South Fork Wind

Outer Continental Shelf Permit – Air Quality Impact Modeling Report for Operations and Maintenance Emissions

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South Fork Wind, LLC

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Acronyms and Abbreviations

Δ	delta
μg/m^3	microgram(s) per cubic meter
AC	alternating current
bhp	brake horsepower
BOEM	Bureau of Ocean Energy Management
CFR	*Code of Federal Regulations*
CMR	*Code of Massachusetts Regulations*
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
COA	corresponding onshore area
CoP	Construction and Operations Plan
CTV	crew transport vessel
DEM	Department of Environmental Management
DEP	Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
FLM	Federal Land Manager
ft/s	foot (feet) per second
GHG	greenhouse gas
H_2S	hydrogen sulfide
HF	hydrogen fluoride
IPF	impact-producing factor
Jacobs	Jacobs Engineering Group Inc.
km	kilometer(s)
kW	kilowatt(s)
m	meter(s)
m/s	meter(s) per second
MAAQS	Massachusetts Ambient Air Quality Standards
MassCEC	Massachusetts Clean Energy Center
MERP	modeled emission rates for precursors
MMIF	Mesoscale Model Interface
MW	megawatt(s)
NAAQS	National Ambient Air Quality Standards
NNSR	Non-attainment New Source Review
NO_2	nitrogen dioxide
NOI	Notice of Intent
NO_x	nitrogen oxide

O&M	operations and maintenance
OCD	offshore and coastal dispersion (model)
OCS	Outer Continental Shelf
OSS	offshore substation
$PM_{2.5}$	particulate matter less than 2.5 micrometers in aerodynamic diameter
PM_{10}	particulate matter less than 10 micrometers in aerodynamic diameter
ppm	part(s) per million
Project	South Fork Wind Farm and South Fork Export Cable Project
ProvPort	Port of Providence
PSD	Prevention of Significant Deterioration
PTE	potential to emit
SFEC	South Fork Export Cable
SFEC-NYS	South Fork Export Cable in New York State territorial waters
SFEC-OCS	South Fork Export Cable in federal waters (Outer Continental Shelf)
SFEC-Onshore	terrestrial underground segment of the South Fork Export Cable
SFWF	South Fork Wind Farm
SIL	Significant Impact Level
SO_2	sulfur dioxide
SO_x	sulfur oxide
tpy	ton(s) per year
U.S.	United States
VOC	volatile organic compound
VW	Vineyard Wind LLC
WDA	Wind Development Area
WTG	wind turbine generator
WRF	Weather Research and Forecasting

1. Introduction

The South Fork Wind Farm (SFWF) includes up to 15 wind turbine generators (WTGs), with a nameplate capacity of 6 to 12 megawatts (MW) per WTG, submarine cables between the WTGs (inter-array cables), and an offshore substation (OSS), all of which will be located within federal waters on the Outer Continental Shelf (OCS), specifically in the Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A 0517,[1] approximately 19 miles (30.6 kilometers [km]) southeast of Block Island, Rhode Island, and 35 miles (56.3 km) east of Montauk Point, New York. The SFWF also includes an operations and maintenance (O&M) facility that will be located onshore at either Montauk in East Hampton, New York or Quonset Point in North Kingstown, Rhode Island (SFW, 2018, 2019a, 2019b).

The South Fork Export Cable (SFEC) is an alternating current (AC) electric cable that will connect the SFWF to the existing mainland electric grid in East Hampton, New York. The SFEC includes both offshore and onshore segments. Offshore, the SFEC will be in federal waters (SFEC-OCS) and New York State territorial waters (SFEC-NYS) and will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 meters [m]) in the seabed. Onshore, the onshore underground segment of the export cable (SFEC-Onshore) will be located in East Hampton, New York. The SFEC-NYS will be connected to the SFEC-Onshore via the sea-to-shore transition where the offshore and onshore cables will be spliced together. The SFEC also includes a new interconnection facility where the SFEC will connect with the Long Island Power Authority electric transmission and distribution system in East Hampton, New York (SFW, 2018, 2019a, 2019b). Figure 1 indicates the locations of the SFWF and SFEC, together referred to as the Project.

Jacobs Engineering Group Inc. (Jacobs) has been retained by South Fork Wind, LLC (SFW) to prepare an air modeling report in support of an OCS air permit application for the Project to fulfill the regulatory requirements of the U.S. Environmental Protection Agency's (EPA's) OCS Air Regulations, as specified in Title 40 *Code of Federal Regulations* (CFR) Part 55. This report discusses the methodology used to quantify impacts from air emissions of O&M activities and the model results that demonstrate compliance with applicable state and federal air quality regulations.

SFW is submitting an OCS permit application for a Non-attainment New Source Review (NNSR) and Prevention of Significant Deterioration (PSD) major source permit to EPA Region 1 for the installation and O&M of the Project. SFW had previously submitted an air quality modeling protocol in August 2020 that described the methodology to be used for determination of impacts from Project O&M emissions. The purpose of this modeling analysis is to demonstrate that the proposed Project will not violate the National Ambient Air Quality Standards (NAAQS), Massachusetts Ambient Air Quality Standards (MAAQS), and PSD increments. The NAAQS, MAAQS, and Class I and II PSD increment modeling are applicable to Project emissions resulting from both routine and infrequent O&M activities.

Installation of the proposed WTGs may involve emission sources attached to and erected on the OCS; therefore, the applications will be made under the OCS permitting rules (40 CFR 55). For OCS projects, construction and O&M emissions apply to the determination of whether projects are subject to the NNSR and PSD permitting process. Potential emissions during construction will exceed the 250-ton-per-year (tpy) PSD major source review threshold and the 50-tpy NNSR threshold for nitrogen oxide (NO_x) emissions. Therefore, the Project is classified as both an NNSR and a PSD major stationary source. Because portions of the Project will be within 25 miles (40.2 km) of the Rhode Island, New York, Connecticut, and Massachusetts seaward boundaries, the Section 55.14 corresponding onshore area (COA) rules apply to construction and O&M within this area. Massachusetts has been designated as the COA for this Project. Section 1.1 provides additional discussion of the Project location.

During O&M, the Project's OCS sources will include compression-ignition (and possibly spark ignition) engines on various support and transport vessels, engines to supply power, jack-up vessels (while attached to the seafloor), and an emergency diesel generator on the OSS. The emergency generator on the OSS will only operate during emergencies and for reliability testing. There are currently no emergency

[1] The leaseholder of Renewable Energy Lease Area OCS-A 0517 is South For Wind LLC (SFW).

generators anticipated for the WTG design. During O&M, the jack-up and lift vessels will be used infrequently for major repairs to the WTGs or OSS. Vessels that anchor or tether to an OCS source within the Wind Development Area (WDA) during O&M, if any, will also become OCS sources. However, no vessels are anticipated to anchor, jack-up, or tether to an OCS source along the SFEC during O&M. Therefore, during O&M, no OCS sources are expected to exist along the SFEC. As a result, the modeling analysis for O&M activities only addresses activities associated with OCS sources in the WDA.

OCS sources used during decommissioning were not considered in this report as decommissioning will occur 25 to 30 years after the commencement of operation. A separate OCS air permit will likely be sought for decommissioning activities at that time, as required. The modeling analysis for construction emissions has been provided to EPA under cover (SFW, 2020b).

1.1 Project Location

The SFWF will be located within federal waters on the OCS, specifically in the BOEM Renewable Energy Lease Area OCS-A 0517, approximately 19 miles (30.6 km) southeast of Block Island, Rhode Island, and 35 miles (56.3 km) east of Montauk Point, New York.

Figures 1 and 2 show the approximate location of the entire Project. The OCS area shown on Figure 2 is consistent with the OCS area shown in the air modeling report for construction emission impacts, which is provided under separate cover. No OCS sources during O&M activities are expected along the SFEC route. However, emissions are determined according to the OCS source layout shown on Figure 2.

1.2 Project Description

The SFWF includes the following components, all of which are located on the OCS within the area of Renewable Energy Lease Area OCS-A 0517:

- Up to 15 WTGs and associated foundations
- One OSS, constructed on similar foundation as the WTG
- Inter-array cables connecting the WTGs and the OSS

The SFEC is an AC electric cable that will connect the SFWF to the existing mainland electric grid in East Hampton, New York and contains the following components:

- An offshore cable will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m) in the seabed.
- An onshore underground segment of the export cable will be located in East Hampton, New York.
- A sea-to-shore transition where the offshore and onshore cables will be spliced together.
- A new interconnection facility will be constructed where the SFEC will connect with the Long Island Power Authority electric transmission and distribution system in East Hampton, New York (SFW, 2018, 2019a, 2019b).

Ports at the following locations are anticipated to be used to support the various O&M activities.

- New Bedford, Massachusetts
- Port of Providence (ProvPort) or Quonset, Rhode Island
- Port of New London, Connecticut
- Montauk, Shinnecock Fish Dock or Port Jefferson, New York

It is not known how the vessel traffic will be allocated at this time, as different vessels may originate from different points depending on several logistical factors.

Three additional ports may be used, but only sparingly, if at all:

- Sparrow Point, Maryland
- Paulsboro Marine Terminal, New Jersey
- Norfolk, Virginia

Section 3.8 provides further discussion on the transit routes modeled as part of this analysis and the rationale for their choice.

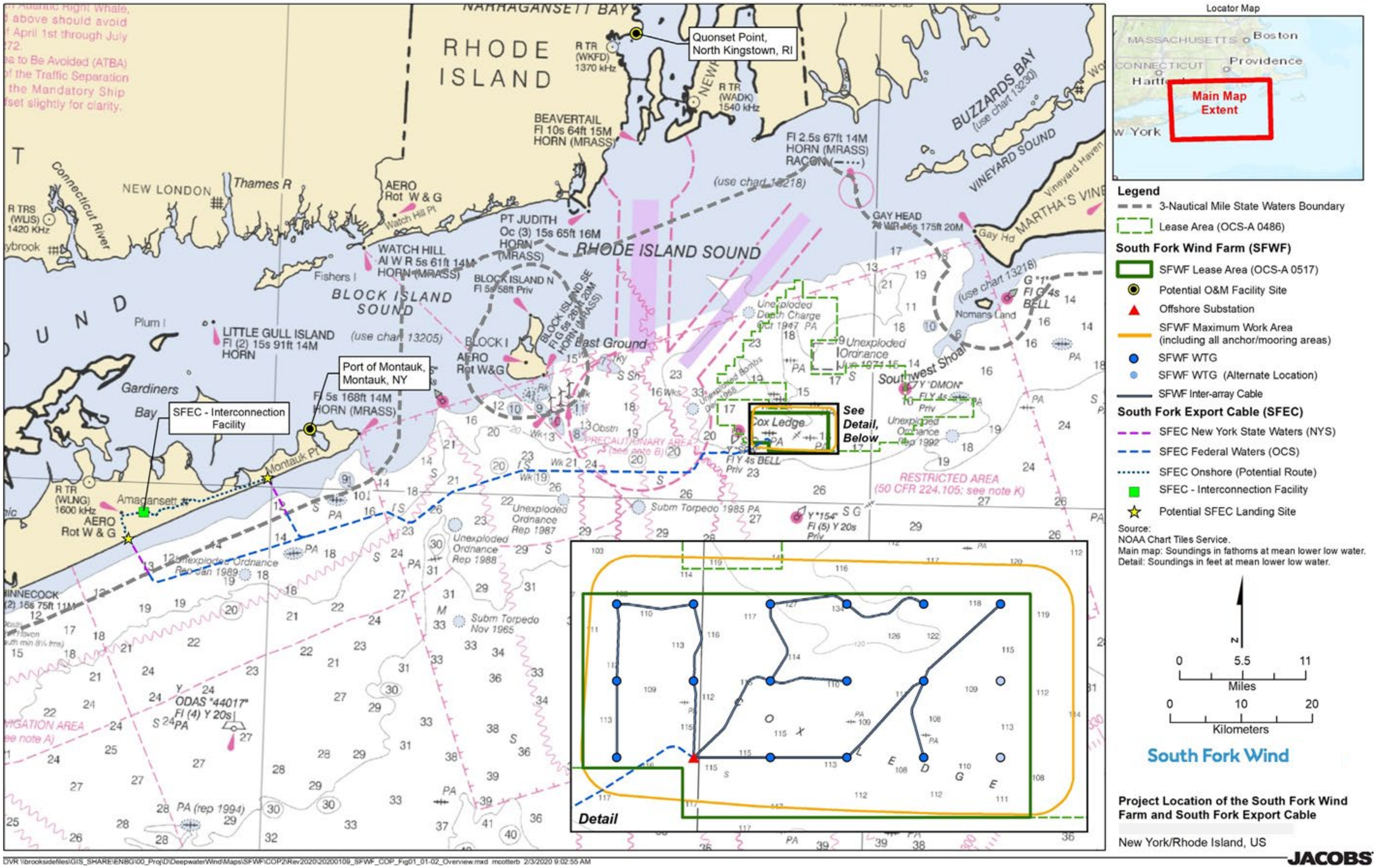

Figure 1. South Fork Wind Farm and South Fork Export Cable Location Plot

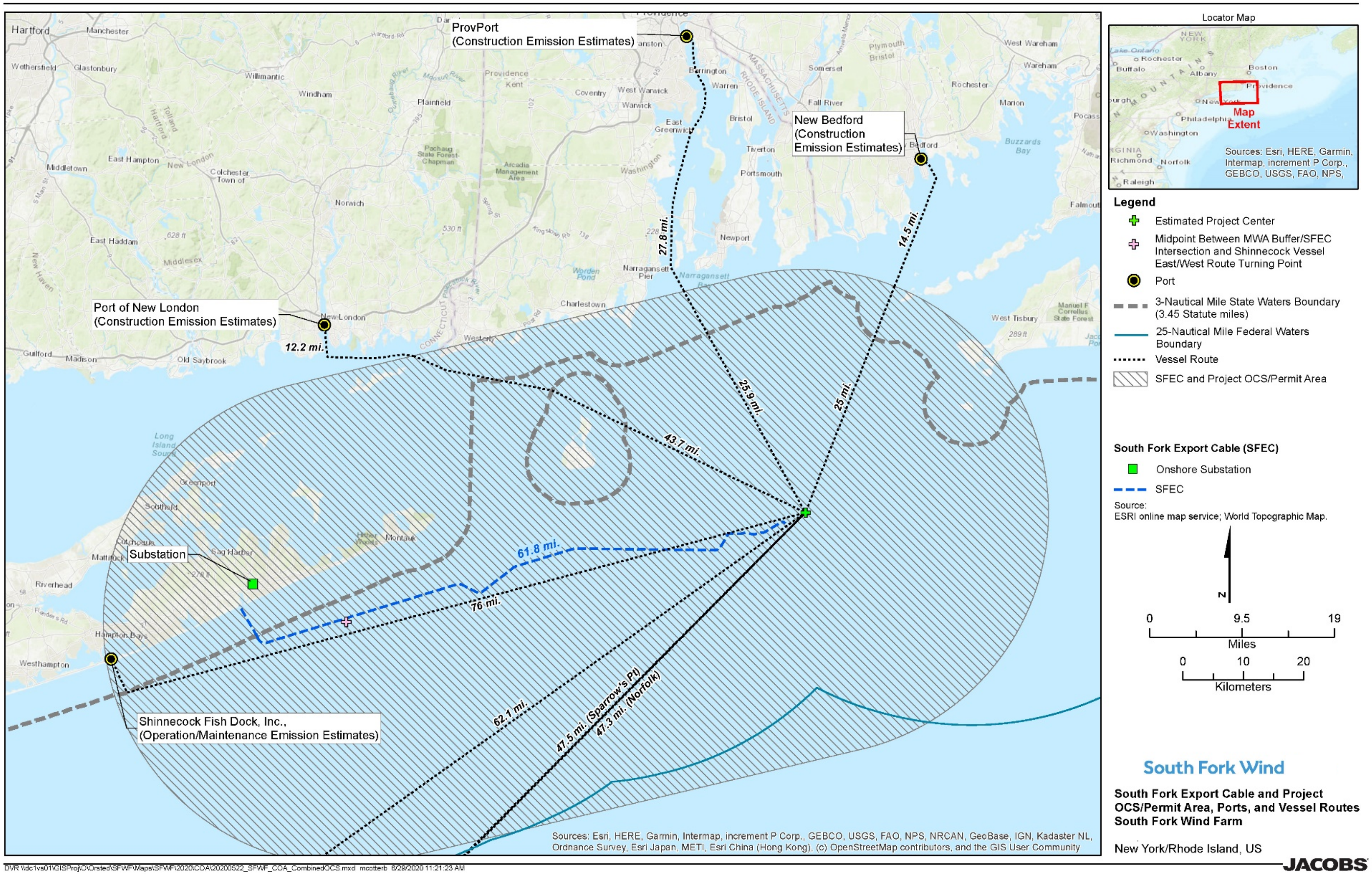

Figure 2. Distances from South Fork Wind Farm Centroid to Proximal Ports Considered for the Air Emissions Inventory

1.3 Emission Sources during Routine Operations and Maintenance

The Project's air emissions sources are mostly due to combustion engines used to power vessels or equipment on vessels during O&M at the Project's offshore sites. There is a continuous evolution of wind turbine technologies, as well as construction techniques and methods for the turbines, cables, and auxiliary equipment. As recognized in the *National Offshore Wind Strategy* (DOE and DOI, 2016), the "Envelope" concept allows for Project optimization after permitting is complete while ensuring a comprehensive review of the Project by regulators and stakeholders.

