hard bottom substrate or shell substrate to a depth of 36 feet (11 m) but is most common between 8 to 18 feet (2.5 to 5.5 m) deep.	Year-round	Not expected to occur at the SFWF or SFEC, as no shellfish beds are known from the vicinity.	Jenkins et al., 1997; Hargis and Haven, 1999
Horseshoe crab (*Limulus polyphemus*)	All	Prefer depths shallower than 98 feet (30 m) but known to occur in depths greater than 656 feet (200 m). Occurs commonly on sandy substrate, but is a habitat generalist and may be found on gravel and cobbles as adult. During full moon tides in spring and summer, migrates inshore to shallow bays and sandy beaches to spawn. Juveniles use shallow nearshore areas as nurseries before moving into deeper waters.	Year-round	Potential presence throughout the SFWF and SFEC route. Juveniles may be present in higher densities in the vicinity of nearshore portions of the SFEC route.	NJDEP, 2016; ASMFC, 2010

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Jonah crab (*Cancer borealis*)[a.]	Adults	Prefers depths ranging from 164 to 984 feet (50 to 300 m), but also occurs in shallower waters, perhaps associated with circadian rhythms. Found across sediment types, from sand, to small gravel, to rocky areas.	Year-round	Presence at the SFWF and potential presence along the SFEC route. Studies found higher abundances in fine sand, followed by coarse sand, and boulders on sand.	Appendix N; Collie and King 2016; Robichaud and Frail, 2006; Jeffries, 1966
Longfin squid (*Loligo pealeii*)[a.]	All	May-November found in inshore waters, and adults are demersal during the day. Eggs are laid on a variety of substrates, including sand and hard bottom. Newly hatched squid become demersal then migrate to offshore waters. December-April: Offshore waters between 328 and 550 feet (100 and 168 m) deep. This species also has designated EFH in portions of the SFWF and SFEC route, including EFH for eggs (see Appendix O).	May-November	Presence within the SFWF and potential presence along the SFEC route where rocky and gravelly areas are found between May-November; eggs have been observed at the SFWF and may be laid along the SFEC. Not expected to be present between December and April.	Appendix N; Macy and Brodziak, 2001; NEFSC, 2004
Northern quahog clam (*Mercinaria mercinaria*)	All	Mud and sandy habitats to depths up to 50 feet (15 m). Burrow into the sediments to a depth of 2 to 4 inches (5 to 10 cm).	Year-round	No potential to occur at the SFWF, may occur in nearshore portions of the SFEC route, but species prefers finer sediments than those found along the SFEC route.	Hill, 2004; DFO, 1996

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Northern shortfin squid (*Illex illecebrosus)*	Adults	Prefers depths ranging from 328 to 656 feet (100 to 200 m) but is also known to occur in waters shallower than 60 feet (18 m). Egg masses are thought to be neutrally buoyant. This species also has designated EFH along part of the SFEC route (see Appendix O).	Year-round	Preferred depth range is deeper than the SFWF and SFEC, but may occasionally be present within the SFWF and along the SFEC route. Neutrally buoyant egg masses may occasionally be present throughout both the SFWF and SFEC routes.	Black et al., 1987; Grinkov and Rikhter, 1981; O'Dor and Balch, 1985
Ocean quahog clam (*Artica islandica*)	Juveniles and Adults	Prefers depths ranging from 82 and 200 feet (25 and 61 m) in medium to fine grain sand. This species also has designated EFH in portions of the SFWF and SFEC route (see Appendix O).	Year-round	Potential presence within the SFWF and deeper portions of the SFEC route. Nearshore portions of the SFEC route are outside of the preferred depth range of the species.	Cargnelli et al., 1999b

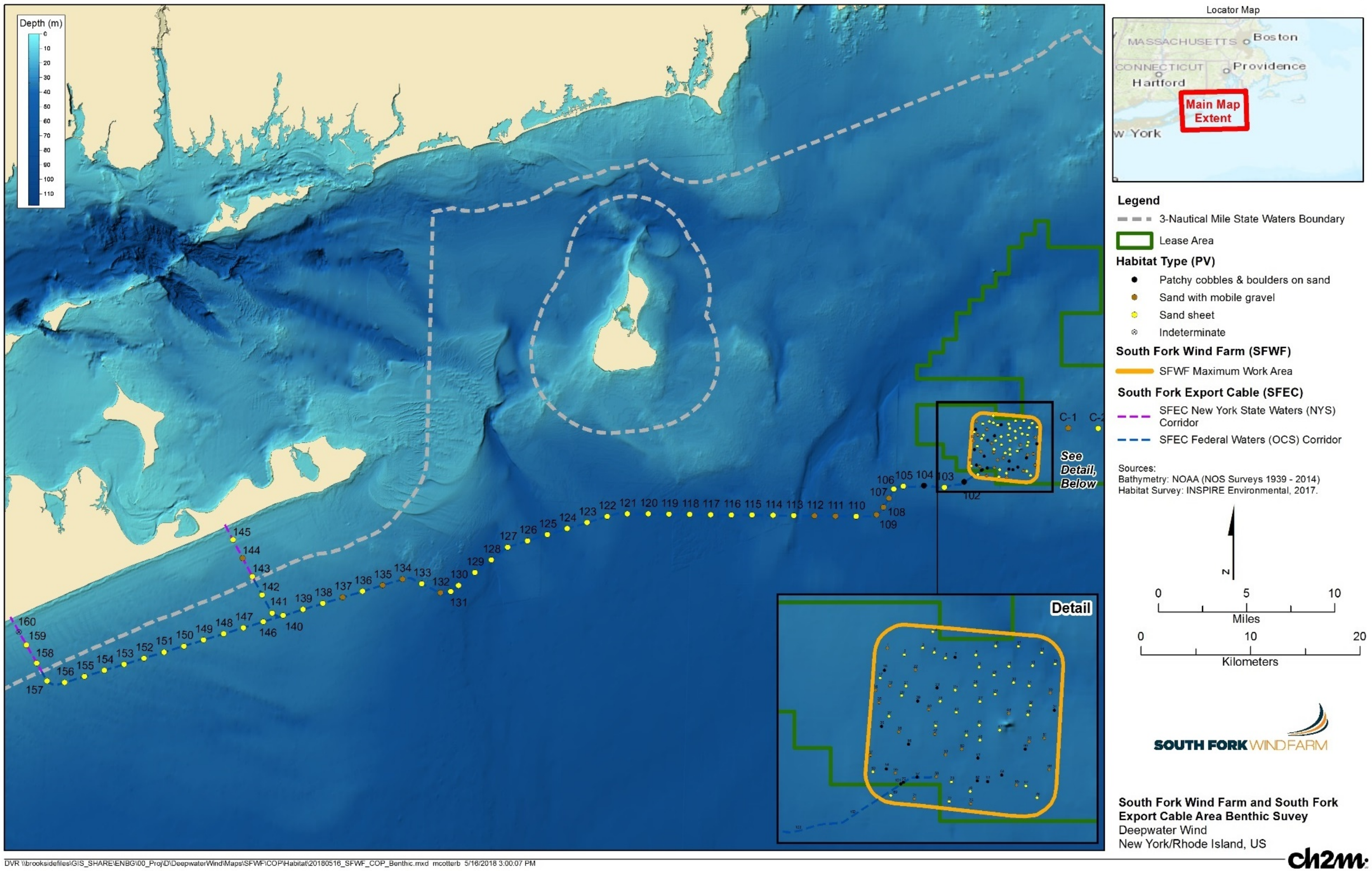
Note: Indicates taxa were observed in SPI/PV imagery for the SFWF or SFEC (Appendix N)

Shellfish Resources

Ecologically and economically important shellfish species in the vicinity of the the SFWF and SFEC are presented in Table 4.3-5. The economic and fisheries importance of these species is discussed further in Section 4.6.5. The patchy cobble and boulder habitat type is considered suitable, and potentially important regionally (Collie and King, 2016), for the American lobster. Sand sheet and sand with mobile gravel habitat types appear to be suitable for the following species: Atlantic sea scallop, Jonah crab, Atlantic rock crab, channeled whelk, ocean quahog clam, Atlantic surf clam, and horseshoe crab (Table 4.3-5). Longfin squid are expected to seasonally be present in the vicinity; they are demersal during the day and lay their eggs on the bottom substrate in patchy cobble and boulder on sand and sand with mobile gravel habitats. Table 4.3-5 includes a summary of these species, likelihood of presence, and the potential time of year that they could be present in the region.