Through the Envelope concept, SFW is defining and bracketing Project characteristics for environmental review, while maintaining a reasonable degree of flexibility regarding final design and construction and O&M logistics. For all modeled activities, SFW has identified the most likely and yet conservative scenario where multiple options and vessel profiles exist. Additionally, SFW has provided estimates of source parameters (exit velocity, stack diameter, stack exit temperature) for the types of vessels that may be used for the activities described in this section. This general modeling conservatism is consistent with the Envelope concept and demonstrates compliance with the applicable standards but allows for flexibility of final construction and O&M methods as the Project is optimized.

Emission sources during O&M that are subject to the OCS air permit include:

- Crew transport vessels (CTVs)
- Feeder or lift barge vessels
- Jack-up crane barges
- Generators used for site power during large-scale repairs
- Emergency generator (OSS only)

The OSS may house a 268-brake-horsepower (bhp) (or 200-kilowatt [kW]) diesel emergency generator to provide backup power to critical systems if the Project's offshore cable system fails. This emergency generator will only operate for emergencies and for less than 100 hours per year of reliability testing. During work tasks at the WDA, there may be a need for a non-road generator at the site to power equipment. For modeling purposes, it was assumed that a 268-bhp (200-kW) generator similar in size to the OSS emergency generator will be used.

During routine daily O&M, the WTGs and OSS will be inspected. In addition, proactive replacement of parts and other preventative maintenance will be conducted. For routine O&M, one CTV will frequently transport crew to the WDA for inspections, routine maintenance, and minor repairs. A second CTV may be necessary, depending on the nature of the work required. Other larger support and work vessels, such as feeder barges and jack-up barges, may be used infrequently for some routine O&M and repairs. When these vessels are within the defined OCS area, their air emissions are included in the Project's potential emissions.

Similar to the activities during construction, O&M activities are subject to change based on operational needs. Therefore, the modeling represents operational activities that are reasonably expected to occur simultaneously and represent a conservative estimate of O&M emissions and impacts. Section 3.4 provides descriptions of the operational scenarios modeled.

The remainder of this report is organized in four additional sections:

- Section 2 describes the federal and state air quality regulations applicable to the modeling analysis and presents the applicable air quality standards.
- Section 3 describes background air quality data and the air quality modeling methodology used for the analysis.
- Section 4 presents the results of the air modeling analysis and conclusions regarding compliance with applicable ambient air quality limits.
- Section 5 provides the references used in this report.

2. Regulatory Requirements

Section 328(a) of the Clean Air Act requires that EPA establish air pollution control requirements for OCS sources located within 25 miles (40.2 km) of states' seaward boundaries that are the same as onshore requirements. This includes state and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and reporting.

OCS sources located within 25 miles (40.2 km) of a states' seaward boundaries are subject to the federal requirements set forth in 40 CFR 55.13 and the federal, state, and local requirements of the COA set forth in 40 CFR 55.14. As the designated COA, the Project is subject to the applicable requirements of the most current Commonwealth of Massachusetts air regulations (310 *Code of Massachusetts Regulations* [CMR] 6.00 - 8.00).

2.1 Prevention of Significant Deterioration Review

The PSD program, as set forth in 40 CFR 52.21, is incorporated by reference into the OCS Air Regulations 40 CFR 55.13(d). PSD applies to OCS sources located within 25 miles (40.2 km) of the Massachusetts (the COA) seaward boundary per 40 CFR 52, Subpart W. The PSD program applies to new major sources of criteria pollutants or major modifications to existing sources in areas designated as being in attainment with or unclassifiable with the ambient air quality standards.

"Potential to emit" (PTE) is defined as the maximum capacity of a source to emit a pollutant under its operational design. 40 CFR 55 defines "potential emissions" from OCS sources similarly. The broad definition of "OCS source" provided in the OCS Air Regulations requires that certain emissions associated with construction equipment and vessels are to be included in the PTE of an OCS source for PSD review. The Project's potential air emissions during construction exceed the 250-tpy PSD threshold; therefore, the Project is subject to PSD review. The SFWF Project is considered "major" because it has a PTE of 250 tpy or more of a regulated New Source Review pollutant per 40 CFR 52.21.

Table 1 presents a PSD major source threshold analysis for the Project for those pollutants with applicable PSD emission criteria. The emissions were determined from the construction phase of the Project, which has higher potential annual emissions when compared to O&M. Though the construction may take 1 or 2 years to complete, the total construction emissions are aggregated into a single year to provide SFW flexibility during Project buildout. Project construction is anticipated in 2022 and should become operational in 2023.

Table 1. Prevention of Significant Deterioration Regulatory Threshold Evaluation

Pollutant	Project Annual Emissions[a] (tpy)	PSD Significant Emission Rate (tpy)	PSD Review Applies
NO_x	452.2	40	**Yes**
CO	67.6	100	No
SO_2	3.2	40	No
PM_{10}	15.3	15	**Yes**
$PM_{2.5}$	14.7	10	**Yes**
Lead	0.002	0.6	No
GHGs (as CO_2e)	29,766	75,000	No
Sulfuric acid mist	None expected	7	No
H_2S	None expected	10	No
Total reduced sulfur	None expected	10	No

Table 1. Prevention of Significant Deterioration Regulatory Threshold Evaluation

Pollutant	Project Annual Emissions[a] (tpy)	PSD Significant Emission Rate (tpy)	PSD Review Applies
Reduced sulfur compounds (including H_2S)	None expected	10	No
Fluorides excluding HF	None expected	3	No

[a] Emissions determined with New London as Port of Call.

CO = carbon monoxide

CO_2e = carbon dioxide equivalent

GHG = greenhouse gas

H_2S = hydrogen sulfide

HF = hydrogen fluoride

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

SO_2 = sulfur dioxide

A PSD permit application must show that emissions from construction or O&M of a source will not cause or contribute to exceedances in applicable air quality standards.

2.2 Ambient Air Quality Standards

There are three applicable sets of ambient air quality standards for this Project: NAAQS and PSD Class I and Class II increments. Since the NAAQS is the same as or more stringent that the MAAQS, the NAAQS will be used to demonstrate compliance with the MAAQS. Table 2 list the applicable standards for seven criteria air contaminants.

The NAAQS primary standards are intended to protect human health, while secondary standards are intended to protect public welfare from anticipated adverse effects associated with the presence of air pollutants. The NAAQS have been developed for various averaging periods corresponding to durations of exposure.

PSD increments are the maximum allowable increase in concentration acceptable exceeding a baseline concentration for a pollutant. EPA has established increment standards for nitrogen dioxide (NO_2), PM_{10}, and $PM_{2.5}$, which are relevant to this Project. The PSD regulations define “minor source baseline date” in 40 CFR 52.21(b)(14)(ii) as “…the earliest date after the trigger date on which… a major modification subject to 40 CFR 52.21…submits a complete application.”

Class I increment consumption is modeled in this assessment based on O&M emission scenarios. Class II areas comprise most of the United States, and only Class II air quality standards are discussed in this report.

Table 2. National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)		Class II PSD Increments ($\mu g/m^3$)
		Primary	Secondary	
CO	1-hour	40,000[a]	Same	None
	8-hour	10,000[a]	Same	None
Lead	Rolling 3-month average	0.15[b]	Same	None
NO_2	1-hour	188[c]	None	None
	Annual	100[d]	Same	25[b]
Ozone	8-hour	137.4[e]	Same	None
$PM_{2.5}$	24-hour	35[f]	Same	9[a]
	Annual	12[g]	15[g]	4[b]
PM_{10}	24-hour	150[a]	Same	30[a]
	Annual	None	None	17[b]
SO_2	1-hour	196.0[h]	None	None
	3-hour	None	1,310[a]	512[a]
	24-hour	None	None	91[a]
	Annual	None	None	20[b]

[a] Not to be exceeded more than once per year.

[b] Not to be exceeded.

[c] 98th percentile of 1-hour daily maximum concentrations averaged over 3 years.

[d] Annual mean.

[e] Annual fourth-highest daily maximum ozone concentration, averaged over 3 years.

[f] 98th percentile, averaged over 3 years.

[g] Annual mean, averaged over 3 years.

[h] 99th percentile of 1-hour daily maximum concentrations averaged over 3 years.

Notes:

$\mu g/m^3$ = microgram(s) per cubic meter

To facilitate this analysis, EPA historically has relied on Significant Impact Levels (SILs) that represent thresholds of insignificant modeled source impacts. EPA has recommended specific SILs for comparison to the NAAQS and a separate set of recommended SILs for comparison to the PSD increment. Table 3 summarizes the Class I and II increments SILs. Justification for the use of SILs as a screening tool for NAAQS assessments is presented in Section 3.1.1.

As the Project also triggers an NNSR for ozone, the Project triggers a requirement for NO_2 offsets; therefore, no modeling is required for ozone. The Project does not trigger PSD review for SO_2, CO, or lead.

Exceeding the PSD increment SIL will require the Project to perform a cumulative source analysis that will account for sources that have consumed the PSD increment within the significant impact area since the baseline date, if any. Sections 2.6 and 2.7 provide discussions about additional cumulative sources for the NAAQS and PSD increment modeling. Table 3 lists the recommended Class I and II SILs used for the analyses, including the recommended SILs for NAAQS.

Table 3. National Ambient Air Quality Standards and Class I and II Prevention of Significant Deterioration Increment Significant Impact Levels

Pollutant	Averaging Period	Recommended SIL for NAAQS Analyses (μg/m^3)	Class II PSD SIL Increments (μg/m^3)	Class I PSD SIL Increments (μg/m^3)
CO	1-hour	2,000[a]	2,000[a]	None
	8-hour	500[a]	500[a]	None
Lead	Rolling 3-month	None	None	None
NO_2	1-hour	7.5[b]	None	None
	Annual	1	1[a]	0.1[a]
Ozone	8-hour	1.96[c]	None	None
$PM_{2.5}$	24-hour	1.2[d]	1.2[d]	0.27[d]
	Annual	0.2[e]	0.2[e]	0.05[e]
PM_{10}	24-hour	5[a]	5[a]	0.3[a]
	Annual	1[a]	1[a]	0.2[a]
SO_2	1-hour	7.8[b]	None	None
	3-hour	None	25[a]	1[a]
	24-hour	None	5[a]	0.2[a]
	Annual	None	1[a]	0.1[a]

[a] Concentration not to be exceeded.

[b] Highest 1-hour modeled concentration averaged over 5 years.

[c] Annual 4th-highest daily maximum 8-hour concentration averaged over 5 years.

[d] Highest 24-hour modeled concentration averaged over 5 years.

[e] Highest annual modeled concentration averaged over 5 years.

2.3 Ambient Air Quality Analysis for Operations and Maintenance Activities

O&M emissions from the Project will be much lower than emissions during construction. As the Project was assessed under PSD requirements for NO_x, PM_{10}, and $PM_{2.5}$, the Project also required an ambient air quality analysis that demonstrated compliance with the SILs, NAAQS, and PSD increments through air quality dispersion modeling for the O&M period only.

Table 4 lists the annual emission estimates for modeled (and additional) criteria pollutants during O&M. During O&M, OCS sources are only expected to be located within the WDA. There will not be any OCS sources located along the SFEC during the Project's O&M period.

Table 4. Emissions during Operations and Maintenance

Parameter	OCS Air Permit Emissions[a]					
	NO_X	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2
Annual Emissions (tpy)	30.6	0.6	5.8	1.0	1.0	0.2

[a] Transit emissions assume one CTV from Shinnecock or Port Jefferson, New York, and all other CTVs originate from New London, Connecticut.

Notes:

VOC = volatile organic compound

2.4 Significant Impact Levels

A preliminary analysis was performed to determine whether the source will have a “significant impact” on air pollutant concentrations and to establish whether a NAAQS or a PSD increment modeling analysis was necessary for those contaminants and averaging periods subject to PSD review. Table 3 lists the SILs. Modeling was conducted for worst-case O&M scenarios that are envisaged by SFW over the life of the Project, as discussed further in Section 3.4.

The analysis also needed to address impacts of direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursor emissions using the approach described in Section 2.5.

2.5 Secondary Particulate Formation

Additional particulate matter can form due to primary emissions of sulfur oxide (SO_x) and NO_x from a source and subsequent conversion into condensed phase nitrates and sulfates. This secondary particulate matter formation was accounted for in the modeling using a method consistent with the EPA guidance found in *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* (EPA, 2019). Both primary and secondary impacts of $PM_{2.5}$ were considered in the analysis.

EPA has developed guidance centered on using the MERPs approach as a Tier 1 screening approach (EPA, 2019). The analysis used the most conservative (lowest) illustrative MERP values (in tpy) by precursor presented for two hypothetical sources in the northeastern United States. These were the same sources used for the construction emission secondary impact assessment, although the NOx and SOx emissions used for the construction analysis were higher than those used in the O&M analysis, as shown in Table 5. The higher of the two secondary impacts was used for the analysis. Annual operational emissions for the Project are 30.6 tpy of NO_x and 0.18 tpy of SO_2.

Table 5. Summary of Secondary Particulate Formation for Daily and Annual Maximum Sulfur Oxide and Nitrogen Oxide Emissions from Hypothetical Sources 3 (Norfolk) and 4 (Franklin)

Source	OCS O&M Emission Rate (tpy)	Norfolk – Maximum Added Secondary Particulate at 500 tpy (μg/m³)	Franklin – Maximum Added Secondary Particulate at 500 tpy (μg/m³)	Contribution to secondary $PM_{2.5}$ Concentration (μg/m³) from SFWF OCS Sources	Total Secondary Contribution (μg/m³)	Percentage of Class II $PM_{2.5}$ SIL
Daily SO_x	0.18	**0.137262**	0.105416	4.9E-5	1.95E-3	0.16% of 1.2
Daily NO_x	30.6	0.030532	**0.031641**	1.9E-3		
Annual SO_x	0.18	**0.004964**	0.004214	2.0E-6	1.2E-4	<0.1% of 0.2
Annual NO_x	30.6	0.00128	**0.002076**	1.2E-4		

Source: EPA, 2020a

Notes:

Bolded values represent values used to calculate secondary contribution.

% = percent

< = less than

For $PM_{2.5}$, the direct and secondary impacts were added together to compare to the SIL, NAAQS, and increments.

2.6 National Ambient Air Quality Standards Assessment

According to 40 CFR 51, Appendix W, additional cumulative sources may have to be considered in a NAAQS assessment if emissions from those sources create a "…significant concentration gradient…" in the vicinity of the modeled source (EPA, 2011, 2017). A concentration gradient is the rate of change in concentration with distance, in both the longitudinal and lateral gradients. Significant concentration gradients in the vicinity of the source implies that the nearby source's potential interaction with the proposed source's impacts will not be well represented by the monitored concentrations at a specific location. Concentration gradients are generally largest between the source and the location of the maximum ground-level impacts. This suggests focusing on nearby sources within 6.2 miles (10 km) of a proposed source in most cases.

A review was conducted of on-land sources with operating permits within 31 miles (50 km) of a central point within the SFWF WDA. This review included sources from Dukes and Bristol Counties in Massachusetts and Newport and Washington Counties in Rhode Island. There were no sources with valid and current operating permits identified within 31 miles (50 km) of the WDA. These finding were verified by both Rhode Island Department of Environmental Management (DEM) and Massachusetts Department of Environmental Protection (DEP) via email (DEM, pers. comm., 2020; DEP, pers. comm. 2020). Therefore, no additional on-land cumulative sources were included in the NAAQS assessment, as there are no sources that could have a significant concentration gradient in proximity to the Project sources. The NAAQS assessment was completed with SFWF sources and ambient background concentrations only.

Vineyard Wind LLC (VW) submitted an OCS permit application to EPA in 2019 for a wind development project southeast of the SFWF WDA. The center of VW WDA is more than 31 miles (50 km) from the approximate center of the SFWF WDA. The maximum significant impact radius for the VW project was shown to be 0.9 mile (1.5 km) or less (VW, 2019) for the modeled contaminants for 24-hour average impacts, and all receptors were less than the applicable SIL for annual averages. As shown in Section 4, SFWF SIL modeling shows that SFWF Project's significant impact radius is 2.8 miles (4.5 km) or less for all short-term average impacts and zero for all annual average impacts. Therefore, VW O&M emissions were not included in SFWF's cumulative assessment, as these sources will not significantly contribute to overall modeled concentrations in the vicinity of the Project sources.

Any other sources in the overland region contributing to overall contaminant concentrations are included in the representative background air quality monitoring data used for the NAAQS analysis, as discussed in Section 3.1. Further, these overland background concentrations are conservative estimates of contaminant concentrations overwater in the vicinity of the SFWF WDA, which is far away from various residential and most transportation emissions. NAAQS comparisons were developed for the worst-case operational scenario discussed in Section 3.2.

For $PM_{2.5}$ impacts, the direct $PM_{2.5}$ Project emissions were modeled using the offshore and coastal dispersion model (OCD). Secondary impacts were added to the primary impacts using the MERP approach described in Section 2.5, along with background concentrations for comparison to the $PM_{2.5}$ NAAQS.

2.7 Prevention of Significant Deterioration Increment Assessment

Table 2 shows the specific Class II PSD increments. A cumulative modeling assessment will typically include additional sources in the PSD increment analysis to reflect emission sources added if the minor source baseline date is triggered. However, if the minor source baseline date has not been triggered for any of the pollutants of concern, no other sources will consume increment, and only Project emission sources will consume increment within the Project's significant impact area. Massachusetts triggers minor source baselines by individual towns. Massachusetts DEP has indicated that the minor source baseline has not been triggered for any pollutants for the towns within the 31-mile (50-km) radius from the SFWF WDA in Massachusetts (DEP, 2020).

As discussed in Section 2.6, a review of major sources was conducted in both Rhode Island and Massachusetts, and no sources with valid operating permits were identified within a 31-mile (50-km) radius of the SFWF WDA. Therefore, no additional on-land cumulative sources were modeled for the Class II PSD increment consumption analysis. Also as discussed in Section 2,6, due to the localized significant impact radius for both the VW project (VW, 2019) and the SFWF Project, VW emissions, and the distance between the projects, VW project emissions were not included in the increment assessment, as their increment consumption in the SFWF SIL area will be insignificant.

A comparison of the Project emission impacts from O&M emissions against the Class I SIL is also provided in Section 4 of this report. For this analysis, the model-predicted concentrations at the 31-mile (50-km) distance was assessed and compared against the applicable Class I SILs for NO_2, PM_{10}, and $PM_{2.5}$.

2.8 Class II Air Quality Related Values Assessments

2.8.1 Visibility

The Lye Brook Wilderness Area in southern Vermont is the closest Class I area to the WDA. Lye Brook is located approximately 167 miles (268 km) to the northwest of the Project WDA. The Brigantine Wilderness Area in New Jersey is approximately 196 miles (316 km) away from the WDA. A Q/D (where Q is the sum worst-case annual emissions of NO_x, SO_2, sulfuric acid mist, and PM_{10} in tpy based on annualized worst-case 24-hour emissions; and D is the distance from the WDA to the Class I area in km) screening analysis was done to confirm that this screening value is less than 10; therefore, is not likely to impact visibility or other air quality related values at the Class I area. Based on preliminary emissions and distance to the nearest Class I location, it is not expected that the Project will have an adverse impact on visibility in the Class I area. This analysis was provided to the Federal Land Managers (FLMs) for both Lye Brook and Brigantine.

A screening visibility analysis was conducted for Class II vistas using the EPA VISCREEN model. The assessment will likely include assumed vistas to and from Block Island and Martha's Vineyard, with the emissions from the WDA O&M emissions plume perpendicular to this potential vista. Section 3.11 discusses this assessment further, and Appendix C provides the analysis.

2.8.2 Soils and Vegetation

PSD regulations require analysis of air quality impacts on sensitive vegetation types with significant commercial or recreational value or sensitive types of soil. Evaluation of impacts on sensitive vegetation was performed by comparison of predicted Project impacts with screening levels presented in *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals* (EPA, 1980). These procedures specify that predicted impact concentrations used for comparison account for Project impacts and ambient background concentrations.

Most of the designated vegetation screening levels are equivalent to or exceed NAAQS or PSD increments (or both), so satisfaction of NAAQS and PSD increments assures compliance with sensitive vegetation screening levels. Section 3.12 provides further discussion on this assessment.

2.8.3 Growth

The Project must assess the impact of emissions from secondary growth during O&M activities. Section 3.13 discusses this assessment further.

2.9 State Requirements

OCS sources located within the offshore SFWF and SFEC areas are subject to the federal, state, and local requirements of the COA set forth in 40 CFR 55.14. In the Project's Notice of Intent (NOI), SFW identified Massachusetts as the COA for the SFWF and SFEC because EPA did not receive a request from any neighboring state's air pollution control agencies to be designated as the COA within 60 days.

The relevant Massachusetts regulations on air modeling center on documenting that the Massachusetts Ambient Air Quality Standards (MAAQS) are not being violated. MAAQS are codified in 310 CMR 6.00 and generally follow the NAAQS but have not yet been updated to reflect the EPA's recent revisions to some of the NAAQS. Table 6 summarizes the MAAQS. The NAAQS is equal to or more stringent than the NAAQS; therefore, it will be used to determine compliance with the MAAQS.

Table 6. Massachusetts Ambient Air Quality Standards

Pollutant	Averaging Period	MAAQS (µg/m^3) Primary	MAAQS (µg/m^3) Secondary
NO_2	Annual[a]	100	100
	1-hour	None	None
SO_2	Annual[a]	80	None
	24-hour[b]	365	None
	3-hour[b]	None	1300
	1-hour	None	None
$PM_{2.5}$	Annual	None	None
	24-hour	None	None
PM_{10}	Annual	50	50
	24-hour[b]	150	150
CO	8-hour[b]	10,000	10,000
	1-hour[b]	40,000	40,000
Ozone	1-hour[b]	240	240
Lead	3-month[a]	1.5	1.5

[a] Not to be exceeded

[b] Not to be exceeded more than once per year.

2.10 Summary of Modeling Requirements

Table 7 summarizes the various modeling requirements applicable to the Project's emissions during construction and O&M.

Table 7. Summary of Modeling Requirements

Modeling Requirement	Short-term Construction Emissions: WDA	Short-term Construction Emissions: Export Cable	O&M Emissions
PSD Class I SIL Analysis (at 31 miles [50 km])	Yes	Yes	Yes
Secondary Formation of $PM_{2.5}$	Yes	Yes	Yes
Ozone Analysis	No	No	No
SIL Analysis for NAAQS and PSD Class II Areas	No	No	Yes
NAAQS Cumulative Source Modeling	No	No	If necessary
PSD Increment Analysis	No	No	If necessary
Visibility Assessment	No	No	Yes

Soils and Vegetation	No	No	Yes
Growth	No	No	Yes

3. Air Quality Impact Analysis

The Project emissions air quality analysis for the O&M phase is discussed in this section. Impacts of criteria emissions were modeled for comparison to ambient air quality standards discussed in Section 2.

The dispersion modeling analysis is separated into two distinct components (EPA, 1990):

1) The preliminary (SIL) analysis
2) A full impact analysis (NAAQS, MAAQS, and PSD increment)

In the preliminary analysis, the emissions of contaminants subject to PSD review from the O&M activities were modeled. The results of this analysis were used to determine which criteria pollutants require a full impact analysis and which receptors were to be included in the cumulative analysis. If the results of the preliminary analysis indicate the emissions from the anticipated O&M activities and resulting emissions will not increase ambient concentrations by more than pollutant-specific SILs (Table 3), no further modeling is required.

3.1 Background Air Quality Data

For modeled impacts greater than the SIL, modeled concentrations due to emissions from the Project were added to ambient background concentrations to obtain total concentration impacts at receptors. These total concentrations were compared to the NAAQS and MAAQS. To estimate background pollutant levels representative of the area, the most recent air quality monitor data available via the EPA website were used (EPA, 2020b).

Background concentrations were determined from air quality monitoring stations with selection criteria based both on proximity to and representativeness of the SFWF. The most representative monitoring site for $PM_{2.5}$ is also the closest monitoring site, which is located at the EPA Laboratory in Narragansett, Rhode Island (AQS Site ID 44-009-0007), approximately 26 miles (42 km) from the SFWF. The most representative monitoring site for CO and NO_2 is in East Providence, Rhode Island at the Francis School (AQS ID 44-007-1010), approximately 49 miles (78 km) from the SFWF. The most representative monitoring station for PM_{10} is located at the Community College of Rhode Island Liston Campus rooftop in Providence, Rhode Island (AQS IS 44-007-0022), approximately 47 miles (75 km) from the SFWF. The most representative monitoring station for SO_2 is located in Fall River, Massachusetts (AQS ID 25-005-1004), approximately 38 miles (61 km) from the SFWF.

Given that the SFWF is mostly distant from anthropogenic emission sources, use of these predominantly urban and suburban monitoring locations for the background concentrations are anticipated to be conservative in nature. Table 8 provides a summary of the background air quality concentrations based on the 2017-2019 data.

Table 8. Observed Ambient Air Quality Concentrations and Selected Background Levels

Pollutant ($\mu g/m^3$)	Averaging Period	2017	2018	2019	Background Level	NAAQS and MAAQS[a]
CO	1-hour[b]	1,501	1,438	1,803	1,803	40,000
	8-hour[b]	1,031	917	1,031	1,031	10,000
NO_2	1-hour[c]	74.2	70.0	77.9	74.0	188
	Annual[d]	12.4	12.2	12.4	12.4	100
PM_{10}	24-hour[e]	26.0	23.0	23.0	26.0	150
	Annual[f]	11.0	11.0	10.3	11.0	50
$PM_{2.5}$	24-hour[g]	13.1	16.8	12.8	14.2	35
	Annual[h]	5.1	5.4	3.9	4.8	12

Table 8. Observed Ambient Air Quality Concentrations and Selected Background Levels

Pollutant (µg/m^3)	Averaging Period	2017	2018	2019	Background Level	NAAQS and MAAQS[a]
SO_2	1-hour[i]	29.3	10.0	7.9	15.7	196
	3-hour[j]	23.3	8.9	7.1	23.3	1,300
	24-hour[e]	12.2	3.9	3.3	12.2	365
	Annual[f]	3.4	2.8	2.2	3.4	80

Source: EPA 2020b.

[a] MAAQS assessed by using the NAAQS, which is the same as or more stringent than the MAAQS.

[b] Background level for 1-hour CO and 8-hour CO is the highest of the second-high values over each of the 3 years of data .

[c] Background level for 1-hour NO_2 is the average concentration of the 98th percentile over 3 years.

[d] Background level for Annual NO_2 is the highest concentration of 3 years.

[e] Background level for 24-hour PM_{10} and SO_2 is the highest of the second-highest 24-hour values over each of the 3 years of data

[f] Background level for annual PM_{10} and SO_2 is the highest value of 3 years.

[g] Background level for 24-hour $PM_{2.5}$ is the average concentration of the 98th percentile over 3 years.

[h] Background level for annual $PM_{2.5}$ is the average concentration of 3 years.

[i] Background level for 1-hour SO_2 is the average concentration of the 99th percentile for 3 years.

[j] Background level for 3-hour SO_2 is the highest of the second-high values over each of the 3 years of data.

Notes:

Conversion factors of 1 ppm = 2,620 µg/m^3 SO_2; = 1,146 µg/m^3 CO; and =1,882 µg/m^3 NO_2 used.

ppm = part(s) per million

3.1.1 Justification to Use Significant Impact Levels

The use of SILs are appropriate if the difference in background concentrations for a specific pollutant and averaging period and the applicable NAAQS are greater than the applicable SIL. Table 9 summarizes the difference between the NAAQS and the monitored background concentration. As shown in Table 9, all averaging periods for each pollutant have differences between the monitored value and the NAAQS, which is greater than the respective SIL; therefore, the use of the SIL pollutants are appropriate as screening criteria, as a Project impact equal to or less than the SIL will result in a concentration less than the NAAQS.

Table 9. Difference Between the Monitored Air Quality Concentrations and the National Ambient Air Quality Standards in Comparison to the Significant Impact Levels

Pollutant	Averaging Period	Background Level (µg/m^3)	NAAQS (µg/m^3)	Difference (NAAQS Background) (µg/m^3)	Significant Impact Level (µg/m^3)
CO	1-hour	1,803	40,000	38,197	2,000
	8-hour	1,031	10,000	8,969	500
NO_2	1-hour	74.0	188	114.0	7.5
	Annual	12.4	100	87.6	1
$PM_{2.5}$	24-hour	14.2	35	20.8	1.2
	Annual	4.8	12	7.2	0.2
PM_{10}	24-hour	26.0	150	124.0	5
	Annual	11.0	50	39.0	1
SO_2	1-hour	15.7	196	180.3	7.8
	3-hour	23.3	1,300[a]	1276.7	25
	24-hour	12.2	365[a]	352.8	5

Table 9. Difference Between the Monitored Air Quality Concentrations and the National Ambient Air Quality Standards in Comparison to the Significant Impact Levels

Pollutant	Averaging Period	Background Level (µg/m³)	NAAQS (µg/m³)	Difference (NAAQS Background) (µg/m³)	Significant Impact Level (µg/m³)
	Annual	3.4	80[a]	76.6	1

[a] Revoked

3.2 Air Quality Model Selection and Options

The OCD model is a near-field air dispersion model, appropriate for evaluating impacts at a distance up to 31 miles (50 km) from a source. The OCD model is currently the preferred model for over-water applications per 40 CFR 51 Appendix W (EPA, 2017). OCD is a straight-line Gaussian model that incorporates overwater plume transport and dispersion, as well as changes that occur as the plume crosses the shoreline.

3.3 Meteorological Data for Modeling

Meteorological data for the air dispersion modeling were extracted from three consecutive years of Weather Research and Forecasting (WRF) prognostic model data (2013 to 2015) obtained from EPA Region 1. The Mesoscale Model Interface (MMIF) program, Version 3.4, was used to extract the necessary meteorological parameters. A detailed analysis of the meteorological data developed for the OCD modeling study is presented within the construction emission modeling protocol, which is being submitted to EPA separately (discussed in Section 3.8 and Appendix B of that protocol). These same data are to be used for the O&M emissions impact study as well.

The data developed for this dispersion modeling extends 3 years and will reasonably provide all combinations of meteorological conditions that will give rise to worst-case modeled impacts. The data used are recent, and any changes in local climatology since the 2013 to 2015 period will be insignificant. Therefore, the meteorological data set previously developed and discussed in the construction emissions modeling protocol remain representative of the OCS permit area and were used for this assessment.

3.4 Rationale for Identified Scenarios

For all modeled activities, SFW has attempted to identify the most conservative scenario, generally choosing the scenario with more and larger air emissions sources where multiple options exist. Additionally, SFW has attempted to determine representative source parameters (exit velocity, stack diameter, stack exit temperature) for the types of vessels that may be used for the various O&M scenarios described in the following sections. The vessels identified in the scenarios are consistent with vessels required for similar scenarios based on SFW operational experience. The emissions used for the vessels are based on BOEM emissions factors using default load factors for each of the vessels.

Appendix B provides details of the emission calculations, emission factors and various activity data, and engine sizes. Final construction and O&M methods may differ as the Project design and logistical factors progress and implementation plans are refined. However, the scenario emissions are conservative in that they include larger engine sizes and vessels than are generally considered necessary for the activity considered; therefore, the modeled impacts of the various scenarios and activities are not likely underestimated. The activities described in Section 3.5 occur in the WDA.

3.5 Operations and Maintenance Activities

The air modeling focuses on the routine anticipated O&M activities that may occur within the WDA and along the transit lines between the Ports of Call and the WDA. Infrequent maintenance and repair activities are included in the assessment, although they are anticipated to occur only a few times over the life of the

SFWF. Large-scale cable rehabilitation is not considered in the modeling, as these activities are neither anticipated or routine; and the labor, schedule duration, or vessel requirements cannot be known in advance.

Table 10 lists the typical O&M activities anticipated to occur annually and the number of days each vessel is expected to be used for the activities. For modeling against annual criteria air contaminant standards, the expected number of days of usage is incorporated into the emission estimates. The anticipated hours of use per year are factored into the emission estimate for 1-hour average NO_2 modeling per the discussion in Section 3.6. For 24-hour $PM_{2.5}$ and PM_{10}, it is conservatively assumed that the vessels are operating continuously over that time period.

There will be an emergency generator located at the OSS that will be operated for maintenance checks and readiness testing periodically up to 100 hours per year. It is not expected that testing of the emergency generator located at the OSS will occur simultaneously with use of other equipment and will last 30 to 60 minutes per week or less frequently. During WTG or OSS repair procedures, it is expected that a power source may be required for various purposes, such as to operate power tools. For modeling purposes, it was assumed that a generator similar in size to the OSS emergency generator listed in Table 10 will be used for that purpose. This generator is expected to be transported from on land with the rest of the required equipment. This generator was assumed to run 200 hours per year for annual averages.

Table 10. Annual Vessel Use during Operations and Maintenance

Purpose and Scenario	Type of Equipment or Emission Source Description (list others as needed)	Number of Each Type of Vessel	Total Engine Rating (bhp)	Usage per year
Daily inspection or cable inspection and repair	CTVs	1-2	1,239	320 days per year
WTG and OSS O&M – Main component exchange service	Floating and jack-up crane barge	1	22,000	14 days per year
	CTV	1	1,239	14 days per year
	Feeder barge	2	9,500	14 days per year
	Generator	1	268	200 hours per year
Emergency generator testing	OSS emergency generator	1	268	100 hours per year

Notes:

Engine rating includes both main and auxiliary engines

Sections 3.5.1 through 3.5.4 provide a description of each of the O&M scenarios and vessels involved. These estimates are specific to SFWF and are based on the number of WTGs that make up the windfarm and the distance of cable.

3.5.1 Wind Turbine Generator and Offshore Substation Repair

O&M for the WTGs is anticipated to include activities such as inspection of components and equipment, and replacement of components and gear box oil as necessary. Most O&M repair and maintenance activities will require only the use of a single CTV and will occur approximately several times per year through the lifetime of the Project. The duration of these repair projects can last as many as 8 days.

Other O&M activities will require additional equipment due to the nature of the work, such as cable repairs and replacements or other underwater maintenance. WTGs or OSS major repairs may consist of the replacement of blades, generator, transformer, main bearing and/or blade bearing. This kind of repair may occur 10 times over a 25-year timeframe. These O&M activities may include the use of a CTV, a jack-up vessel, and perhaps a feeder barge (or similar). The duration of these maintenance and repair excursions could last approximately 14 days per year during the years these repairs are necessary. Because of the nature of this work, public access to the immediate vicinity around the vessels will be prevented for safety reasons.

The vessels and air emission sources involved in WTG larger-scale repair O&M projects are assumed to include the following:

- One CTV
- One jack-up vessel
- Possibly one or two feeder or lift barges
- Possibly a site generator for repair work power needs

The exact size and nature of the vessels and equipment to be used could vary based on availability and the specific nature of the work required. However, the emissions and modeling are based on the number of vessels and size of engines as listed herein, including in Table 10. The bhp estimates for the engines were based on input from SFW and on other projects of similar scope. A scenario that includes all of the equipment listed will provide conservative estimates of total engine hp-hours and fuel usage that will actually be used; therefore, will lead to conservative estimates of Project impacts.