South Fork Wind Farm Benthic Habitat Distribution

Based on data from these surveys, the SFWF has a highly variable and patchy distribution of benthic habitats, including sand sheets, sand with mobile gravel, and patchy cobbles and boulders on sand (Figure 4.3-6 and Appendix N). Although sand sheets were the most common habitat type encountered during the benthic surveys, the heterogeneity of sediment types on small scales was high, with variable presence of gravel (i.e., granules, pebbles, cobbles, boulders) on sandy substrates characterizing much of the SFWF (Appendix H). The presence of cobbles and boulders at the SFWF was patchy at both the sub-square meter scale of the SPI/PV images and at a larger landscape scale (Appendix H). Patchy presence of cobbles and boulders with attached fauna within and near the SFWF indicate that there is likely greater relative areal coverage of these features than was captured in SPI/PV images. Further, landscape scale data collected during the G&G survey show that boulders are present throughout the site with a much higher frequency than could be captured with SPI/PV (Appendix H). These data show that the highest density of boulders was found in the western and central portion of the SFWF (Appendix H).



Note: inset map is zoomed-in view of the SFWF.

Figure 4.3-6. Dominant Benthic Habitat Types Observed Across the Surveyed Area

The dominant CMECS Biotic Subclass across the SFWF was Soft Sediment Fauna. Attached Fauna were present as the CMECS Biotic Subclass or Co-occurring Biotic Subclass at approximately one-third of the stations sampled within the SFWF, and sensitive taxa in the form of squid eggs (Figure 4.3-5) were observed at two stations (Appendix N). Because only a small portion of the boulders that exist at the SFWF were captured by SPI/PV images, data on the prevalence of attached and potentially sensitive fauna associated with these features (Appendix N) should be considered an underrepresentation of their presence at the SFWF, and data should be extrapolated over the boulder presence density noted in the geophysical data (Appendix H).

South Fork Export Cable Benthic Habitat Distribution

All three benthic habitats were observed along the SFEC route; however, their distribution varied with distance from the SFWF and as the SFEC routes near land in NYS waters, where waters are shallower than 25 feet (7 m) (Figure 4.3-6 and Appendix N). The SFEC route was dominated by sand sheet habitats except for the following SFEC segments, where this habitat type was interspersed with other habitat types. Areas of the SFEC - OCS immediately adjacent to the SFWF were more heterogenous than the remainder of the SFEC, with patchy cobble and boulder on sand habitats observed within 19-25 miles (30-40 km) of the SFWF. Sand with mobile gravel habitats were observed along the SFEC - OCS route between the SFWF and for about half the distance along the SFEC - OCS to due south of Block Island. These habitats were also present in the section of the SFEC - NYS south of Montauk Point and near the Hither Hills landing point within NYS waters (Figure 4.3-6 and Appendix N). Within New York State waters, sand sheets were the predominant benthic habitat type, with mobile gravel present at one station (Appendix N), and sediment grain size was largely homogeneous (Appendix H). Sediment grain size was moderately variable on small scales along the SFEC - OCS, but most of the variability was between grain size classes within the overall sand category. Deposits of very fine silt, on the order of 6 inches (15 cm) thick, were observed overlying sand at two locations offshore of the Beach Lane SFEC landing location; one of these locations fell within New York State waters (Appendix H).

The dominant CMECS Biotic Subclass along the SFEC route was Soft Sediment Fauna at all stations where Biotic Subclass could be determined. Attached Fauna was present as the CMECS Co-occurring Biotic Subclass at a handful of locations along the SFEC, on patchy boulders close to the SFWF and on small pebbles or cobbles in sand sheet and sand with mobile gravel habitats. The Attached Fauna Biotic Subclass was not observed along the SFEC - NYS. No sensitive taxa were observed along either the SFEC - OCS or SFEC - NYS (Appendix N).

The nearshore portion of the SFEC - NYS passes through areas that are shallow enough for SAV to be present; however, all known SAV beds identified in the vicinity are on the northern side of Long Island. No eelgrass beds were identified near the routes during a review of historical aerial imagery from the vicinity of the routes (Tiner et al., 2003; NYSDOS Seagrass Taskforce, 2009; Stephenson, 2009). In addition, because these portions of the route are open to wave activity and are not located in shallow, sheltered, estuarine habitat, it is unlikely that SAV occurs along these routes. Similarly, depth and wave energy are anticipated to limit macroalgae that may be present in the nearshore areas of the SFEC - NYS; floating algal masses and drifting algae composed of species such as sea lettuce and wire weed are the most likely to occur (Table 4.3-3). Neither eelgrass beds nor macroalgae were observed in the nearshore areas of the SFEC - NYS (Appendix N).

As the majority of the SFEC is located at a similar depth as the SFWF, the macrobenthic communities associated with each benthic habitat type present are expected to be similar (Table 4.3-4). In shallower areas with greater exposure to waves and shifting sands in New York State waters, benthic communities and organisms are expected to be less prevalent than in deeper areas because of higher wave energy and more frequent disturbance patterns, preventing large populations of epifauna and infauna from becoming established. There is also expected to be a shift in dominant ecologically and economically important species in the shallower nearshore waters of the SFEC - NYS, with increased densities of Northern quahog clam, Atlantic rock crab, Atlantic surf clam, horseshoe crab, and a limited potential for eastern oyster if shell beds are present. These shallower nearshore areas of the SFEC - NYS are also less suitable for lobster, Atlantic sea scallop, Jonah crab, and as egg-laying sites for longfin squid than benthic habitats within the SFWF and along the SFEC - OCS.

Reference Area Benthic Habitat Distribution

The physical and biological characteristics of the reference area were within the range observed across the SFWF and SFEC. Therefore, the area can serve as a valid reference area for the SFWF project. The potential presence of macroalgae (Table 4.3-3), macrofauna (Table 4.3-4), and ecologically and economically important shellfish species (Table 4.3-5) in the reference area is expected to be similar to that predicted for the SFWF and the SFEC-OCS in direct relation to the complement of habitat types present.

All three benthic habitat types were observed in the reference area (Figure 4.3-6 and Appendix N). Sediments exhibited low to medium heterogeneity and were composed of mostly coarse and medium sands, with pebbles and cobbles present at the western and eastern ends of the area and a boulder observed at the eastern end (Appendix H). The dominant CMECS Biotic Subclass in the reference area was Soft Sediment Fauna, and Attached Fauna was the Co-occurring Biotic Subclass at the eastern edge of the reference area where sea pens and hydroids were observed attached to cobbles (Appendix N). Sensitive taxa were not observed within the reference area.