For example, it is unlikely that two feeder barges will be necessary for a large-scale repair project, but both were included in the modeled scenario to provide flexibility for SFW. This work activity was one of two scenarios that were modeled. It includes emissions from most expected vessel types; therefore, will likely have the highest impact of any of the other scenarios. Appendix A provides a figure depicting a typical layout for air modeling of the WTG O&M scenario. Sections 3.5.2, 3.5.3, and 3.5.4 describe additional O&M activities.

Additional large-scale repairs may include the following:

- **Inter-array cables major repair** may consist of cable replacement. This may occur once in the lifetime of the windfarm.
- **Export cable major repair** may consist of the replacement of a damaged section. This may occur once in the lifetime of the windfarm.

These major repair scenarios were not explicitly modeled, as the vessels anticipated for these very infrequent repairs (if they are required at all) will be similar to the WTG major repairs scenario. Although individual vessels may be required, total engine power is not likely to be greater than that considered in the WTG major repair scenario.

Short-term emissions were calculated according to the default BOEM load factors, as shown in Table 11.

Table 11. Load Factor Allocation for On-site and Transit Emissions

Vessel	Main Engine (while onsite)	Auxiliary Engine (while onsite)	Transit
CTV	Maneuvering power	Maneuvering power	Main and auxiliary default loads
Jack-up vessel	Not used (vessel assumed jacked up)	Maneuvering power	Main and auxiliary default loads
Feeder barge	Maneuvering power	Maneuvering power	Main and auxiliary default loads

Source (Eastern Research Group, 2017):

BOEM default load factors included:

Main engines: 0.82

Auxiliary engines: 1

Maneuvering power: 0.2

Short-term NO_2 emissions are treated as intermittent, as described in Section 3.6. Short-term 24-hour $PM_{2.5}$ and PM_{10} emissions assumed continuous O&M of the vessels and equipment listed, as well as the generator. Annual averages of all contaminants consider the number of anticipated hours of use, as listed in Table 10. Appendix B provides additional details regarding the calculation of emissions used in the assessment.

3.5.2 Cable Inspection and Repair

O&M for the offshore cable system includes surveys to monitor cable exposure and the depth of burial. This activity is anticipated to occur the first year after construction completion, another 2 to 3 years after construction, and another 5 to 8 years after construction. Surveys thereafter will occur at a frequency dependent on the findings of the preliminary surveys, as well as site seabed dynamics and seabed soil conditions. It is estimated each trip will last as long as 4 to 7 days. This activity involves the use of a multirole survey vessel.

The vessel and air emission sources involved in cable inspection and repairs are assumed to include one or two multirole survey vessels of similar size to a CTV. This O&M emissions scenario was modeled using two CTVs at the WDA site. This scenario is similar to the daily O&M scenario discussed in Section 3.5.3.

3.5.3 Daily and Miscellaneous Operations and Maintenance

For daily O&M, one or two CTVs will be frequently used to transport crew to the offshore SFWF and SFEC areas for inspections, routine maintenance, and minor repairs. The CTVs will each make daily trips to the WDA for approximately 70 to 90 percent of the year (about 320 days per year).

Two CTVs at the WDA are modeled as part of the Cable Inspection and Repair scenario discussed in Section 3.5.2. Transit emissions for all vessels moving between the WDA and the ports were not modeled for short-term averaging periods, as they will not remain in one place long enough to significantly impact any single receptor over that averaging period. Transit emissions of the CTVs and other vessels were modeled for annual averaging periods only. For annual averages, CTVs usage corresponding to the daily O&M scenario were used, as this will lead to higher emissions that the Cable Inspection and Repair scenario, which is expected to occur less frequently. The short-term emissions are identical between the two scenarios, as both are modeled assuming two CTVs located and dynamically positioning at the repair and inspection site. Emissions assume continuous use of both the main and auxiliary engines using maneuvering power while at the site.

3.5.4 Operation of the Engines Located on the Offshore Substation and Wind Turbine Generators

Likely as part of routine O&M discussed in Section 3.5.3, the engine located on the OSS will be tested routinely up to a maximum of 100 hours per year. There are no emergency engines currently anticipated in the WTG platform design. Generators are also anticipated to be needed for various power tool usage at the site, mostly during larger-scale repairs (Section 3.5.1). Therefore, a non-road 268-bhp (200-kW) engine was modeled annually for 200 hours per year. OSS generator emergency testing is not explicitly modeled, as the emission impacts from that testing are implicit in the modeling of the onsite generator used for large-scale repairs (assumed 200 hours per year).

The emission and source parameters associated with these generators were included in the O&M repairs scenario discussed in Section 3.5.1.

3.6 Treatment of Intermittent Emissions

Intermittent emission sources present a challenge for demonstrating compliance with 1-hour NO_2 NAAQS, assuming continuous O&M. Given the implications of the probabilistic form of the 1-hour NO_2 NAAQS, EPA has stated that "…assuming continuous operations for intermittent emissions would effectively impose an additional level of stringency beyond that intended by the level of the standard itself" (EPA, 2011)

EPA also indicates that it will be acceptable to limit the emissions scenarios included in the 1-hour NO_2 modeling to those emissions that are continuous or frequent enough to significantly contribute to the annual distribution of daily maximum 1-hour concentrations (EPA, 2011). As discussed in Section 3.5.1 and Table 10, O&M vessels take part in large-scale WTG rehabilitation and repairs that are expected to occur a few times over the lifetime of the Project, and these repair excursions will likely take place at different turbine locations, with different vessels and at different locations relative to either the turbine or OSS foundation Further, the 1-hour NO_2 NAAQS is a multiyear average of 98th percentile daily maxima. Therefore, the likelihood of these vessels significantly contributing to the 98th percentile model design values is small.

Consistent with EPA guidance (2011) and established precedent for intermittent sources, O&M that occurs for significantly less than the full year and does not occur on a predictable schedule was modeled using their operating hours divided by 8,760 when addressing 1-hour NO_2 impacts. This O&M includes activities that only occur once or twice a year at most, and intermittent sources, such as the emergency and standby generators. As shown in Table 10, the daily inspection CTV is expected to be used most days of the year. While some of the inspections and maintenance are routine, the exact timing, usage, and location of these CTVs are highly variable, depending on a number of logistical factors (such as weather). However, the CTVs are conservatively assumed to be in continuous use at a particular site.

Use of the vessels performing regular O&M activities are most appropriately modeled as intermittent sources when documenting compliance with probabilistic standards.

3.7 Nitrogen Oxide Conversion

For 1-hour NO_2 impacts, modeled NO_x concentrations were scaled according to a representative empirical relationship of ambient NO_2 to NO_x ratios that was supplied by EPA Region 1 (EPA, pers. comm., 2020c). These NO_2 to NOx ratios were applied through postprocessing of OCD output files to OCD model-predicted hourly NO_2 concentrations on an hour-to-hour basis. The hourly varying ambient ratio was bounded by a minimum ratio of 0.5 to a maximum of 0.9.

3.8 Receptor Locations

During use of a jack-up vessel, it is assumed that an exclusion zone will be established that precludes public access to the immediate vicinity near the vessel. For modeling, it was assumed that the jack-up barge is located at the center of the receptor grid, and the exclusion zone is 82 feet (25 m) in all directions from this barge. For modeling of O&M emissions, a polar grid of receptors was used in which receptors were placed in 10 degree increments around the ring.

Receptor ring spacing included the following:

- 82 feet (25 m) out to 1,640 feet (500 m)
- 820 feet (250 m) out to 3,281 feet (1,000 m)
- 1,640 feet (500 m) out to 16,404 feet (5,000 m)
- 1.5 miles (2.5 km) out to 6.2 miles (10 km)
- 3.1 miles (5 km) out to 31 miles (50 km)

This receptor layout produces 1,404 receptors in total over 39 receptor ring distances. Receptor base elevations were applied to the receptors for modeling if they were located on land. All other receptors were assigned a base elevation of zero.

The center of the work area was placed at a point corresponding to the northern-most WTG, similar to the point source used in the construction emissions modeling (as summarized in Table 11 of the construction emissions modeling protocol submitted by SFW [2020a]). Figure 3 shows the polar receptor grid to be used for this study. The nearby receptors are over water with no residences and where the public is extremely unlikely to remain for any extended period of time.

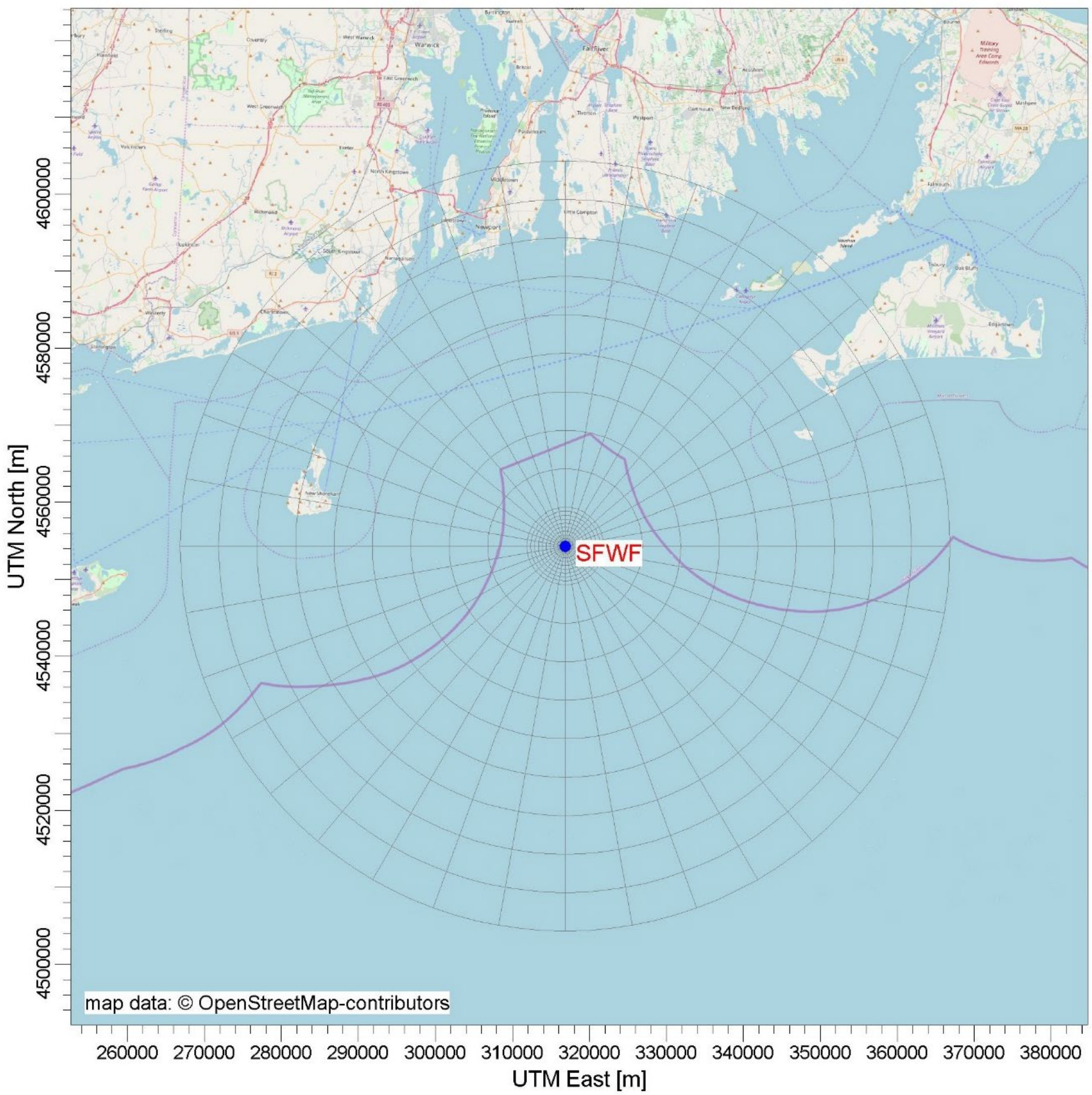

Figure 3. Receptors Used in Operations and Maintenance Modeling

3.9 Structure Downwash

Structure downwash is incorporated into the OCD model by specifying a structure height and width that are nearby a specific source and could influence dispersion from that source. The building downwash due to platform influence is treated using a revised platform downwash algorithm based on laboratory experiments, with dispersion coefficients enhanced, and final plume rise reduced as a result of downwash effects (DiCristofaro and Hanna, 1989, OCD User's Manual, 1997).

The main structure that could influence dispersion for all scenarios is the OSS structure. The final design of the OSS structure has not yet been determined but based on information provided by SFW in the *Construction and Operations Plan* (CoP), the OSS structure can be 150 feet (45.7 m) to 200 feet (61 m) above water level, and a typical value of 164-foot (50-m) height was assumed. This structure will sit on a single monopile foundation, and the height will be approximately 164 feet (50 m) above sea level. Based on the figure presented in Section 3.1.2.4 of the CoP, the maximum lateral distance is estimated at approximately 164 feet (50 m) (SFW, 2020).

These downwash dimensions were assigned to the jack-up barge and the feeder barges, as these vessels will likely be attached or near the OSS structure during large-scale repairs; therefore, they will potentially be influenced by its wake effects. The dimensions are considered conservative in that the downwash algorithms assume a solid foundation down to sea level, instead of the OSS being several feet (meters) above sea level on the monopile foundation. The power generator may be located on top of the OSS platform; therefore, it may be subject to its influence as well.

The CTVs were assumed to be moving and away from the platform such that their emissions releases are mostly independent of the platform wake; therefore, downwash effects were not assigned to these vessels. The solid structures on the vessels (cabins, vessel hulls) themselves are considerably smaller than those of the OSS; therefore, downwash from the vessels themselves were not included. Also, the exact dimensions of the CTVs and other vessels to be used will likely change each visit, so modeling a single vessel layout for downwash purposes is not appropriate.

3.10 Operations and Maintenance Repair Scenario Modeling Layout

The O&M activities will not occur on a set schedule and will depend on weather conditions and other factors. The vessels will visit each of the 16 positions (15 WTGs and 1 OSS) and survey the inter-array and export cables, but the timing and sequence of those visits will vary. The vessels' position will not be the same for each visit, as some inspections will involve disembarkment, while others will be done visually from the vessels by onboard personnel. Similarly, the OCD model can only assess impacts at stationary receptors. The most impacted nearby receptors are entirely in locations where there are not any residences, and where the public is unlikely to remain in one location for any extended period of time.

For modeling, the layout of the scenario is considered typical for the activity being undertaken. The modeling of moving vessels and the assessment of over-water receptors using the OCD model requires the use of more conservative assumptions than a traditional assessment of stationary sources on land. There are two O&M scenarios (larger-scale O&M repairs and daily O&M) that were modeled and included the vessels and equipment listed in Table 10 and as described in Section 3.5. Modeling of these scenarios implicitly assessed possible impacts from other smaller O&M scenarios, such as routine inspections, cable inspections, and emergency generator testing. These smaller O&M tasks will likely use fewer vessels with lower overall engine capacity than the scenarios modeled; therefore, these tasks will likely have lower overall modeled impacts.

The two modeled scenarios include:

- Scenario 1 – Two CTVs at a typical WDA site
- Scenario 2 – One jack-up barge, one CTV, two feeder barges, and one 268-bhp (200-kW) generator at a typical WDA or OSS site

Appendix B presents the emissions associated with each of these scenarios.

As mentioned, the typical WDA site modeled is the location corresponding to the northernmost point of the WDA area. This location is consistent with the northernmost point source discussed in the construction modeling protocol (SFW, 2020b. Scenario 2 is modeled using the OSS dimensions for building downwash, which will result in conservative impacts compared to repairs at a WTG, due to its larger size and enhanced downwash compared to the WTG platforms.

O&M supply routes may originate from:

1. ProvPort or Quonset, Rhode Island
2. New London, Connecticut
3. New Bedford, Massachusetts
4. Shinnecock, Montauk, or Port Jefferson, New York
5. Sparrow Point, Maryland
6. Paulsboro Marine Terminal, New Jersey
7. Norfolk, Virginia

Appendix A shows the first four transit lines. The emissions from the supply routes from the last three ports listed will not be modeled because, due to the distance of these ports from the WDA, they are much less likely to be used (if at all). These ports are included in the list of possible ports to provide flexibility to SFW during O&M and construction. Travel routes from ProvPort, New London, and New Bedford are modeled assuming 100 percent of traffic originates from each of the three ports listed, and as such, are conservative estimates of emissions along these routes. Shinnecock, Montauk, Port Jefferson, New York, or Quonset Rhode Island will be used for the CTVs associated with daily inspection O&M activities only.

The specific usage percentage of each port is not known at this time, as it will depend on vessel availability and a number of other logistical factors. Therefore, the three model transit line locations are meant to represent a worst-case yet unlikely scenario when a single port handles all of the supply trips to the SFWF work area. The different locations of the vessel transit lines modeled were to determine which location represents the highest impact.

Travel routes were modeled for annual averaging periods only, as these emissions correspond to emissions that are transitory in nature, continuously moving (albeit with varying frequency) to and from the Port of Call and WDA; therefore, they will not significantly impact any single receptor over periods of 24 hours or less. The annual average transit lines will run to and from the center of the WDA.

Appendix A shows the layout for site work for the two O&M scenarios. These layouts are anticipated to be representative of typical vessel locations, but it must be emphasized that these vessels will rarely be at the same location at each of the WTGs or OSS for each visit. Appendix A also shows the locations of the work vessels at a typical WDA location (such as a WTG or the OSS). The line source representing the daily O&M activities CTV transport (labeled "Shinnecock Transit" in Figure A-1) was assumed to run between Long Island and the WDA. However, it is possible some daily CTV transit could occur from Quonset, Rhode Island although this specific transit line is not modeled for these vessels.

Table 12 provides a summary of the modeling scenario.

Table 12. Summary of Sources for the Modeling Scenarios

Source	Number	Averaging Period		
		Annual	24-hour	1-hour
Scenario 1 – Daily O&M activities and routine repairs				
CTV	2	√	√	√
Shinnecock, Quonset, Montauk, or Port Jefferson transit source[a]	1	√	No	No
Scenario 2 – Larger-scale OSS and WTG repairs				
Jack-up barge	1	√	√	√
Feeder or lift barge	2	√	√	√
CTV	1	√	√	√
Generator[b]	1	√	√	√
Shinnecock, Quonset, Montauk, or Port Jefferson transit source[a]	1 (line source)	√	No	No
New Bedford, New London, or ProvPort transit source[c]	1 (line source)	√	No	No

[a] CTV emissions, both vessels for Scenario 1 and one vessel for Scenario 2.

[b] Worst-case annual emissions assume 200 hours per year. Modeling of this source also implicitly addresses impacts from the OSS emergency generator testing, as both are assumed 268 bhp (200 kW) in size.

[c] The worst-case impact of the three transit lines were modeled for the final annual average model run, which included the WDA site sources.

Appendix B shows the emission rates and stack parameters associated with the various sources.

3.11 Visibility

3.11.1 Class I Visibility and Other Air Quality Related Values

The Lye Brook Wilderness Area is the nearest Class I area, which is 166 miles (268 km) northwest from the approximate central point of the SFWF area. A Q/D screening assessment was provided to the FLMs for each of the Lye Brook and Brigantine Class I areas. Appendix D provides the correspondence with the FLMs.

Contaminant emissions were based on annualized expected worst-case 24-hour estimates and are based on sources that could emit simultaneously during Project construction. These emissions assumed transit from ProvPort, the port most likely to be used for construction. Project construction is expected to last 1 year.

The sum of annualized maximum 24-hour emissions listed in Table 12 is 2,503 tpy; therefore, Q/D is 9.3 at the closest Class I area: Lye Brook Wilderness Area. The Q/D ratio at the Brigantine Wilderness Area is 7.9. At its closest point, the Lye Brook Wilderness Area is approximately 139 miles (223 km) away from the shoreline in a line connecting it with the approximate center of the SFWF work area and approximately 167 miles (268 km) from the center of the SFWF work area. The Brigantine Wilderness Area is approximately 196 miles (316 km) away from the center of the WDA. The emissions will be released from low-lying sources (such as cable installation, transit emissions); therefore, contaminant transport to these Class I areas will be negligible. The Q/D value is less than 10, and this screening assessment is considered conservative. Therefore, further assessment of Air Quality Related Values was deemed not necessary.

During the O&M phase, the Q/D factor is 1.9 at Lye Brook Wilderness Area, based again on annualized worst-case 24-hour emissions associated with large-scale turbine maintenance and repair. This activity is expected to occur only a few days during a year when it is required, which is only a few times over the lifetime of the Project (25-30 years).

3.11.2 Class II Visibility

A visibility analysis was conducted using the EPA VISCREEN model for Class II vistas at Block Island and Martha's Vineyard. The worst-case annual emission rates for NO_x and particulate matter were used for the analysis. The observer is located at the closest location of the Class II areas (Block Island, Martha's Vineyard) to the proposed source per VISCREEN guidance (EPA, 1988).

As shown in Table 13, the results of the Tier I assessment demonstrate that the Project does not exceed the significance criteria for delta (Δ)E and contrast at all analyzed observation points. As a result, additional analysis is not required to determine compliance of the Project with visibility requirements.

Despite O&M of the Project not being consistent on a day-to-day basis in terms of emissions and location, this analysis is still conservative in its approach. The modeling analysis used worst-case meteorological conditions of a windspeed of 3.2 feet per second (ft/s) (1 meter per second [m/s]) and stable atmospheric condition of F, which only occurs during night hours (observation criteria do not apply during nighttime hours). Based on the results of this analysis, a refined statistical analysis of daylight hour only meteorological conditions, daily emissions uncertainty, and background visibility range variation is not warranted.

Appendix C provides the full VISCREEN assessment.

Table 13. Tier I VISCREEN Results

Liberty Island Observation Point	Variable	Sky	Terrain	Criteria
Martha's Vineyard	ΔE	0.365	0.113	2
	Contrast	-0.002	0.001	|0.05|
Block Island	ΔE	0.430	0.154	2
	Contrast	-0.002	-0.001	|0.05|
Beavertail Lighthouse	ΔE	0.339	0.104	2
	Contrast	-0.001	0.001	|0.05|

3.12 Soils and Vegetation

A component of the PSD review includes an analysis to determine the potential air quality impacts on sensitive vegetation types that may be present near the Project. This evaluation was conducted in accordance with *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA, 1980). Predicted air quality concentrations of various pollutants from the Project are added to ambient background concentrations and compared to screening concentrations to determine whether there exists the potential for adversely impacting vegetation with significant commercial or recreational value.

As shown in Table 14, all predicted over-water concentrations are well less than the thresholds used to evaluate impacts to vegetation. Over-land impacts will be much less. Therefore, the Project will not cause impacts to vegetation.

Table 14. Comparison of Maximum Modeled Concentrations to Vegetation Screening Concentrations

Pollutant	Average Period	Maximum Modeled Concentration (μg/m^3)	Background Concentration (μg/m^3)	Total Concentration (μg/m^3) [a]	Screening Concentration Sensitive (μg/m^3) [b]
SO_2	1-hour	NA	15.7	-	917
	3-hour	NA	15.7[c]	-	786
NO_2	4-hour	44.9[d]	74.0[e]	118.9	3780
	8-hour	44.9[d]	74.0[e]	118.9	3780
	Annual	0.85	12.4[e]	13.3	-
CO	1-week	NA	1803[c]	-	1,800,000

[a] Total concentration = maximum modeled facility concentration + background concentration.

[b] Screening concentrations found in Table 3.1 of *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA, 1980).

[c] Based on 1-hour background.

[d] Maximum modeled concentration conservatively based on 1-hour averaging period.

[e] Maximum of values listed in Table 16.

Notes:

- = no screening concentration available

NA = not available or not modeled; however, these maximum concentrations are expected to be less than the 1-hour NO_2 impacts and can be reasonably assumed to be less than the applicable screening threshold

3.13 Growth

The affected environment for population, economy, and employment are the same for the SFWF and SFEC and are presented together in this subsection.

Project-related activities and infrastructure that could potentially result in direct or indirect impacts to population, economy, and employment resources were identified as part of the impact-producing factor (IPF) analysis in the SFW CoP (SFW, 2020). The analysis assessed IPFs, such as the following:

- Socioeconomic factors
- Population
- Economy
- Employment
- Coastal land uses
- Tourism

Navigant Consulting Inc. conducted an economic development and jobs analysis for the SFWF and SFEC (SFW, 2020). That analysis found that the SFWF and SFEC will support an estimated 1,741 local job-years (full-time-equivalent jobs multiplied by the number of construction years) during the construction phase and approximately 87 additional local annual jobs during the O&M phase. During construction, this includes 166 direct jobs, 790 indirect jobs, and 620 induced jobs. During O&M, this includes 10 direct annual jobs, 48 indirect jobs, and 29 induced jobs.

Expected job creation from development of the offshore wind industry in the northeastern United States was also recently described in the report *U.S. Job Creation in Offshore Wind* (BVG Associates Limited, 2017) prepared for the New York State Energy Research and Development Authority and reflected collaboration with representatives of the Massachusetts Department of Energy Resources, the Massachusetts Clean Energy Center (MassCEC), and the Rhode Island Office of Energy Resources.

SFW will hire local workers to the extent practical for SFWF and SFEC management, fabrication, and construction. Non-local construction personnel typically include mariners, export cable manufacturing personnel, and other specialists who may temporarily relocate during construction and decommissioning. Population impacts to the communities in the socioeconomic return on investment could result primarily from the short-term influx of construction personnel. The total population change will equal the total number of non-local construction workers plus any family members that may accompany them. However, because of the short duration of construction activities, it is unlikely that non-local workers will relocate families to the area.

Several environmental protection measures will reduce potential impacts to population, economy, and employment, including:

- Where possible, local workers will be hired to meet labor needs for Project construction, O&M, and decommissioning.
- The location of the SFWF WTGs restricts available views from visually sensitive public resources and population centers.
- The SFEC-Onshore construction schedule has been designed to minimize impacts to the local community during the summer tourist season.
- At the SFEC Interconnection Facility, additional screening will further reduce potential visibility and noise.
- New York State Law requires that the SFEC-Onshore be constructed in compliance with a detailed plan that includes traffic and other control 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.
- Vessel engines will meet the appropriate EPA air emission standards for NOx emissions 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.

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 GHG emissions.

If any new personnel move to the area to support the Project, a significant housing market is already established and available. Therefore, no new housing is expected. Further, due to the small number of new individuals expected to move into the area to support the Project and the significant level of existing commercial activity in the area, new commercial construction is not foreseen to be necessary to support the Project's work force. Thus, no new significant emissions from secondary growth during either construction or O&M are anticipated.

4. Model Results

Air dispersion modeling was performed for the two operational scenarios discussed in Section 3 to document compliance with ambient air quality standards during the O&M phase of the Project. A preliminary analysis of each of the contaminants and averaging periods was modeled to determine the highest air quality impact for each scenario.

This section is organized as follows:

- Section 4.1 presents the results of this preliminary analysis used to inform the remainder of the modeling.
- Sections 4.2 and 4.3 discuss the refined NAAQS modeling and Class II PSD increment modeling conducted as a result of the preliminary modeling.
- Section 4.4 provides the Class I PSD increment assessment for receptors located 31 miles (50 km) from the WDA.
- Section 4.5 provides conclusions.

4.1 Preliminary Significant Impact Level Modeling

The predicted air quality levels for the contaminants NO_2, PM_{10}, and $PM_{2.5}$ were assessed through initial modeling of the operational scenarios, as discussed in Section 3.5.

Table 15 presents the results of the preliminary modeling for the annual averages for each of the three transit routes considered. There is an additional transit route corresponding to the CTV transit between Shinnecock or Port Jefferson New York and the WDA included in these runs, but this route is common to all three scenarios listed in Table 15 (Table 12 provides a list of modeled sources). The preliminary results indicate that, assuming 100 percent travel from the New London transit line to the WDA, this line results in the highest modeled impact. Table 16 provides the model results corresponding to the New London transit line. Transit lines are not modeled for short-term averages; therefore, they include only vessels and equipment at the repair or inspection site.

Table 16 summarizes the preliminary modeling analysis compared to the SILs for each pollutant and averaging time. As discussed in Section 3.5, there were two scenarios modeled for each preliminary analysis, Scenario 1 and Scenario 2; only the higher impact of the two scenarios is shown in Table 16. The preliminary SIL modeling shows that a NAAQS and Class II PSD increment analysis are required for 1-hour NO_2, 24-hour PM_{10}, and 24-hour $PM_{2.5}$. The NO_2, $PM_{2,5}$, and PM_{10} annual averages are all less than their respective SILs; therefore, no additional modeling of these averaging periods is required. Table 16 also reports the extent of the significant impact areas for each of the pollutants and averaging period; these distances are:

- 0.46 mile (0.75 km) for 24-hour PM_{10}
- 1.6 miles (2.5 km) for 24-hour $PM_{2.5}$
- 2.8 miles (4.5 km) for 1-hour NO_2

Table 15. Preliminary Modeling of Transit Routes

Pollutant	Averaging Period	2013 NB	2013 PP	2013 NL	2014 NB	2014 PP	2014 NL	2015 NB	2015 PP	2015 NL
NO_2	Annual	0.82	0.83	**0.83**	0.71	0.71	**0.71**	0.84	0.84	**0.85**
$PM_{2.5}$	Annual	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03
PM_{10}	Annual	-	-	0.03	-	-	0.02	-	-	0.03

Notes:

All units are µg/m^3.

Annual NO_2 assumes 100% NOx conversion.

Gray highlights indicate worst-case scenario.

- = not modeled

NB = New Bedford Transit Line

NL = New London Transit Line

PP = ProvPort Transit Line

Table 16. Preliminary Modeling Comparison to Contaminant Significant Impact Levels

Pollutant	Averaging Period	Scenario[a]	Class II SIL	Concentration (µg/m^3)	UTM X (km)[b]	UTM Y (km)[b]	Significant Impact Radius (km)
NO_2	1-hour[c]	2	7.5[d]	44.9	317.044	4554.533	4.5
	Annual[c]	NA	1	0.85	317.029	4554.515	0
PM_{10}	24-hour[e]	2	5	13.28	316.826	4554.452	0.75
	Annual	NA	1	0.03	317.08	4554.57	0
$PM_{2.5}$	24-hour[f]	2	1.2	8.35	316.852	4554.429	2.5
	Annual[g]	NA	0.2	0.02	317.08	4554.57	0

[a] Higher of scenario 1 or 2; short-term model runs shown only.

[b] Location of maximum modeled concentration.

[c] 1-hour NO_2 concentrations processed using an ambient ratio method, as discussed in Section 3.7. Annual NO_2 assume 100% conversion.

[d] Highest 1-hour modeled concentration averaged over 3 years.

[e] Maximum 24-hour concentration.

[f] Highest 3-year average.

[g] Highest annual modeled concentration averaged over 3 years.

4.2 Refined Modeling Analysis

For those pollutants and averaging periods with Project impacts exceeding the SILs, an analysis was performed to verify that the Project will not cause or contribute to a violation of the NAAQS or cause a violation of any PSD increment. For the NAAQS assessment, Project impacts were added to the background concentrations presented in Table 8. Per the discussion in Section 2.6, no additional cumulative sources were included in the assessment due to the distance to the nearest sources and the small Project significant impact area. For the PSD increment assessment, the Project impacts (primary plus secondary) only were compared to the applicable increments for 24-hour $PM_{2.5}$ and PM_{10}. Again, no additional cumulative sources were included in the increment consumption modeling per the discussion in Section 2.7.

4.3 National Ambient Air Quality Standards Comparison

Each of the operational scenarios in Table 16 that exceeded its respective SIL were modeled for comparison to the NAAQS. Results from this modeling were postprocessed to extract model design values that were consistent with the form of the standard. Results were then combined with the appropriate background ambient air quality value, as described in Section 3.1 and Table 8 for comparison to the NAAQS. PM2.5 results include the secondary impact analysis described in Section 2.5. However, the secondary particulate contribution is minor compared to the primary modeled impacts and the NAAQS. Results from this analysis are reported in Table 17 and show that for all modeled pollutants and averaging times, impacts are well less than the NAAQS.

Table 17. National Ambient Air Quality Standards Comparison Modeling Results

Pollutant	Averaging Period	Scenario	NAAQS	Modeled Concentration (µg/m^3)	Background (µg/m^3)	Concentration (µg/m^3)	Exceeds NAAQS?
NO_2	1-hour	2	188	42.8[a]	74.0	116.8	No
$PM_{2.5}$	24-hour	2	35	4.43[b]	14.2	18.6	No
PM_{10}	24-hour	2	150	9.21[c]	33.0	42.2	No

a Highest 3-year average of annual 98th percentile 1-hour daily maxima.

b Highest 3-year average of annual 98th percentile 24-hour concentrations.

c Highest of the second highest annual 24-hour concentration.

For the $PM_{2.5}$ and NO_2 NAAQS, the form of the standard is a multiyear average of annual daily maxima. The reported average assumes that the same major repairs layout is occurring continuously at the same location for 3 sequential years, and the likelihood of this occurring is zero for all realistic purposes.

4.4 Class II Prevention of Significant Deterioration Increment Analysis

The Class II PSD increment analysis was run for the scenarios described in Table 15 for each of the pollutants and averaging periods where impacts were greater than the Class II PSD SIL. This included 24-hour $PM_{2.5}$ and 24-hour PM_{10}. The PSD regulations define "…the minor source baseline date…" at 40 CFR 52.21(b)(14)(ii) as the "…earliest date after the trigger date on which… a major modification subject to 40 CFR 52.21… submits a complete application." As a result, no other nearby sources need to be included in the PSD increment analysis, as there are no other sources that have consumed the PSD increment in Dukes or Bristol Counties within 31 miles (50 km) of the WDA. Also, there were no major sources identified within Rhode Island that are within 31 miles (50 km) of the WDA.

Finally, there is a proposed wind farm PSD source for which a modeling study and application have been recently received by EPA (VW, 2018, 2019). It is to be located approximately 31 miles (50 km) from the SFWF at its nearest point. A review of the VW predicted significant impact radius for the modeled contaminants show a maximum significance radius as follows:

- 0.9 mile (1.5 km) for 24-hour $PM_{2.5}$
- 0.6 mile (1.0 km) for 1-hour NO_2
- 0.3 mile (0.5 km) for 24-hour PM_{10}

Table 16 shows that the significant impacts radii for SFWF is similarly small:

- 0.46 mile (0.75 km) for 24-hour PM_{10}
- 1.6 miles (2.5 km) for 24-hour $PM_{2.5}$
- 2.8 miles (4.5 km) for 1-hour NO_2

Based on this comparison, it is reasonable to assume that the VW increment consumption within the significant impact area of the SFWF will be negligible; therefore, these sources were not modeled.

Table 18 provides the results from this analysis, and all are less than all PSD increments for each pollutant and averaging period.