4.3.2.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to cause both direct and indirect impacts on benthic resources and shellfish, as discussed in the following sections. IPFs associated with the construction, O&M, and decommissioning phases for the SFWF and SFEC are described in Section 4.1.

An overview of the potential impacts to benthic and shellfish resources associated with the SFWF and SFEC is presented on Figure 4.3-7. IPFs not expected to impact benthic resources are depicted with slashes through the circle. For the IPFs that could impact benthic resources, but were found to be negligible in the analyses in Section 4.1, the circle is gray without a slash. The IPFs with potential to impact benthic resources are indicated by gray shading.

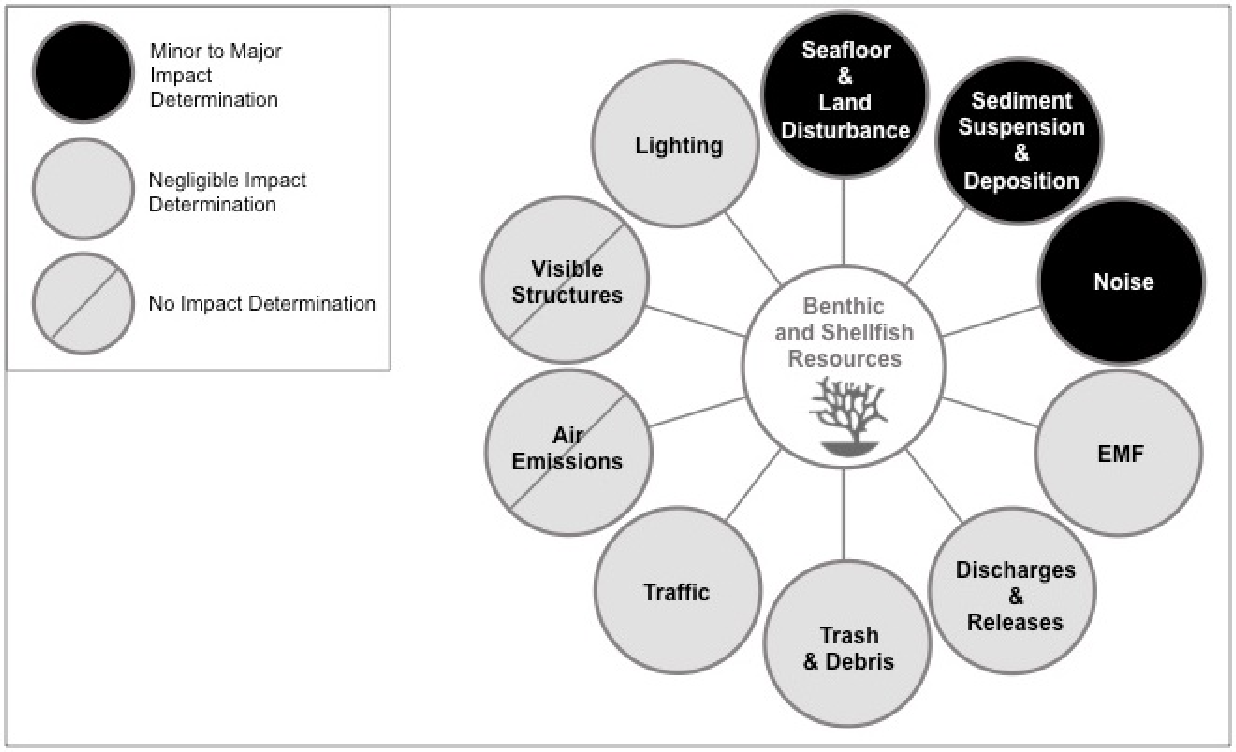


Figure 4.3-7. IPFs on Benthic and Shellfish Resources

South Fork Wind Farm

Impacts associated with the construction, O&M, and decommissioning of the SFWF to benthic species overall are expected to be ***negligible to minor, localized, and short-term***. Impacts to sessile species and species with limited mobility are more likely to experience ***minor impacts***, while more mobile species are more likely to experience ***negligible impacts***. See Section 4.1 for the acreage range of benthic habitat that is expected to be affected by construction.

Following completion of construction and during O&M of the SFWF, the majority of the substrates at the SFWF will return to pre-project conditions and allow for the continued use by benthic species. Benthic infauna and epifauna are expected to recolonize the area after sediment disturbance, allowing these areas to continue to serve as habitat. The exception is the conversion of soft substrate to hard substrate associated with the WTGs, scour protection, and protective armoring. The acreage of benthic habitat that is expected to be affected by construction (Section 4.1) is small relative to the total area of available surrounding habitat and EFH. Impacts to EFH for shellfish are discussed in Appendix O.

Construction

Table 4.3-6 summarizes the level of impacts expected to occur to benthic and shellfish resources during the construction and decommissioning phases of the SFWF. Decommissioning of the SFWF is included in Table 4.3-6 because the structures are expected to be removed, and their removal will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to benthic and shellfish resources from the various IPFs of the SFWF during construction are described in the following sections.

Table 4.3-6. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Seafloor preparation	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Pile driving and foundation installation	Minor short-term direct	Minor short-term direct
	OSS platform installation	Minor short-term direct	Minor short-term direct
	SFWF inter-array cable installation	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible long-term indirect
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Pile driving	Minor short-term direct Minor short-term indirect	Minor short-term direct Minor short-term indirect
	Vessel noise, trenching noise, aircraft noise	Negligible short-term direct	Negligible short-term direct
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct
Discharges and releases [c]		Negligible	Negligible
Trash and debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category. For further information on potential impacts associated with the IPFs, see the following sections.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Releases and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Seafloor disturbance during construction of the SFWF occurs during the following activities: seafloor preparation, pile driving and foundation installation, OSS platform installation, the SFWF inter-array cable installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce ***minor direct impacts*** to species, depending on the mobility of the benthic species and shellfish species. See Section 4.1 for the impact area associated with the inter-array cable and impact areas associated with each of the potential foundation types that could be installed for the WTGs and OSS.

Seafloor Preparation

Clearing and leveling of the seafloor and grapnel runs to prepare areas for installation of the inter-array cable is expected to result in ***minor, short-term direct impacts,*** including mortality to benthic species within the area of impact. Benthic species are expected to recolonize the impact area following construction activities, and this may occur within months or 1 to 3 years of disturbance (BERR, 2008; BOEM, 2012). Recolonization rates of benthic habitats are driven by the benthic communities inhabiting the area surrounding the impacted region. Communities well adapted to disturbance within their habitats (e.g., sand sheets) are expected to quickly recolonize a disturbed area, while communities not well adapted to frequent disturbance (e.g., deep boulder communities) may take upwards of a year to begin recolonization, resulting in ***minor, long-term, direct impacts***. Impacts to benthic resources will be limited to the area of direct disturbance. ***Minor, short-term, direct impacts*** may also include disruption of feeding during seafloor preparation; however, post-seafloor preparation predatory infaunal and epifaunal species may be attracted to the area to prey upon dislodged or injured organisms.

Pile Driving and Foundation Installation

In disturbed areas where no structures are placed, benthic species are expected to recolonize following the disturbance. In areas where foundations and associated scour protection (if necessary) are placed ***minor, short-term, direct impacts*** to benthic species through crushing and displacement of all life stages of species, including eggs and larvae are anticipated. Long-term impacts to benthic species because of the presence of the foundations and scour protection are discussed in the O&M section for the SFWF.

Offshore Substation Platform Installation

Impacts associated with the installation of the OSS platform are expected to be similar to those described for seafloor preparation and pile driving and foundation installation.