Table 18. Class II Prevention of Significant Deterioration Increment Comparison Modeling Results

Pollutant	Averaging Period	Scenario	Class II PSD Increment (µg/m^3)	Modeled Concentration (µg/m^3)[a]	Exceeds Increment?
$PM_{2.5}$	24-hour	2	9	8.71	No
PM_{10}	24-hour	2	30	9.21	No

[a] Highest of the second highest annual 24-hour concentrations

4.5 Class I Prevention of Significant Deterioration Increment Analysis

Model results for receptors at 31 miles (50 km) for each of the scenarios were compared to the Class I PSD SIL for annual average NO_2, and 24-hour annual average PM_{10} and $PM_{2.5}$. Table 19 provides the results. All modeled concentrations are less than the Class I PSD SILs at 31 miles (50 km) from the WDA.

Table 19. Class I Prevention of Significant Deterioration Increment Comparison Modeling Results

Pollutant	Averaging Period	Class I PSD SIL (µg/m^3)	Modeled Concentration (µg/m^3)[a]	Exceeds SIL?
$PM_{2.5}$	24-hour	0.27[b]	0.08	No
$PM_{2.5}$	Annual	0.05[c]	<0.01[d]	No
PM_{10}	24-hour	0.3[e]	0.13	No
PM_{10}	Annual	0.2[e]	< 0.01[d]	No
NO_2	Annual	0.1[e]	0.01	No

[a] Results are for receptors at 31-mile (50-km) distance only.

[b] Highest 24-hour concentration averaged over 3 years.

[c] Highest annual average averaged over 3 years.

[d] OCD model reports annual concentrations to two decimal places. Concentrations in OCD model output files were reported as zero.

[e] Concentration not to be exceeded.

4.6 Conclusion

This report describes the air quality modeling analysis that was performed as part of the EPA OCS air permit application process for the 15 WTG offshore wind farms proposed by SFW. Using the EPA preferred guideline OCD model, the purpose of the modeling analysis was to demonstrate that the proposed Project will not violate the NAAQS or other related federal and Massachusetts air quality regulations. Per the EPA, the NAAQS "…provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly."

This report addresses the O&M-related compliance documentation. The modeling analysis for construction is being submitted separately. During O&M, all modeled scenarios are less than both the NAAQS and PSD increments. Impacts during O&M to visibility in Class I and Class II areas, soils and vegetation, and growth are all well less than protective levels. Therefore, impacts from the proposed SFW offshore wind farm during O&M will not cause or contribute to a violation of ambient air quality standards.

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Appendix A
Air Quality Modeling Layout Figures

This appendix provides the air quality modeling layout figures.

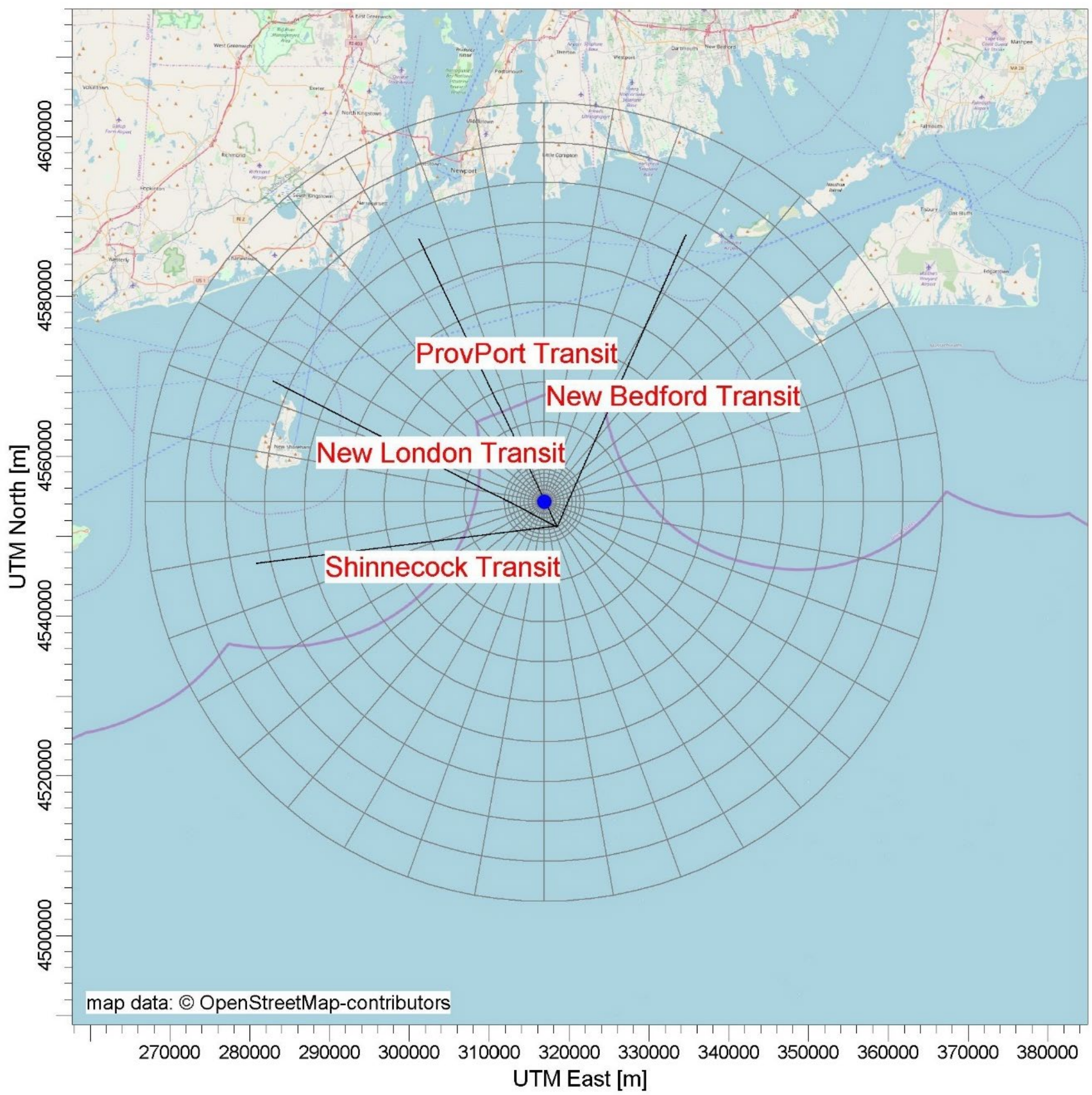


Figure A-1. Transit Line Layout for Annual Average Modeling

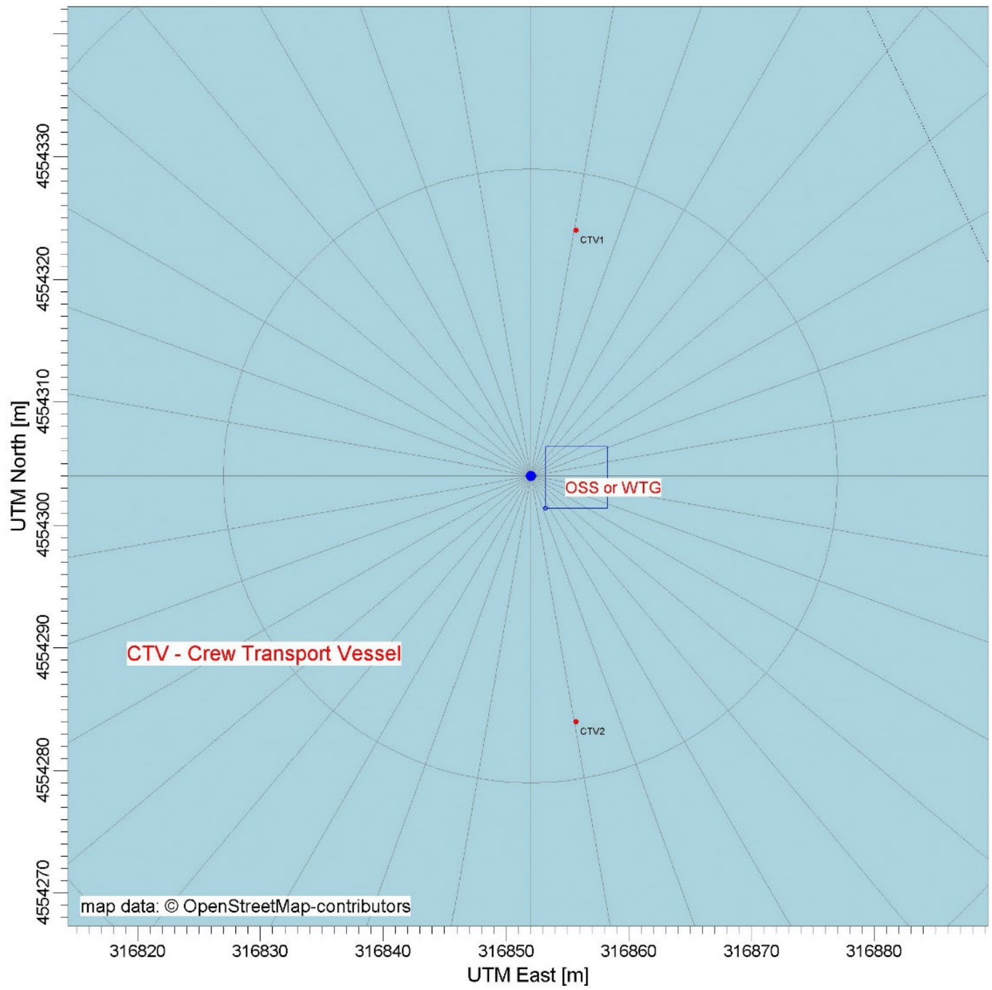


Figure A-2. Typical Daily Operations and Maintenance Scenario Modeling Layout (Scenario 1)

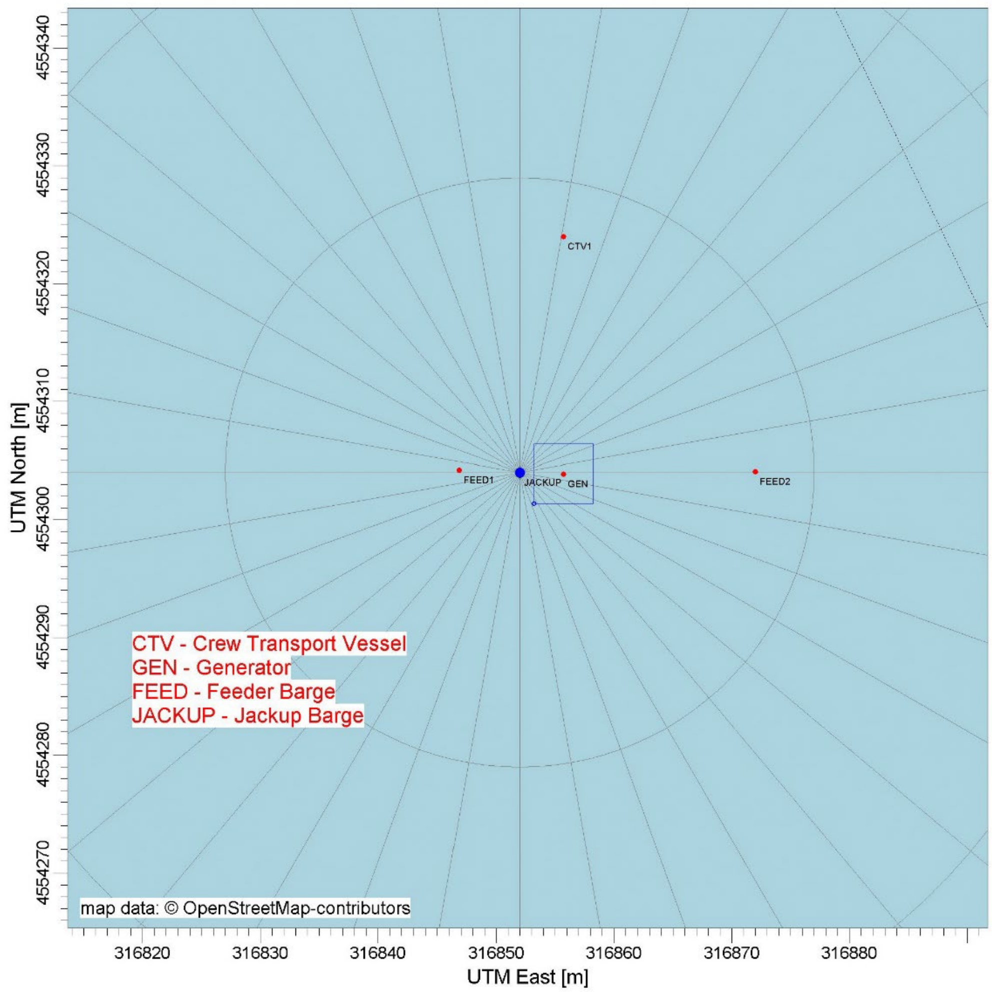


Figure A-3. Typical Operations and Maintenance Repair Scenario Modeling Layout (Scenario 2)

Appendix B
Source Parameters and Emissions

Tables in this appendix summarize the source parameters and emissions.

Table B-1. Source Parameters and Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
Jack-up Vessel	1	20	1.0	3.3	555
CTVs 1 and 2	2	10	0.33	20	555
Feeder Barge, Main Repair Vessel, and Liftboat	2	30	0.6	6.6	800
268-bhp (200-kW) Generator	1	53[a]	0.33	39.38	758
New Bedford, ProvPort, New London Lines[b]	[c]	10	2	5.5	350
Daily CTV Transit Line[d]	[c]	10	0.33	20	555

[a] Assume located on top of OSS or WTG deck (approximate).

[b] Same parameters as construction line sources assumed.

[c] Point source every 0.6-3.1 miles (1-5 km) of line distance.

[d] Parameters same as CTV

Notes:

bhp = break horsepower

CTV = crew transport vehicle

K = Kelvin

km = kilometer(s)

kW = kilowatt(s)

m = meter(s)

m/s = meter(s) per second

OSS = offshore substation

ProvPort = Port of Providence, Rhode Island

WTG = wind turbine generator

Table B-2. Short-term Emissions during Operations and Maintenance

Vessel	Scenario 1 Count	Scenario 2 Count	Annual Hours of Use[d]	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	0	1	112	0.0221[a]	0.048[b]	0.046[b]
Daily O&M CTV	1	0	2002	0.472[a]	0.0042[b]	0.0040[b]
CTV	1	1	168	0.0099[a]	0.008[b]	0.0077[b]
Feeder Barge, Main Repair Vessel, Liftboat [a,b,c]	0	2	112	0.0677[a]	0.169[b]	0.158[b]
268-bhp (200-kW) Generator [a,b]	0	1	200	0.0076[a]	0.0061[b]	0.0061[b]
Daily CTV Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA
New London, ProvPort, New Bedford Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA

[a] 1-hour emissions.

[b] 24-hour emissions.

[c] Emissions shown per vessel or generator.

[d] Anticipated number of hours of use onsite (not including transit time) applied to 1-hour NOx emissions

Notes:

g/s = gram(s) per second

NA = not applicable

NOx = nitrogen oxide

O&M = operations and maintenance

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

Table B-3. Annual Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	1	0.0179	0.0005	0.0005
Daily O&M CTV	1	0.108	0.0036	0.0035
CTV	1	0.0070	0.0002	0.0002
Feeder Barge, Main Repair Vessel, Liftboat[a]	2	0.115	0.0037	0.0034
268-bhp (200-kW) Generator	1	0.0076	0.00014	0.00014
Daily CTV Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.411	0.0138	0.0134
New London Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.215	0.0067	0.0064
New Bedford Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.123	0.0038	0.0036
ProvPort Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.127	0.0039	0.0038

[a] Emissions shown per vessel or generator.

[b] Total line source emissions.

Table B-4. South Fork Wind Farm Operations and Maintenance Annual Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**27.4**	**0.9**	**0.9**
Transit emissions	18.6	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area - ProvPort	**27.6**	**0.9**	**0.9**
Transit emissions	18.7	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area – New London	**30.6**	**1.0**	**1.0**
Transit emissions	21.8	0.7	0.7
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0

[a] All vessels in total.

Notes:

Units in tpy.

OCS = Outer Continental Shelf

tpy = ton(s) per year

Table B-5. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Daily CTV)[a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area - ProvPort	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Daily CTV) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area – New London	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Daily CTV) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006

[a] Not modeled for 24-hour averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per 24 hours.

Table B-6. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area – New Bedford	**13.48**	**0.42**	**0.40**
Transit emissions (Daily CTV) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area - ProvPort	**13.48**	**0.42**	**0.40**
Transit emissions (Daily CTV) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area – New London	**13.48**	**0.42**	**0.40**
Transit emissions (Daily CTV) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table B-7. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area New Bedford	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area - ProvPort	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area – New London	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per hour.

Table B-8. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area – New Bedford	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – ProvPort	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – New London	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table B-9. Transit and Maneuvering Emission Factors

Engine	Type	Units	Emission Factors										
			CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Main	Anchor Handling Tugs	g/kW/h	6.36E+02	4.00E-03	3.10E-02	2.54E-01	2.16E+00	9.26E+00	3.44E-01	3.30E-01	7.87E-02	4.03E-05	2.39E-01
Main	Barge	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	1.36E+01	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.31E-01	2.30E+00	9.15E+00	3.10E-01	3.00E-01	6.24E-03	4.65E-05	1.37E-01
Main	Jack-up	g/kW/h	6.47E+02	4.00E-03	3.10E-02	2.29E-01	2.30E+00	1.00E+01	3.08E-01	2.98E-01	1.27E-02	4.51E-05	1.44E-01
Main	Research and Survey	g/kW/h	6.38E+02	4.00E-03	3.10E-02	2.51E-01	2.25E+00	9.86E+00	3.39E-01	3.26E-01	6.57E-02	4.15E-05	2.21E-01
Main	Tug	g/kW/h	6.44E+02	4.00E-03	3.10E-02	2.43E-01	2.29E+00	9.52E+00	3.27E-01	3.16E-01	3.33E-02	4.48E-05	1.77E-01
Main	Cable Laying	g/kW/h	6.35E+02	4.00E-03	3.10E-02	2.52E-01	2.20E+00	9.49E+00	3.41E-01	3.27E-01	8.51E-02	3.88E-05	2.46E-01
Main	Dredging	g/kW/h	6.31E+02	4.00E-03	3.10E-02	2.63E-01	2.13E+00	9.60E+00	3.57E-01	3.41E-01	1.12E-01	3.70E-05	2.85E-01
Main	Shuttle Tanker	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	9.05E+00	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Supply Ship	g/kW/h	6.45E+02	4.00E-03	3.10E-02	2.38E-01	2.29E+00	9.44E+00	3.20E-01	3.09E-01	2.77E-02	4.45E-05	1.67E-01
Main	Ice Breaker	g/kW/h	6.11E+02	4.00E-03	3.10E-02	2.90E-01	1.78E+00	9.92E+00	3.99E-01	3.77E-01	2.30E-01	2.48E-05	4.48E-01
Auxiliary	Anchor Handling Tugs	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.88E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Barge	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.26E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Jack-up	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.15E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Research and Survey	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.02E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Tug	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Cable Laying	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.89E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Dredging	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.85E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Shuttle Tanker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.80E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Supply Ship	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Ice Breaker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	2.48E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01

Table B-9. Transit and Maneuvering Emission Factors

<table>
<tr><th rowspan="2">Engine</th><th rowspan="2">Type</th><th rowspan="2">Units</th><th colspan="11">Emission Factors</th></tr>
<tr><th>CO_2</th><th>CH_4</th><th>N_2O</th><th>Black Carbon</th><th>CO</th><th>NO_X</th><th>PM_{10}</th><th>$PM_{2.5}$</th><th>SO_2</th><th>Lead</th><th>VOC</th></tr>
<tr><td colspan="2">Engine Loading Factor:</td><td colspan="4">BOEM Tool default loading factors are used.</td><td colspan="3">Propulsion Engine</td><td colspan="3">Auxiliary Engine</td><td colspan="2">Maneuvering</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td><td colspan="3">0.82</td><td colspan="3">1</td><td colspan="2">0.2</td></tr>
<tr><td colspan="2">Vessel Emissions (tons) =</td><td colspan="12">Engine Power Rating (kW) x Loading Factor x Activity Hours (hours) x Emission Factor (g/kW/h) x (1 lb / 454 g) x (1 ton / 2,000 lb) x (No. of Sources)</td></tr>
</table>

Notes:

BOEM = Bureau of Ocean Energy Management

CH_4 = methane

CO = carbon monoxide

CO_2 = carbon dioxide

g = gram(s)

g/kW/h = gram(s) per kilowatt per hour

kW = kilowatt(s)

lb = pound(s)

N_2O = nitrous oxide

No. = number

NOx = nitrogen oxides

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table B-10. Annual Emission Estimate for Transit in Offshore and Coastal Dispersion Model Area

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours for Transit Within OCS Area	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, Montauk, Port Jefferson NY or Quonset RI						**14.29**	**0.48**	**0.47**
CTV	Crew	1	881	43	1,837.7	14.29	0.48	0.47
Port of New Bedford, Massachusetts based						**4.27**	**0.13**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	13.6	2.15	0.06	0.06
CTV	Crew	1	881	43	24.6	0.19	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	10.9	1.93	0.06	0.06
ProvPort, Rhode Island based						**4.43**	**0.14**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	14.1	2.23	0.07	0.06
CTV	Crew	1	881	43	25.4	0.20	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	11.3	2.00	0.06	0.06
Port of New London, Connecticut based						**7.47**	**0.23**	**0.22**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	23.7	3.76	0.11	0.11
CTV	Crew	1	881	43	42.9	0.33	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1119	19.0	3.38	0.11	0.10

Notes:

Units are tpy.

Transit emissions assume load factor of 0.82 for all main engines, and 1 for auxiliary engines.

Table B-11. South Fork Wind Farm Onsite Emergency Generator

Type	Units	Emission Factors									
		CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Offshore emergency generator	g/kW/h	6.5E+02	4.0E-03	3.1E-02	8.5E-02	2.0E+00	6.0E+00	1.1E-01	1.1E-01	6.0E-03	7.0E-02

Emission calculation:	
Generator Emissions (tpy) =	*Engine Power Rating (kW) x Activity Hours (hours/year) x Emission Factor (g/kW/h) x (1 lb /454 g) x (1 ton / 2000 lb) x (No. of Sources)*

Type of Equipment and Emission Source Description (list others as needed)	No. of equipment	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - annual testing and run time	NO_x	PM_{10}	$PM_{2.5}$
Generator (268 bhp [200 kW])	1	200		200.0	0.263	0.005	0.005

Notes:

Units are tpy.

Table B-12. Annual Emission Estimate for Onsite Maneuvering

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - Maneuvering Onsite	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, Port Jefferson or Montauk NY, or Quonset RI						**3.75**	**0.13**	**0.12**
CTV	Crew	1	881	43	2002.3	3.75	0.13	0.12
Port of New Bedford, Massachusetts based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
PortProv, Rhode Island based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
Port of New London, Connecticut based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12

Notes:

For onsite maneuvering, CTVs and feeder barges assume load factor of 0.2 for both main and auxiliary engines; jack-up barge assumes load factor of 0.2 for the auxiliary engine only.

Emission units are tpy.

Appendix C
Class II VISCREEN Visibility Assessment

South Fork Wind – OCS Permit Application

Class II Visibility Assessment

South Fork Wind LLC

Executive Summary

A screening visibility analysis was conducted for identified Class II vistas using the EPA VISCREEN model. The assessment will likely include assumed vistas to and from Block Island, Beavertail Lighthouse, and Martha's Vineyard. The results of the Tier I assessment demonstrate that the Project does not exceed the significance criteria for ΔE and contrast at all analyzed observation points.

Class II Areas of Concern

A survey of areas designated as Federal Class I areas was conducted within 300-km of the Project and concluded the nearest Class I area is Lye Brooks Wilderness, located over 250-km northwest of the project. There are no Class I areas within 50-km of the Project's Wind Development Area. As a result, nearby locations of Federal designated Class II areas of potential observation were selected for this visibility analysis. A total of three potential areas and corresponding viewpoints were selected for analysis to capture potential visibility impacts from the Project. A list of these three vistas, distances for the Project, observed area, and observation points are included in Table 1 and presented in a map as Figure 1.

Table 1. Project Distances

Class II Area and Observer Distances for Visibility Analysis

Observed Area	Observation Point	Observer Distance from Source (km)	Minimum Source-Observed Area Distance (km)	Maximum Source-Observed Area Distance (km)
Martha's Vineyard	Cuttyhunk	39.5	37.8	69.3
Block Island	Point Judith	36.8	30.9	36.6
Beavertail Lighthouse	Eastern Narragansett Coast	42.6	40.5	45

km = kilometers

Project Emissions

The emission rates used in this analysis are presented in Table 2. These are more conservative (i.e. higher) than the emissions presented in the air dispersion modeling analysis (see Table 2 of the O&M Emissions air dispersion modeling report).

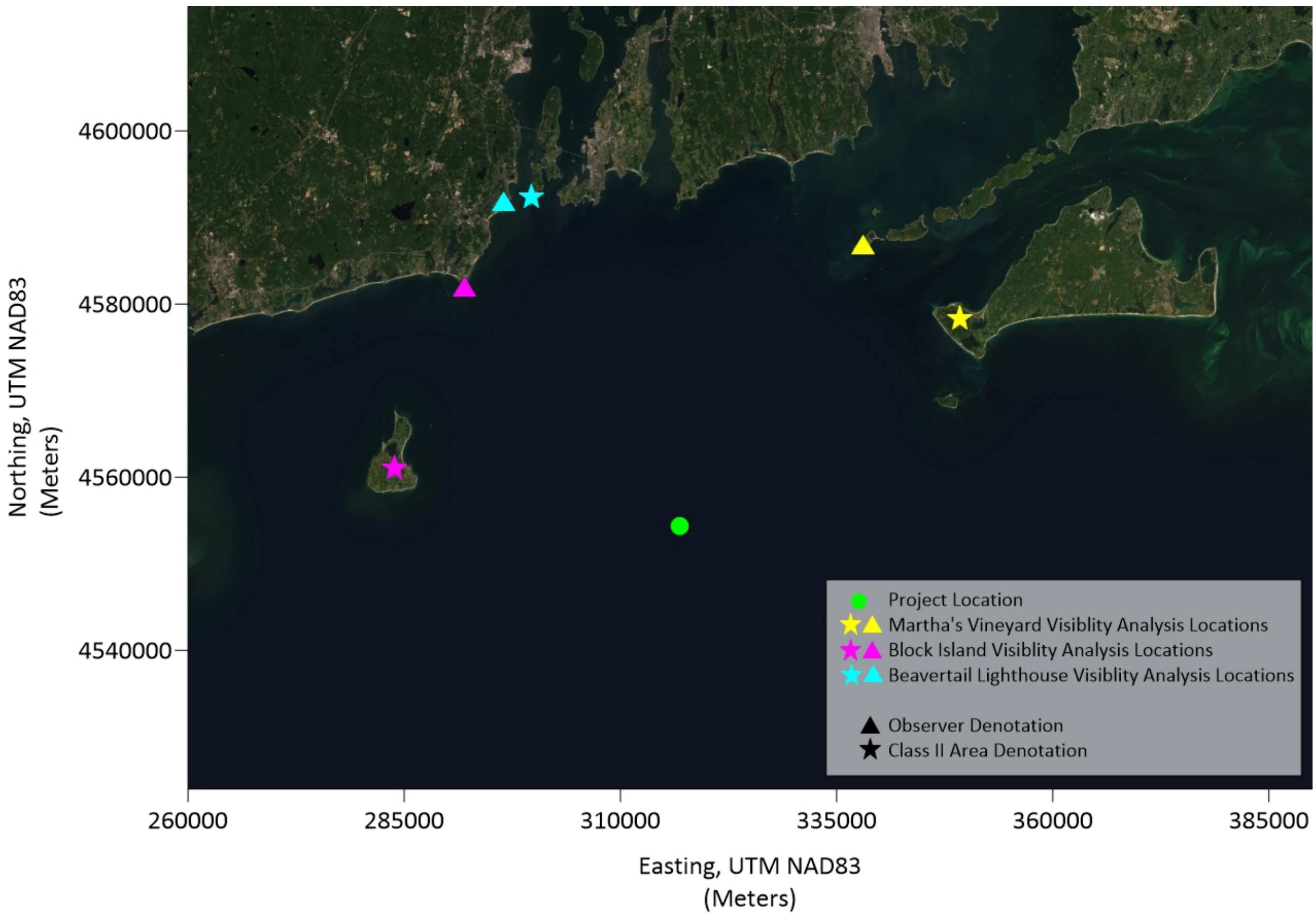
Table 2. Project Emissions

Project Emissions Rates Used in Visibility Analysis

Pollutant	Emissions (TPY)
Particulates	2.81
NO_X as NO_2	88.13

TPY = tons per year

Figure 1



Visibility Assessment Approach

No specific requirements or criteria exist for assessing Class II visibility impacts in the PSD regulations. Therefore, the general approach used to assess visibility impacts of Class I areas within 50-km of a PSD project site were used. The *Federal Land Managers Air Quality Related Values Workgroup (FLAG) Phase I Report, Revised 2010* (FLM, 2010) guidance document for addressing Class I areas recommends the use of the U.S Environmental Protection Agency's (EPA) VISCREEN model to assess the change in color difference (ΔE) and contrast between the facility's plume and the viewing background. Therefore, procedures outlined in the *Workbook for Plume Visual Impact Screening and Analysis (Revised)* (EPA, 1992) to conduct a visibility assessment with VISCREEN at the nearby Class II areas were followed.

The VISCREEN model was developed to present a visual effect evaluation of emissions from a source as observed from a given vantage point on either a sky or terrain background. Emissions input into the model are assumed to travel along an infinitely long, straight line toward the specified area of concern. VISCREEN allows for the use of a tiered approach to assess a proposed source's impacts on visibility. A Tier I assessment utilizes conservative assumptions for both plume characteristics and dispersion conditions to determine if the plume would have an impact on visibility. If a Tier I assessment exceeds the FLAG guidance levels of concern for Class I areas of 2.0 for ΔE and 0.05 for contrast, then a refined Tier II assessment would be conducted. A Tier II assessment provides a more realistic representation of the meteorology and plume transport for a specific area to be analyzed.

Background visual ranges for the selected Class II areas were selected from the nearest Interagency Monitoring of Protected Visual Environments (IMPROVE) monitor shown in Figure 2 (Site ID: MAVI1) located approximately 40 kilometers Northeast of the Project. This data source was selected over the *Workbook for Plume Visual Impact Screening and Analysis (Revised)* (EPA, 1992) Figure 9 regional background visual range map due to the close proximity of the monitor to the analysis area and the recency of the data. Deciview data available at this monitor[1] ranges from February 2003 to December 2018, which is much more recent that the 1992 EPA Workbook (EPA, 1992). These monitored data were processed to calculate the average background visual range presented in Table 3.

Figure 2

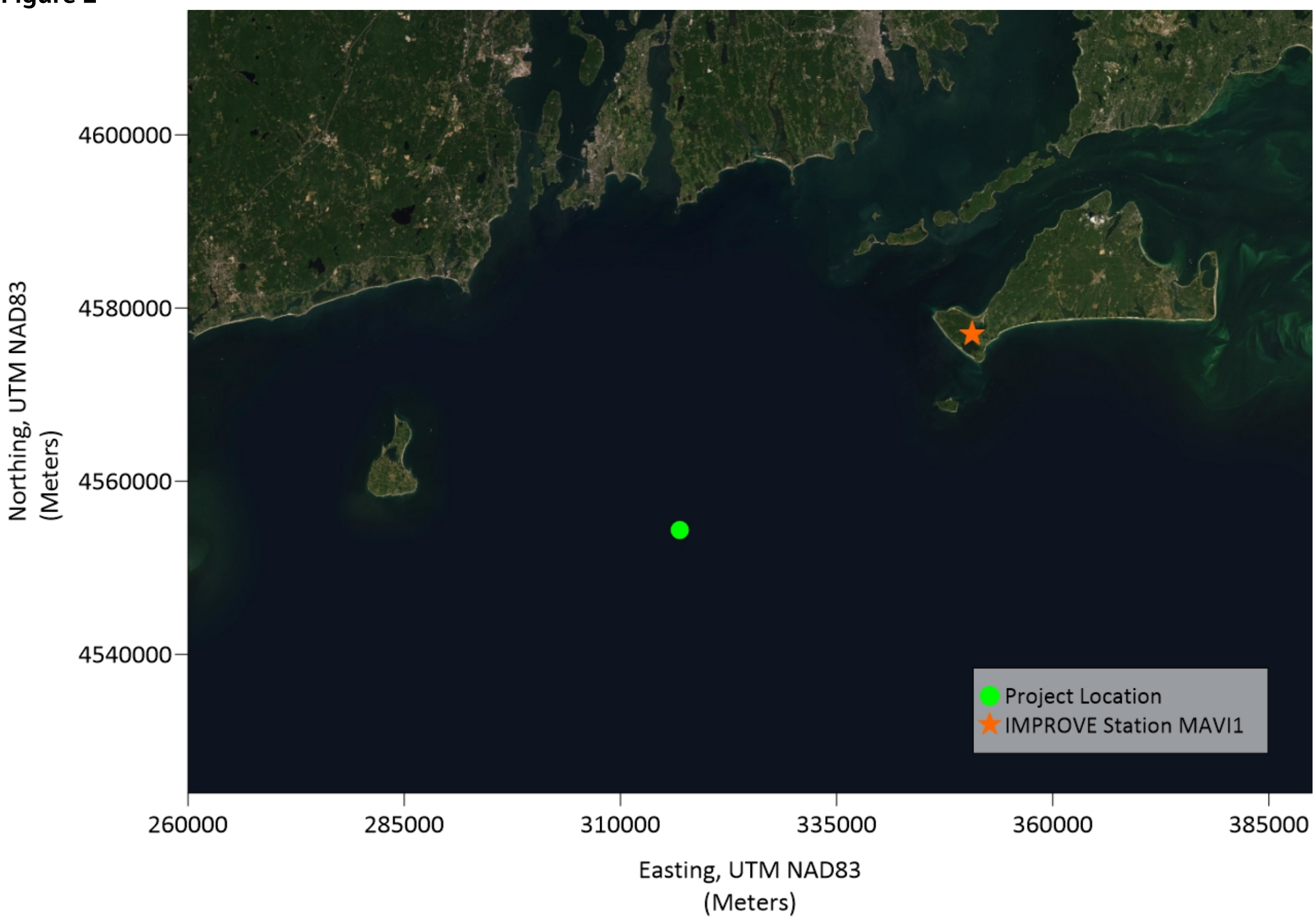


Table 3. Background Visual Range Data

Class II Area and Observer Distances for Visibility Analysis

	Monitored Deciview	b_{ext}	Visual Range (km)
max	38.4	465	8.39
min	1.9	12.0	324
average	15.9	49.2	79.3

Monitoring data from IMPACT monitor ID: MAVI1
b_{ext} = 10*exp(DV/10)
b_{ext} = K/V.R [V.R. in Mm] (K assumed as 3.9, typical for a human eye)
km = kilometers
Mm = mega meters

[1] http://vista.cira.colostate.edu/Improve/monitoring-site-browser/

Visibility Assessment Results

As shown in Table 4, the results of the Tier I assessment demonstrate that the Project does not exceed the significance criteria for ΔE and contrast at all analyzed observation points. As a result, additional analysis is not required to determine compliance of the Project with visibility requirements.