SFWF Inter-Array Cable Installation

Installation of the inter-array cable is expected to result in impacts similar to these described for seafloor preparation, pile driving and installation of foundations resulting in ***minor, short-term, direct impacts*** to benthic species. Sessile and slow-moving benthic species, including infaunal species that cannot get out of the way of the mechanical/hydro-jet plow, may be subject to mortality and injury to individuals. Because of the slow speed of equipment and limited size of the impact area, it is expected that most mobile benthic species, such as American lobster, crabs, Atlantic sea scallops, and juvenile and adult squid, will be able to move out of the way and not be subject to mortality, but may still experience ***minor, short-term, direct impacts***. Sessile and slower moving species, such as clams, oysters, whelks, and egg masses for a variety of species, including squid, may be subject to mortality or injury if within the impact area. The inter-array cable may also require armoring, and the installation of this armoring is expected to result in ***minor, short-term, direct impacts***.

Similar to seafloor preparation, ***minor to negligible, long- and short-term, direct impacts*** may include longer-term recolonization of the affected area, and short-term disruption of feeding of benthic species.

Vessel Anchoring (Including Spuds)

Impacts associated with vessel anchoring are similar to those discussed for seafloor preparation and pile driving and foundation installation. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary, depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, direct impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during construction can result from seafloor disturbance associated with foundation placement and inter-array cable installation, as well as vessel traffic and anchoring. These activities have the potential to cause localized increases in sediment suspension and deposition in adjacent areas as the suspended sediment settles out of the water column. ***Direct impacts*** associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. ***Minor, long-term, direct impacts*** associated with habitat loss through sediment deposition in surrounding areas would be anticipated. Vessel mooring or anchoring activity resulting in sediment suspension and deposition is expected to be limited to areas of the seafloor immediately adjacent to the spuds or anchors. For mechanical/ hydro-jet plow installation activities, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from mechanical/hydro-jet plow installation of the inter-array cable (Appendix I).

To estimate the extent of potential impacts from sediment suspension and deposition generated by mechanical/hydro-jet plow installation, a modeling simulation was conducted on a representative section of the inter-array cable, which indicated that the maximum modeled TSS concentration from the SFWF inter-array cable installation is 100 mg/L. Water column concentrations of 100 mg/L are predicted to extend up to 131 feet (40 m) from the mechanical/hydro-jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) within 18 minutes (0.3 hour) from the conclusion of mechanical/hydro-jet plow trenching. The model predicted that sediment deposition resulting from the installation of the inter-array cable will be limited to the area immediately adjacent to the burial route, typically extending no more than 196 feet (60 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.4 inch (10 mm) and limited to within 26 feet (8 m) of the burial route, covering an estimated cumulative area of 0.1 acre (0.04 ha) (Appendix I).

Increased deposition could result in mortality of benthic organisms through smothering and irritation to respiratory structures; however, mobile benthic organisms are expected to temporarily vacate the area and move out of the way of incoming sediments (DOI-MMS, 2007). Eggs and larval organisms are especially susceptible to smothering through sedimentation, and smaller organisms are likely more affected than larger organisms, as larger organisms may be able to extend feeding tubes and respiratory structures above the sediment (BERR, 2008). Maurer et al. (1986) found that several species of marine benthic infauna (the clam *Mercenaria mercenaria*, the amphipod *Parahaustorius longimerus*, and the polychaetes *Scoloplos fragilis* and *Nereis succinea*) exhibited little to no mortality when buried under up to 3 inches (8 cm) of various types of sediment (from predominantly silt-clay to pure sand). This suggests that burial with 0.4 inch (10 mm) of sediment will have little impact on some species of benthos if they are present near the trench.

Recolonization of areas covered in sediment may take months to years to occur, and studies associated with cable laying found that benthic infauna were still recovering 2 years after the cable-laying activity had ceased (Gill, 2005; DONG Energy et al., 2006).

Increased sediment suspension and deposition could also result in a reduction in feeding success of benthic species because prey species may be covered or temporarily vacate the area. Levels of TSS could also reach lethal or sublethal levels for benthic species; however, given the limited extent and duration of the elevated project-related TSS concentrations, this would be considered a minor impact to the benthic population. Indirect impacts may also include mobilization of contaminants within the sediments; however, the inter-array cable is not located near a known disposal site or area of contamination, so this is unlikely.

Sand sheet and mobile sand with gravel habitats as found near the SFWF are often more dynamic in nature; therefore, they are quicker to recover than more stable environments, such as fine-grained (e.g., silt) habitats and rocky reefs (Dernie et al., 2003). Species found in these more dynamic areas are often adapted to deal with more dynamic habitats and handle increases in sedimentation associated with wind and waves.

Noise

Direct impacts associated with noise during construction of the SFWF may occur during pile driving and installation of the inter-array cable. Noise associated with vessels and aircrafts may also cause impacts during construction. Pile driving is expected to cause ***minor, short-term, direct impacts***, while the other sources of noise are expected to have ***negligible impacts***. Expected impacts from these activities are discussed separately in the following sections. Criteria for assessing injury to invertebrates associated with sound levels and sound exposure levels have not been established.

Pile Driving Noise

Little scientific research has been conducted on noise impacts on benthic species and shellfish; however, because benthic species and shellfish lack gas-filled organs, they are likely to be less sensitive than finfish and marine mammals to pressure waves. Few marine invertebrates have the sensory organs to perceive sound pressure, but many can perceive particle motion (Vella et al., 2001). ***Minor, short-term, direct impacts*** are expected for benthic resources and shellfish from pile driving noise. Increased underwater noise may result in short-term behavioral changes, including area avoidance by mobile species. ***Minor, short-term, direct impacts*** may be associated with increased underwater noise, resulting in an increased potential for predation, and potential interruption of communication leading to behavioral changes.

Vessel Noise, Trenching Noise, Aircraft Noise

Little research has been conducted on how benthic resources and shellfish are affected by underwater noise from vessels, trenching, or aircraft noise. Vessel noise may cause short-term behavioral changes; however, this is not expected to be different than what currently occurs when vessels transit the area. Similarly, trenching noise levels are not expected to result in adverse impacts to benthic resources. As a result, ***short-term, negligible, direct impacts from*** trenching, vessel noise, and aircraft noise could be anticipated

Traffic

Impacts associated with vessel traffic during the SFWF construction are expected to be ***negligible*** and ***short-term*** related to benthic resources.

Lighting

BOEM does not identify potential impacts to benthic or shellfish species from lighting at offshore facilities (Orr et al., 2013). There is the potential that lighting associated with construction of the OSS may serve to attract species such as squid to the area at night; however, because of the limited size of the lit area during construction and the depth of the water at the SFWF, potential impacts are expected to be ***short-term*** and ***negligible***.

Operations and Maintenance

Table 4.3-7 summarizes the level of impacts expected to occur to benthic and shellfish resources during the O&M phases of the SFWF. ***Minor, long-term, indirect impacts*** during O&M are largely associated with the presence of the SFWF. Additional details on potential impacts to benthic and shellfish resources from the various IPFs during O&M are described in the following sections.

Table 4.3-7. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact[a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Foundation	Minor long-term indirect	Minor long-term indirect
	OSS platform	Minor long-term indirect	Minor long-term indirect
	SFWF inter-array cable	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Vessel Anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Vessel Noise and Aircraft Noise	Negligible short-term direct	Negligible short-term direct
	WTG Operational Noise	Negligible long-term direct	Negligible long-term direct
EMF		Negligible	Negligible
Traffic		Negligible short-term direct	
Lighting		Negligible long-term direct	Negligible long-term direct
Discharges and Releases [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category. For further information on potential impacts associated with the IPFs, see the following sections.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Releases and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

During O&M of the SFWF, the presence of the foundations, inter-array cable, and vessel anchoring may result in seafloor disturbance. See Section 4.1 for the expected impact areas associated with each foundation type that may be used to support the WTGs and OSS, and the impact area associated with the inter-array cable and vessel anchoring.

Foundations

The presence of the foundations and associated scour protection (if necessary) is expected to result in ***minor, long-term, direct impacts*** to benthic organisms because of the conversion of existing sand sheet or sand with mobile gravel habitat to hard bottom habitat. This conversion to hard-bottom habitat would result in ***long-term, minor direct impacts*** to species that occur in soft-bottom because of loss of habitat. Species that are associated with hard bottom habitat are expected to experience ***long-term benefits*** due to an increase of hard bottom habitat.

Habitat conversion is expected to cause a ***long-term, minor, indirect impact*** resulting in a potential shift in species assemblages towards those found in rocky reef and rock outcrop habitat; this is known as the "reef effect" (Wilhelmsson et al., 2006; Wilhelmsson and Malm, 2008; Maar et al., 2009; Reubens et al., 2013). This effect is also well known from other anthropogenic structures in the sea, such as oil platforms, artificial reefs piers, and shipwrecks (Claudet and Pelletier, 2004; Wilhelmsson et al., 2006; Seaman, 2007; Langhamer and Wilhelmsson, 2009; Langhamer et al., 2009). The impact is expected to be minor because both soft and hard bottom habitats are already present in and around the SFWF. Data collected as part of the G&G survey at the SFWF (Appendix H) indicate that sand sheet habitat is not a limiting habitat in the region, and that numerous hard bottom boulder habitats are also present within the area. As a result, the conversion of a small area of sand sheet habitat to hard bottom habitat is unlikely to result in perceptible changes to the benthic community outside of the immediate area impacted.

These converted hard bottom habitat areas may serve as artificial reefs and are expected to be colonized by fouling organisms, including macroalgae, shellfish, barnacles, tunicates, and bryozoans (Gill and Kimber, 2005). Recruitment of marine organisms to new structures such as foundations primarily occurs in two different ways: by migration of adults from the surrounding substrate or by settling of larvae and juveniles. This recruitment will be influenced by the local hydrodynamic regime that will be carrying the larvae to the area (Jonsson et al., 2004), the material and texture of the foundations and structures (Glasby, 2000), the location of the foundations and structures with respect to water depth (Relini et al., 1994), and temperature (Anil et al., 1995; Verween et al., 2007). Design components may influence the specific species that settle and colonize scour protection structures, as structural complexity of exposed surfaces is an important factor (Petersen and Malm, 2006; Langhamer and Wilhelmsson, 2009; Langhamer, 2012).

The use of gravel or boulders for scour protection around the foundations will create new hard substrate, and this substrate is expected to be initially colonized by barnacles, tube-forming species, hydroids, and other fouling species found on existing hard bottom habitat in the region. Mobile organisms, such as lobsters and crabs, may also be attracted to and occur in and around the foundation in higher numbers than surrounding areas. Hard substrate generally has a higher biodiversity and species abundance than surrounding soft bottoms (Linnane et al., 2000).

Concrete, which will be used for a gravity-based foundation, attracts benthic organisms, but is typically coated with compounds that deter the settling of organisms in sub-marine settings (RICRMC, 2010). Monopiles, if treated with anti-fouling paint, may deter some species, but still attract barnacles and filamentous algae (Petersen and Malm, 2006). Jacket foundations provide a more complex structure than monopile foundations, and may increase habitat complexity through more suitable fouling surfaces and increased protection from predators (DOI-MMS, 2009).

As these foundations extend from below the seafloor to above the surface of the water, there is expected to be a zonation of macroalgae from deeper growing red foliose algae and calcareous algae, to kelps and other species, including those that may grow in subtidal, intertidal, and splash zone areas. Foundations typically also have crevices that increase structural complexity of the area and attract finfish and invertebrate species seeking shelter, including crabs and American lobster. Other species that may be beneficially affected include sea anemones and other anthozoans, bivalves such as horse mussel, green sea urchin, barnacles, hydrozoans, sponges, and other fouling organisms. There is expected to be a similar zonation of these species with depth, as well. Species that prefer softer bottom habitat may be adversely affected, and these include ocean quahog, waved and chestnut astarte clam, Atlantic surf clam, sand shrimp, channeled whelk, and horseshoe crab. For further information on preferred habitat of benthic species, see Table 4.3-3.

Hard bottom habitat is present, but limited in the area and conversion of soft bottom habitat to hard bottom habitat is expected to provide ***long-term benefits*** that may increase diversity and biomass of benthic and shellfish species in the vicinity of the SFWF, including those species discussed in the cobbles, boulders, rocky reef, and rock outcrop portion of Table 4.3-3. The conversion to hard bottom associated with the WTGs is expected to have a ***minor, long-term, impact*** on species associated with sandy bottom habitats. Because of the amount of surrounding sand sheet soft bottom habitat in the area, sand sheet habitat is not expected to be a limiting factor on benthic resources and shellfish. In addition, because of the dispersed nature and small spatial footprint of the WTGs and other locations that may be converted to hard bottom, any reef effect observed will be limited to the immediate vicinity of that structure and will not cover the entire area where the SFWF is located.

Offshore Substation Platform

Impacts associated with the presence of the OSS platform during operation are expected to be similar to those described for the foundation.

SFWF Inter-Array Cable

Some portions of the inter-array cable may require armoring, which will result in conversion of existing habitat to hard bottom, as described in the Foundation section. Areas that require armoring are expected to result in ***minor, long-term impacts*** to benthic organisms and their habitat, as described in the Foundation section.

Benthic organisms are expected to experience ***minor, short-term, direct impacts*** if the inter-array cable requires maintenance that will expose the inter-array cable. Maintenance of the inter-array cable is considered a nonroutine event and is not expected to occur regularly. Impacts associated with exposing the inter-array cable will be similar but less frequent to those described for the SFWF inter-array cable installation during the construction and decommissioning stage.

Vessel Traffic - Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the inter-array cable or WTGs require maintenance. Impacts associated with potential vessel anchoring during operation are expected to be similar to but less frequent than those discussed for vessel anchoring during the construction phase. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition
Increases in sediment suspension and deposition during O&M will primarily result from vessel anchoring and any maintenance activities that require unburying or reburying the inter-array cable. Both activities are expected to be nonroutine events and not expected to occur with regularity. Sediment suspension and deposition impacts resulting from vessel activity during the SFWF O&M are expected to be similar to vessel-related sediment suspension and deposition impacts described for the construction phase.

Noise
Noise associated with O&M activities is expected to have ***negligible impacts*** on the benthic resources at the SFWF.

Vessel and Aircraft Noise
Vessel and aircraft noise during the SFWF O&M are expected to have ***negligible, short-term, direct impacts*** and will be similar to or less than those impacts described in the construction phase.

WTG Operational Noise
The WTGs will produce low-level continuous underwater noise (infrasound) during operation; however, there are no conclusive studies associating WTG operational noise with impacts on benthic resources and shellfish. Because of this, direct impacts are expected to be ***long-term*** and ***negligible*** for WTG operational noise. No indirect impacts are expected.

Electromagnetic Field
Operation of the WTG does not generate EMF; however, once the inter-array cable becomes energized, the cable will produce a magnetic field, both perpendicularly and in a lateral direction around the cable. The inter-array cable will be shielded and buried beneath the seafloor. Shielded electrical transmission cables do not directly emit electrical fields into surrounding areas, but are surrounded by magnetic fields that can cause induced electrical fields in moving water (Gill et al., 2012). Exposure to EMF could be short- or long-term, depending on the mobility of the species. Mobile species are likely to pass through the area, and be exposed for a short duration. Sessile species, which are unable to move, will be exposed for the entire duration that the inter-array cable is energized (BERR, 2008; Woodruff et al., 2012; Love et al., 2015, 2016).

Compared to fish and elasmobranchs, relatively little is known about the response of marine invertebrates to AC EMF, and how this might impact migration, orientation, or prey identification. Aquatic crustaceans, a group that includes commercially important crab and lobster species, have been observed to use geomagnetic fields to guide orientation and migration, which suggests that this group of organisms is capable of detecting static magnetic fields (Ugolini and Pezzani, 1995; Cain et al., 2005; Boles and Lohmann, 2003; Lohmann et al. 1995). The ability to detect geomagnetic fields, however, is likely integrated with other environmental cues, including slope, light, currents, and water temperature. Furthermore, Project cables will produce AC magnetic fields, which differ from the static geomagnetic fields to which magnetosensitive marine invertebrates are attuned; therefore, operation of the inter-array cable is not expected to adversely impact benthic invertebrate orientation or migration.

As described in Appendix K, data from field studies constitute the best source of evidence to assess population-level impacts to benthic invertebrates. These demonstrate that impacts on benthic invertebrate behavior or distribution are not expected due to the presence of energized cables. Field surveys on the behavior of large crab species at 60-Hz AC submarine cable sites indicate that the project's calculated magnetic-field levels are not likely to impact the distribution and movement of large epibenthic crustaceans. Ancillary data and observations from these field studies also suggest that cephalopod predation is similarly unaffected by the presence of 60-Hz AC cables (Appendix K).

Appendix K provides more detail on field study evidence that supports the conclusion that large benthic and epibenthic invertebrates will not be affected by the installation of the SFWF inter-array cable. Impacts on sea urchin embryonic development observed in laboratory studies were minor and were only documented to occur after exposure to magnetic fields between 500 and 34,000 mG (Appendix K). These levels are much higher than magnetic fields expected to be produced by the SFWF and SFEC cables. Based on these studies, negligible impacts to benthic invertebrates are expected from the EMF associated with operation of the SFWF inter-array cable.

Traffic
Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting
Impacts associated with lighting are expected to be similar to impacts described in the construction phase. Because of the limited size of lit area during O&M at the OSS and individual WTGs, the depth of the water at the SFWF, the limited area associated with artificial lighting, and the height of the lights above the water, these potential impacts are expected to be ***negligible*** but would occur over the duration of the O&M of the SFWF.

Decommissioning

Decommissioning of the SFWF is expected to have similar impacts as those described for construction of the WTGs, OSS, and inter-array cable, and. the SFWF area is expected to return to pre-project conditions after completion of decommissioning.

South Fork Export Cable

Similar to the SFWF inter-array cable, the construction, installation, and decommissioning of the SFEC is not expected to have more than minor long-term impacts on benthic or shellfish resources. Impacts are largely expected to be ***negligible to minor, localized,*** and ***short-term*** in nature. See Section 4.1 for the acreage of benthic habitat that is expected to be affected by construction.

Following completion of construction and during O&M of the SFEC, the substrates along the SFEC are expected to fundamentally remain the same as pre-project conditions, since the SFEC will be buried below the seafloor. This will allow for benthic species to recolonize the disturbed areas. The exception is the conversion of sand sheet and sand with mobile gravel habitats to hard bottom habitat associated with the protective armoring for discrete portions of the SFEC. This acreage is small relative to the total area of available surrounding benthic habitat, and such adverse impacts to benthic species are expected to be ***localized*** and ***minor at the short- and long-term***.

SFEC – OCS and SFEC - NYS

Construction and Decommissioning

Table 4.3-8 summarizes the level of impacts expected to occur to benthic and shellfish resources during the construction and decommissioning phases of the SFEC. Decommissioning of the SFEC is included in Table 4.3-8 because decommissioning of the structures will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to benthic and shellfish resources from the various IPFs during construction are described in the following sections. Impacts to EFH for shellfish are discussed in Appendix O.

Table 4.3-8. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources for the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Seafloor preparation	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Pile driving and cofferdam installation	Minor short-term direct	Minor short-term direct
	SFEC installation	Minor short-term direct	Minor short-term direct
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Pile driving	Minor short-term direct	Minor short-term direct
	Vessel noise, trenching noise, aircraft noise	Negligible short-term direct	Negligible short-term direct
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct
Discharges [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Seafloor disturbance, associated with construction of the SFEC, results from the following activities: seafloor preparation, cofferdam installation, cable installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce ***minor direct*** and ***indirect impacts*** to species depending on the mobility of the benthic species and shellfish species. See Section 4.1 for the expected impact areas associated with the SFEC cable and HDD cofferdam.

Seafloor Preparation

Seafloor preparation activities at the SFEC during construction include removal of obstructions prior to installing the SFEC. A PLGR will be used to clear debris from the area prior to laying the SFEC. Impacts associated with seafloor preparation are expected to be similar to those described for the SFWF inter-array cable, with the one difference that shallower areas will be affected as the SFEC nears shore. These shallower areas are expected to have slightly different species assemblages than the deeper offshore areas near the SFWF. See Tables 4.3-3 and 4.3-4 for species that may occur in these areas and be affected by seafloor preparation.

Pile Driving and Cofferdam Installation
Vibratory pile driving will be used to install the temporary cofferdam at the HDD exit point. Direct impacts will be primarily associated with the placement of the piles and the potential to crush benthic species. This is expected to be a ***minor, short-term impact*** for sessile and slow-moving species, while mobile species are expected to have a reduced potential for direct impacts because they are expected to temporarily vacate the area where the piles will be placed. These impacts are expected to be similar to those described for pile driving at the SFWF; however, at a much smaller spatial and temporal scale.

SFEC Installation
Installation of the SFEC is expected to result in direct impacts similar to those described for the SFWF inter-array cable. Nearshore portions of the SFEC and the HDD to transition the onshore cable to the submarine cable will take place in shallower waters than the SFWF. During the HDD event, fluids are pumped into the borehole to lubricate it and aid in the return of drilled sediments. These fluids typically consist of bentonite clay and water with some stabilizing compounds (i.e., drilling mud).

During the HDD event, the bentonite-sediment slurry is managed landside at the entry pit through a recycling system. However, the bentonite slurry can be released to the seafloor into the water column. The pressure from boring causes an upward rupture of the seafloor or at the terminus of the borehole. When an unexpected rupture occurs followed by a release of drilling mud, this is known as a frac-out.

In the event of a frac-out, a series of containment and cleanup procedures are implemented. These procedures are typically described in a HDD inadvertent release control plan. The bentonite slurry is viscous and tends to easily coagulate. These properties allow for cleanup of releases, if necessary, through a vacuum or suction dredge system designed for that purpose.

In the event of drilling mud release out of the end of the completed borehole, the cofferdam (steel sheet piles or gravity) contains the material in a confined space. Any significant volume of the material within the confined space can be recovered as described. In either case, drilling mud will not be purposely released into the marine environment. If it does, it is expected to be confined and cleaned up so that a plume will not move through and about the water column.

If a drilling mud release occurs, it is expected to result in a ***minor, short-term impacts*** due to seafloor disturbance at the frac-out location. If any benthic organisms are in the vicinity of the release, impacts to those few individuals will occur. Species such as Atlantic rock crab and horseshoe crab are mobile and expected to vacate the impact area associated with the installation of the SFEC and any areas requiring cable armoring. Northern quahog clam, eastern oyster, and Atlantic surf clam may be subject to mortality or injury if they are present in the impact areas.

Vessel Anchoring (Including Spuds)
Impacts associated with vessel anchoring and the use of spuds during construction of the SFEC are expected to be similar to those described for the SFWF. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary

depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during construction of the SFEC will result from seafloor disturbance caused by vessel anchoring, installation of the SFEC, and limited excavation required at the cofferdam. Direct impacts associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. Indirect impacts to benthic and shellfish resources from increases in sediment suspension and deposition are expected to be ***minor*** and ***long-term*** for sessile species, and ***negligible*** and ***long-term*** for mobile species, as described for the SFWF. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For mechanical/hydro-jet plow installation at the SFEC - OCS and SFEC - NYS, and excavation at the cofferdam, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from these activities (Appendix I). A summary of the modeling results for these three project components is provided in the following subsections.

SFEC - OCS Installation

The modeling results indicate that the maximum modeled TSS concentration from SFEC - OCS installation is 1,347 mg/L. The highest TSS concentrations are predicted to occur in locations where the hydro-jet plow passes over pockets of finer sediments (e.g., between VC-217 and VC-220, and again between VC-235 and the end of the route – see Appendix H), but concentrations exceeding 30 mg/L otherwise remain within approximately 328 feet (100 m) of the source during the simulation. Water column concentrations of 100 mg/L or greater are predicted to extend up to 1,115 feet (340 m) from the mechanical/hydro-jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.4 hours after the conclusion of mechanical/hydro-jet plow trenching.

The model predicted that sediment deposition resulting from installation of the SFEC - OCS will be limited to the area immediately adjacent to the burial route, typically, extending no more than 328 feet (100 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.45 inch (11.4 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.74 ha) of the seabed (Appendix I).

SFEC - NYS Installation

The modeling results indicate that the maximum modeled TSS concentration from SFEC - NYS installation is 578 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 394 feet (120 m) from the mechanical/hydro-jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.3 hours after the conclusion of mechanical/hydro-jet plow trenching. A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The maximum predicted TSS concentration from suction dredging at the HDD site is 562 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 476 feet (145 m) from the source, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.1 hours after the conclusion of suction dredging (Appendix I).

The model predicted that sediment deposition resulting from installation of the SFEC - NYS will also be limited to the area immediately adjacent to the burial route, as described. The maximum predicted deposition thickness is estimated to be 0.39 inch (9.9 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.72 ha) of the seabed (Appendix I).

Cofferdam Installation

A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The model predicted that sedimentation will be limited to the area immediately adjacent to the exit pit (within 656 feet [200 m] of the source). Unlike previous scenarios where sediment is resuspended along a linear path, the dredge and side-cast operation occurs from a single point within the model domain. For this reason, the deposit is thicker, but is far more limited in extent. The maximum predicted deposition thickness is 12.5 inches (318 mm). Sedimentation at or above 10 mm extends a maximum of 177 feet (54 m) from the side-cast point and covers a cumulative area of only 1.38 acres (0.56 ha) of the seabed (Appendix I).

Potential impacts to benthic organisms from increases in sediment suspension and sediment deposition are similar to those described for the SFWF. Given the limited extent and duration of the elevated TSS and sedimentation based on the predictive modeling described, direct impacts are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species; indirect impacts are expected to be ***minor*** and ***long-term*** and associated with short-term habitat loss through sediment deposition in surrounding areas.

Noise

Pile Driving Noise and Vibration

Direct impacts associated with noise and vibration during construction of the SFEC may occur during vibratory hammer pile driving for the cofferdam and mechanical/hydro-jet plow installation of the SFEC. Pile driving is expected to cause ***minor, short-term, direct impacts*** on benthic organism in the proximity of the SFEC – NYS cofferdam installation. Project-related underwater sounds were modeled as a part of the broader acoustic modeling effort presented in Appendix J. Vibratory hammer pile driving in water causes sound energy to radiate directly into the water by vibrating the pile between the surface of the water and the bottom and causes ground-borne vibration at the bottom substrate. Direct impacts will be experienced by those organisms close enough to the vibratory hammer pile driving to be exposed to injurious or disturbing sounds and vibrations. Indirect impacts are expected to be similar to those discussed in the Pile Driving section for the SFWF. In general, because of the shorter duration (12 to 24 hours) expected for vibratory hammer pile driving associated with the SFEC cofferdam and the continuous, nonimpulsive sounds, as opposed to impulse sounds from pile driving for the foundations, noise impacts to benthic organisms are expected to be less than those described for the SFWF pile driving.

Vessel Noise, Trenching Noise, Aircraft Noise

Impacts associated with vessel noise, trenching noise, and aircraft noise are expected to be similar to those described for the SFWF and include ***negligible, short-term, direct impacts***.

Traffic

Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting

Lighting will be associated with the vessels that will be conducting the work and installing the SFEC. Potential impacts associated with vessel lighting are expected to be ***negligible*** and similar to those discussed for the SFWF construction phase. These impacts will be ***short-term*** and localized, as the vessels installing the SFEC are expected to pass quickly through each location during laying of the cable. They will be similar to impacts that currently occur in the vicinity when vessels pass through the area. As such, impacts associated with lighting are expected to be ***negligible***.

Operations and Maintenance

Table 4.3-9 summarizes the level of impacts expected to occur to benthic and shellfish resources during the O&M phases of the SFEC. ***Minor, long-term impacts*** during O&M are associated with the presence of the SFEC and associated cable armoring. Additional details on potential impacts to benthic and shellfish resources during O&M are described in the following sections.

Table 4.3-9. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	SFEC	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Vessel A\anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Vessel and Aircraft Noise		Negligible short-term direct	Negligible short-term direct
Electromagnetic Field		Negligible	Negligible
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct
Discharges [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Seafloor disturbance during O&M of the SFEC may result from maintenance to the SFEC and vessel anchoring (including spuds). See Section 4.1 for the expected impact areas associated with the SFEC and HDD cofferdam.

Cable Repair and Maintenance

Benthic organisms are expected to experience ***minor, short-term, direct impacts*** if the SFEC requires maintenance that will expose it. Similar to the maintenance of the SFWF inter-array cable, maintenance of the SFEC is considered a nonroutine event and is not expected to occur with regularity. Impacts associated with exposing the SFEC are expected to be similar but less frequent to those described for the construction phase. Benthic organisms are expected to experience ***negligible, short-term, direct impacts*** from the presence of the SFEC because it will be buried beneath the seabed. However, some areas of the SFEC may require armoring, which will result in conversion to hard bottom, as described for the SFWF inter-array cable. Areas that require armoring are expected to result in ***minor, long-term impacts*** to benthic organisms and their habitat.

Vessel Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the SFEC requires maintenance. Impacts associated with potential vessel anchoring during O&M of the SFEC are expected to be similar to those described for the SFWF. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M of the SFEC will primarily result from vessel anchoring and maintenance activities that will require exposing the SFEC. Both activities are expected to be nonroutine events and not expected to occur with regularity. Sediment suspension and deposition impacts resulting from vessel activity during O&M of the SFEC are expected to be similar to vessel-related sediment suspension and deposition impacts described for the SFEC construction phase, but less frequent and at a smaller scale. Direct impacts associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. Indirect impacts to benthic and shellfish resources from increases in sediment suspension and deposition are expected to be ***minor*** and ***long-term*** for sessile species, and ***negligible*** and ***long-term*** for mobile species, as described for the SFWF.

Noise

Direct impacts to benthic organisms associated with noise during O&M of the SFEC may occur associated with vessels and aircraft. Impacts associated with vessel noise and aircraft noise are expected to be similar to those described for the SFWF and include ***negligible, short-term, direct impacts***.

Electromagnetic Field

Negligible impacts to benthic organisms from the EMF associated with the SFEC are expected and impacts are expected to be similar to those described for the inter-array cable at the SFWF. Appendix K provides an assessment of potential effects on marine life from submarine cables.

Traffic

Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting

There will be no artificial lighting associated with the SFEC in nearshore and aquatic areas during O&M. As such, ***negligible*** direct and indirect impacts associated with lighting will only occur from vessels during maintenance activities on the SFEC. These activities are expected to be ***short-term*** and ***localized,*** and similar to those discussed for the construction phase of the SFEC.

Decommissioning

Decommissioning of the SFEC is expected to have similar impacts as construction. The SFEC area is expected to return to pre-project conditions after decommissioning.

4.3.2.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to benthic resources.

- The SFWF and SFEC - Offshore will minimize impacts to harder and rockier bottom habitats to the extent practicable.
- Installation of the SFWF inter-array cable and SFEC - Offshore will occur via the mechanical/hydro-jet plow. Compared to open cut dredging/trenching, this method will minimize long-term impacts to the benthic habitat.
- The SFWF inter-array cable and SFEC - Offshore will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m).
- Use of DPV for cable installation for the SFWF inter-array cable and SFEC - Offshore will minimize impacts to surficial geology, as compared to use of a vessel relying on multiple-anchors.
- A plan for vessels will be developed prior to construction to identify no-anchor areas inside the MWA to protect sensitive areas or other areas to be avoided.

4.3.3 Finfish and Essential Fish Habitat

The description of the affected environment and assessment of potential impacts for finfish and EFH was evaluated by reviewing current public data sources related to finfish and EFH, including state and federal agency-published papers and databases, published journal articles, online data portals and mapping databases, and correspondence and consultation with federal and state agencies. DWW has completed a benthic habitat assessment as described in Section 4.3.2. Finfish and EFH within the potentially affected environment are described below, followed by an evaluation of potential project-related impacts.

4.3.3.1 Affected Environment

Regional Overview

The regional waters off the coast of Rhode Island, Massachusetts, and Long Island, New York are transitional waters that separate Narragansett Bay and Long Island Sound from the OCS (BOEM, 2013). These waters straddle the Mid-Atlantic and New England regions and serve as the northern boundary for some Mid-Atlantic species and the southern boundary for some New England species. The species evaluated as possibly present in the SFWF and SFEC areas reflect the transitional nature of this regional area.

Habitat and spatial factors (temperature, salinity, pH, current, etc.) affect the distribution of fish within the oceans. Major habitat types expected to be found within the SFWF and SFEC are described in Section 4.3.2. As summarized in BOEM's Revised Environmental Assessment

(BOEM, 2013), finfish off the coasts of Rhode Island and Massachusetts include demersal, pelagic, and shark finfish assemblages. In addition, there are important shellfish (Section 4.3.2) and migratory pelagic finfish throughout the Southern New England-New York Bight.

BOEM (2013) states that demersal species (groundfish) spend at least their adult life stage on or close to the ocean bottom. They are generally considered to be high-value fish and are sought by both commercial and recreational anglers. Pelagic fishes are generally schooling fish that occupy the mid- to upper water column as juveniles and adults and are distributed from the nearshore to the continental slope. Some species are highly migratory and are reported to be present in the near-coastal and shelf surface waters of the Southern New England-New York Bight in the summer, taking advantage of the abundant prey in the warm surface waters. Coastal migratory pelagics include fast-swimming schooling fishes that range from shore to the continental shelf edge and are sought by both recreational and commercial anglers. These fish use the highly productive coastal waters of the more expansive Mid-Atlantic Bight during the summer months and migrate to deeper and/or distant waters during the remainder of the year (BOEM, 2013). Pelagic sharks, large coastal sharks, and small coastal sharks also occupy this region. The sections below identify these groups of finfish species and their associated habitats that may be found within the SFWF and SFEC.

South Fork Wind Farm

This section describes finfish resources (demersal and pelagic) within and surrounding the areas of the SFWF. Also, outlined in this section are the finfish species and their habitats that may be affected by the SFWF project activities. Benthic resources, including shellfish and habitat types, are described in Section 4.3.2. A thorough EFH Assessment for designated species in the SFWF and SFEC is provided as Appendix O.

Table 4.3-10 summarizes species of economic or ecological importance potentially present within the region of the SFWF and SFEC, generally characterized by their life stage and location in the water column. The species listed in Table 4.3-9 were selected based on literature review, agency correspondence, fish sampling results from the BIWF, and EFH source document review. This table does not include every species that has the potential to occur in the SFWF or SFEC, but focuses on those that are abundant, commercially or recreationally important, important prey species, or have designated EFH within the areas of the SFWF or SFEC. The table delineates species characteristics, including: habitat preference (demersal versus pelagic), early life stage presence, EFH designation, commercial/recreational importance, potential prey species, and seasonality in the region. The type or types of potential impact(s) of the SFWF on each species is related to these characteristics.

Demersal species occur near the bottom of the water column in benthic habitats, and pelagic species occupy space near the surface and within the water column. Benthic and pelagic invertebrates are discussed in Section 4.3.2. Each species type that is ecologically or economically important is described in more detail in relation to proposed SFWF activities in the following sections.

Demersal Finfish in the South Fork Wind Farm

Demersal habitat includes the bottom substrate within continental shelf and shallow areas (Scotti et al., 2010). Demersal species interact with and consume benthic organisms. Because of this interaction, demersal species are reliant on the complex relationship between benthic habitats and species. More diverse fish communities occupy more complex habitats (Malek, 2015 and Malek et al., 2016). Some demersal species are present year-round; however, there are distinct variations in local populations because of seasonal migrations and inter-annual population dynamics (declines and increases) (Malek, 2015). Within nearby Narragansett Sound, demersal fish community structure has been changing over the past six decades with some demersal species declining (winter flounder, whiting, and red hake), while others have increased (Atlantic butterfish, scup, and squid) (Collie et al., 2008). These population changes are related to overfishing, fishery closures, changes in food sources, and changes in habitat (ASMFC, 2018).

Many of the members of the New England groundfish complex (cod, haddock, pollock, and various species of hake and flounders, monkfish, whiting, scup, and black sea bass), have been collected in local surveys (Petruny-Parker et al., 2015). Groundfish are an important part of the ecosystem within the SFWF and have an important economic role for the region.

Some demersal fish species migrate seasonally to the SFWF area. These migrations are often correlated with seasonal variation in water temperature. Most demersal species are abundant nearshore and offshore, extending along the continental shelf in winter and spring, (the cold season), and decline as they migrate out of the area during the summer and fall months, (the warm season) (Scotti et al., 2010).

Anadromous species are those which migrate between ocean and riverine environments. These types of fish spend their lives in both freshwater and marine environments. Juveniles from anadromous species leave coastal rivers and estuaries in the spring to enter the ocean. During this period, they grow and mature prior to returning to estuarine habitat to spawn, generally during fall months. There are two demersal species of anadromous fish that are potentially present within the SFWF area: striped bass and Atlantic sturgeon (BOEM, 2013; Scotti et al., 2010).