Despite operations of the Project not being consistent on a day-to-day basis in terms of emissions and location, this analysis is still conservative in its approach. The modeling analysis utilized worse-case meteorological conditions of a windspeed of 1 meter per second and stable atmospheric condition of F which only occurs during night hours (observation criteria do not apply during nighttime hours). Based upon the results of this analysis, a refined statistical analysis of daylight hour only meteorological conditions, daily emissions uncertainty, and background visibility range variation is not warranted.

Table 4. Tier I VISCREEN Results

Tier 1 VISCREEN Visibility Assessment Results for Class II Area Observation Points

Liberty Island Observation Point	Variable	Sky	Terrain	Criteria
Martha's Vineyard	Delta E	0.365	0.113	2
	Contrast	-0.002	0.001	|0.05|
Block Island	Delta E	0.430	0.154	2
	Contrast	-0.002	-0.001	|0.05|
Beavertail Lighthouse	Delta E	0.339	0.104	2
	Contrast	-0.001	0.001	|0.05|

References

U.S. Environmental Protection Agency (EPA). 1992. Workbook for Plume Visual Impact Screening and Analysis (EPA-454/R-92-023). October.

Federal Land Managers (FLM). 2010. *Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010), Natural Resource Report NPS/NRPC/NRR-2010/232*. October.

Appendix D
Request for Applicability of Class I Area Modeling Analysis Correspondence

Request for Applicability of Class I Area Modeling Analysis
Eastern Region, U.S. Forest Service

Facility Name (Company Name)	South Fork Wind LLC (SFW)
New Facility or Modification?	New
Source Type	Wind Turbine Farm Installation
Project Location (County/State/ Lat. & Long. in decimal degrees)	OCS Latitude 41.092° N, Longitude 71.162° W (OCA Massachusetts)

Application Contacts

Applicant		*Consultant*		*Air Agency Permit Engineer*	
Company	South Fork Wind LLC	**Company**	Jacobs	**Agency**	US EPA Region 1
Contact	Robert Soden	**Contact**	Darryl Chartrand	**Contact**	Patrick Bird
Address	56 Exchange Tower, Suite 300 Providence RI 02903	**Address**	120 St James Ave, 5th Floor Boston, MA 02116	**Address**	5 Post Office Square Mailcode OEP05-2 Boston MA 02109
Phone #	978-447-2958	**Phone #**	401-996-1851	**Phone #**	617-918-1287
Email	rodod@orsted.com	**Email**	Darryl.chartrand@jacobs.com	**Email**	Bird.patrick@epa.gov

Briefly Describe the Proposed Project

The South Fork Wind Farm (SFWF) includes up to 15 wind turbine generators (WTGs) with a nameplate capacity of 6 to 12 megawatts per turbine, submarine cables between the WTGs, and an offshore substation, all of which will be located within federal waters on the Outer Continental Shelf (OCS), specifically in Bureau of Ocean Energy Management Renewable Energy Lease Area OCS-A 0517 (Lease Area), approximately 19 miles (30.6 kilometers [km], 16.6 nautical miles [nm]) southeast of Block Island, Rhode Island, and 35 miles (56.3 km, 30.4 nm) east of Montauk Point, New York.

Proposed Emissions and BACT

Criteria Pollutant	***Proposed Emissions (tons/year)***	***Emission Factor (AP-42, Stack Test, Other?)***	***Proposed BACT***
Nitrogen Oxides	2399	AP-42	40 CFR 60 Subpart IIII, 40 CFR 60 Subpart JJJJ, 40 CFR 63 Subpart ZZZZ
Sulfur Dioxide	11.7	AP-42	40 CFR 60 Subpart IIII, 40 CFR 60 Subpart JJJJ, 40 CFR 63 Subpart ZZZZ
Particulate Matter	83.2	AP-42	40 CFR 60 Subpart IIII, 40 CFR 60 Subpart JJJJ, 40 CFR 63 Subpart ZZZZ
Volatile Organic Compounds	9.5	AP-42	40 CFR 60 Subpart IIII, 40 CFR 60 Subpart JJJJ, 40 CFR 63 Subpart ZZZZ
Sulfuric Acid Mist	0		

Proximity to U.S. Forest Service Class I Areas

Class I Area	Lye Brook Wilderness Area	Brigantine Wilderness Area	Presidential Range-Dry River Wilderness Area

For Additional Information or Questions, Contact Ralph Perron
(802) 222-1444 or rperron@fs.fed.us

Distance from Facility (km)	Approx 268 km	Approx. 316 km	Approx. 333 km

Contaminant emissions listed above are based on annualized expected worst-case 24-hour estimates and are based on sources that could emit simultaneously during Project construction. These emissions assume transit is from the Port of Providence, RI, the port likeliest to be used for construction. Project construction is expected to last one year only.

The sum of annualized maximum 24-hour emissions listed in the table above is 2503 tons/year and therefore Q/D is **9.3** at the closest Class I area: Lye Brook WA. The Q/D ratio for the Brigantine Wilderness Area is **7.9**.

At its closest point, the Lye Brook Wilderness Area is approximately 223 km away from the shoreline in a line connecting it with the approximate center of the SFWF work area and approximately 268 kilometers from the center of the SFWF work area. The Brigantine WA is approximately 316 kilometers away from the center of the WDA. The emissions will be released from low lying sources (cable installation, transit emissions, etc) and therefore contaminant transport to these Class I areas will be negligible. The Q/D value is less than 10 and this screening assessment is considered conservative.

Based on operations and maintenance phase, the Q/D factor is **1.9** at Lye Brook, based again on annualized worst-case 24-hour emissions associated with large scale turbine maintenance/repair. This activity is expected to occur only a few days during a year when it is required, which is only a few times over the lifetime of the Project (25-30 years).

Based on the information provided, SFW requests concurrence that no further assessment of Class I AQRVs are necessary.

From:	Chartrand, Darryl/TOR
To:	Perron, Ralph -FS
Cc:	Robert Soden
Subject:	Southfork Wind Farm - USFS request for determination - Lye Brook WA
Date:	Friday, September 18, 2020 1:00:00 PM
Attachments:	PSD Permit Request for Determination_Sep18_2020.doc

Dear Ralph

Jacobs, on behalf of South Fork Wind LLC is formally requesting a determination (see information attached) that there is no need to perform a Class I air quality related values analysis for the Lye Brook Wilderness Area in Vermont as part of the proposed Project's PSD permit application. The attached information was also sent to Tim Allen and Catherine Collins at the FWS.

Please let me know if you have any questions.

Best Regards
Darryl

Darryl Chartrand
Principal Air Quality Technologist
Jacobs
245 Consumers Rd
Toronto, Ontario, M2J 1R3
Office 416-499-0090 Ext 73642
Mobile 416-992-5759

From: Chartrand, Darryl/TOR
To: catherine_collins@fws.gov; tim_allen@fws.gov
Cc: Robert Soden
Subject: Southfork Wind Farm - FWS request for determination -Brigantine WA
Date: Friday, September 18, 2020 1:05:00 PM

Hello Tim and Catherine

Jacobs, on behalf of South Fork Wind LLC is formally requesting a determination (see information attached) that there is no need to perform a Class I air quality related values analysis for the Brigantine Wilderness Area in New Jersey as part of the proposed Project's PSD permit application. The attached information was also sent to Ralph Perron at USFS for Lye Brook.

Please let me know if you have any questions.

Best Regards
Darryl

Darryl Chartrand
Principal Air Quality Technologist
Jacobs
245 Consumers Rd
Toronto, Ontario, M2J 1R3
Office 416-499-0090 Ext 73642
Mobile 416-992-5759

From:	Perron, Ralph -FS
To:	Chartrand, Darryl/TOR
Cc:	Robert Soden
Subject:	[EXTERNAL] RE: Southfork Wind Farm - USFS request for determination - Lye Brook WA
Date:	Friday, September 25, 2020 1:22:07 PM
Attachments:	image001.png image002.png image003.png image004.png PSD Permit Request for Determination_Sep18_2020.doc

Hi Darryl,

Thank you for sharing this information with us for the proposed South Fork Wind LLC Wind Turbine Farm Installation, approximately 268 km from the Lye Brook Wilderness Area. Based on the annualized expected worst-case 24-hour emissions for Nitrogen Oxides (2399 tpy), Sulfur Dioxide (12 tpy), and Particulate Matter (83 tpy), from sources that could emit simultaneously during Project construction, which you discuss in the attached document, the US Forest Service will not be requesting AQRV analyses of this project.

Please keep us informed of any significant changes in this project, as well as any other proposal which may have an impact on the Lye Brook Class I area.

Ralph Perron
Air Quality Specialist
Forest Service
Eastern Region
p: 603-536-6228
c: 802-222-1444
ralph.perron@usda.gov
71 White Mountain Drive
Campton, NH 03223
www.fs.fed.us
Caring for the land and serving people

From: Chartrand, Darryl/TOR <Darryl.Chartrand@jacobs.com>
Sent: Friday, September 18, 2020 1:01 PM
To: Perron, Ralph -FS <ralph.perron@usda.gov>
Cc: Robert Soden <ROSOD@orsted.com>
Subject: Southfork Wind Farm - USFS request for determination - Lye Brook WA

Dear Ralph

Jacobs, on behalf of South Fork Wind LLC is formally requesting a determination (see information attached) that there is no need to perform a Class I air quality related values analysis for the Lye Brook Wilderness Area in Vermont as part of the proposed Project's PSD permit application. The attached information was also sent to Tim Allen and Catherine Collins at the FWS.

Please let me know if you have any questions.

Best Regards
Darryl

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Appendix E
Operations and Maintenance Emissions Modeling Protocol

South Fork Wind Farm

Outer Continental Shelf Permit – Air Quality Impact Modeling Protocol for Operations and Maintenance Emissions

Draft

August 2020

South Fork Wind Farm

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Acronyms and Abbreviations

μg/m^3	micrograms per cubic meter
bhp	brake horsepower
BOEM	Bureau of Ocean Energy Management
CFR	*Code of Federal Regulations*
CH_4	methane
CMR	Code of Massachusetts Regulations
CO	carbon monoxide
CO_2	carbon dioxide
COA	corresponding onshore area
EPA	U.S. Environmental Protection Agency
g/s	grams per second
hp	horsepower
km	kilometer
m	meter
MAAQS	Massachusetts Ambient Air Quality Standards
MERP	modeled emission rates for precursors
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
nm	nautical mile
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
O&M	operations and maintenance
OCD	offshore and coastal dispersion (model)
OCS	Outer Continental Shelf
OSS	offshore substation
$PM_{2.5}$	particulate matter less than 2.5 micrometers in aerodynamic diameter
PM_{10}	particulate matter less than 10 micrometers in aerodynamic diameter
Project	South Fork Wind Farm and South Fork Export Cable Project
ProvPort	Port of Providence
PSD	Prevention of Significant Deterioration
PTE	potential to emit
SFEC	South Fork Export Cable
SFEC-NYS	South Fork Export Cable in New York State territorial waters
SFEC-OCS	South Fork Export Cable in federal waters (Outer Continental Shelf)
SFEC-Onshore	terrestrial underground segment of the South Fork Export Cable
SFWF	South Fork Wind Farm

SIL	Significant Impact Level
SO_2	sulfur dioxide
SO_x	sulfur oxide
tpy	tons per year
VOC	volatile organic compound
WDA	Wind Development Area
WTG	wind turbine generator

1. Introduction

The South Fork Wind Farm (SFWF) includes up to 15 wind turbine generators (WTGs), with a nameplate capacity of 6 to 12 megawatts per WTG, submarine cables between the WTGs (inter-array cables), and an offshore substation (OSS), all of which will be located within federal waters on the Outer Continental Shelf (OCS), specifically in the Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A 0517,[1] approximately 19 miles (30.6 kilometers [km], 16.6 nautical miles [nm]) southeast of Block Island, Rhode Island, and 35 miles (56.3 km, 30.4 nm) east of Montauk Point, New York. The SFWF also includes an operations and maintenance (O&M) facility that will be located onshore at either Montauk in East Hampton, New York or Quonset Point in North Kingstown, Rhode Island (DWSF, 2018, 2019a, 2019b).

The South Fork Export Cable (SFEC) is an alternating current electric cable that will connect the SFWF to the existing mainland electric grid in East Hampton, New York. The SFEC includes both offshore and onshore segments. Offshore, the SFEC will be in federal waters (SFEC-OCS) and New York State territorial waters (SFEC-NYS) and be buried to a target depth of 4 to 6 feet (1.2 to 1.8 meters [m]) in the seabed. Onshore, the onshore underground segment of the export cable (SFEC-Onshore) will be located in East Hampton, New York. The SFEC-NYS will be connected to the SFEC-Onshore via the sea-to-shore transition where the offshore and onshore cables will be spliced together. The SFEC also includes a new interconnection facility where the SFEC will connect with the Long Island Power Authority electric transmission and distribution system in East Hampton, New York (DWSF, 2018, 2019a, 2019b). Figure 1 indicates the locations of the SFWF and SFEC, together referred to as the Project.

Jacobs Engineering Group Inc. (Jacobs) has been retained by Deepwater Wind South Fork LLC (DWSF) to prepare an air modeling report in support of an OCS air permit application for the Project to fulfill the regulatory requirements of the U.S. Environmental Protection Agency's (EPA's) OCS Air Regulations, as specified in Title 40 *Code of Federal Regulations* (CFR) Part 55. This protocol addresses the proposed methodology to quantify impacts from air emissions of O&M activities as required by relevant regulations.

DWSF will submit an OCS permit application that will follow Prevention of Significant Deterioration (PSD) permit requirements. DWSF had previously submitted an air quality modeling protocol, and approval was received, in September 2019 that described the methodology to be used for determination of impacts from Project construction emissions at the nearest Class I areas. Revisions to that protocol have been made and submitted to EPA as a separate document. This protocol and the protocol addressing construction emission impacts describe the air quality modeling analysis to be performed as part of the EPA OCS Air Permit application. The purpose of this modeling analysis is to demonstrate that the proposed project will not violate the National Ambient Air Quality Standards (NAAQS), PSD increments, and other applicable federal and state regulations. The NAAQS and Class II PSD increment modeling is applicable to Project emissions resulting from O&M activities.

This protocol defines the sources and scenarios to be modeled, provides current preliminary emissions estimates (final estimates will be provided in the application), and describes the modeling technique DWSF proposes to utilize to quantify these emission impacts. Once EPA approves this protocol, DWSF will use it to guide the additional air quality impact required modeling for the project.

Installation of the proposed WTGs will involve emission sources located on the OCS; therefore, the applications will be made under the OCS permitting rules (40 CFR 55). It is anticipated that potential construction emissions from the Project will exceed the 250-ton-per-year (tpy) PSD major source review threshold. Thus, the source will be classified as a PSD major stationary source. Because some of the Project will be within 25 miles (40.2 km, 21.7 nm) of the several state's seaward boundaries, the Section 55.14 corresponding onshore area (COA) rules will apply to construction and O&M with these areas. It is expected that Massachusetts will be designated as the COA for this project. For emissions

---

[1] The leaseholder of Renewable Energy Lease Area OCS-A 0517 is DWSF.

outside the 25-mile distance from the Massachusetts seaward boundary, the 40 CFR 71 permitting requirements apply; for emissions within the 25-mile distance, both 40 CFR 71 and Massachusetts air permitting rules apply. Additional discussion of the Project location is presented in Section 1.1.

During O&M, the Project's OCS sources will include compression-ignition (and possibly spark ignition) engines on various support and transport vessels, engines to supply power, jack-up vessels (while their legs are attached to the seafloor), and an emergency diesel generator on the OSS. The emergency generator will only operate during emergencies and for reliability testing. Jack-up vessels during O&M will be used infrequently for major repairs to the WTGs or OSS. During O&M, if smaller crew and supply vessels (e.g. crew transport vessels) tether to a jack-up barge or use the docking structures on WTGs and OSS, those vessels' stationary source aspects would be regulated as OCS sources. Engines on vessels that anchor within the Wind Development Area (WDA) during O&M, if any, would also become OCS sources. However, no vessels are anticipated to anchor, jack-up, or tether to an OCS source along the South Fork Export Cable (SFEC) during O&M. Therefore, during O&M, no OCS sources are expected to exist along the SFEC. As a result, the modeling analysis for O&M activities will only address activities associated with OCS sources in the WDA.

OCS sources used during decommissioning are not considered in this protocol as decommissioning will occur 25 to 30 years after the commencement of operation. A separate OCS Air Permit will likely be sought for decommissioning activities at that time.

1.1 Project Location

The SFWF will be located within federal waters on the OCS, specifically in the BOEM Renewable Energy Lease Area OCS-A 0517, approximately 19 miles (30.6 km, 16.6 nm) southeast of Block Island, Rhode Island, and 35 miles (56.3 km, 30.4 nm) east of Montauk Point, New York.

The approximate location of the entire Project is shown on Figures 1 and 2. The OCS area shown on Figure 2 is consistent with the OCS area shown in the protocol for construction emission impacts. As mentioned above, no OCS sources during O&M activities are expected to exist along the SFEC route. However, emissions are determined according to the OCS source layout shown on Figure 2.

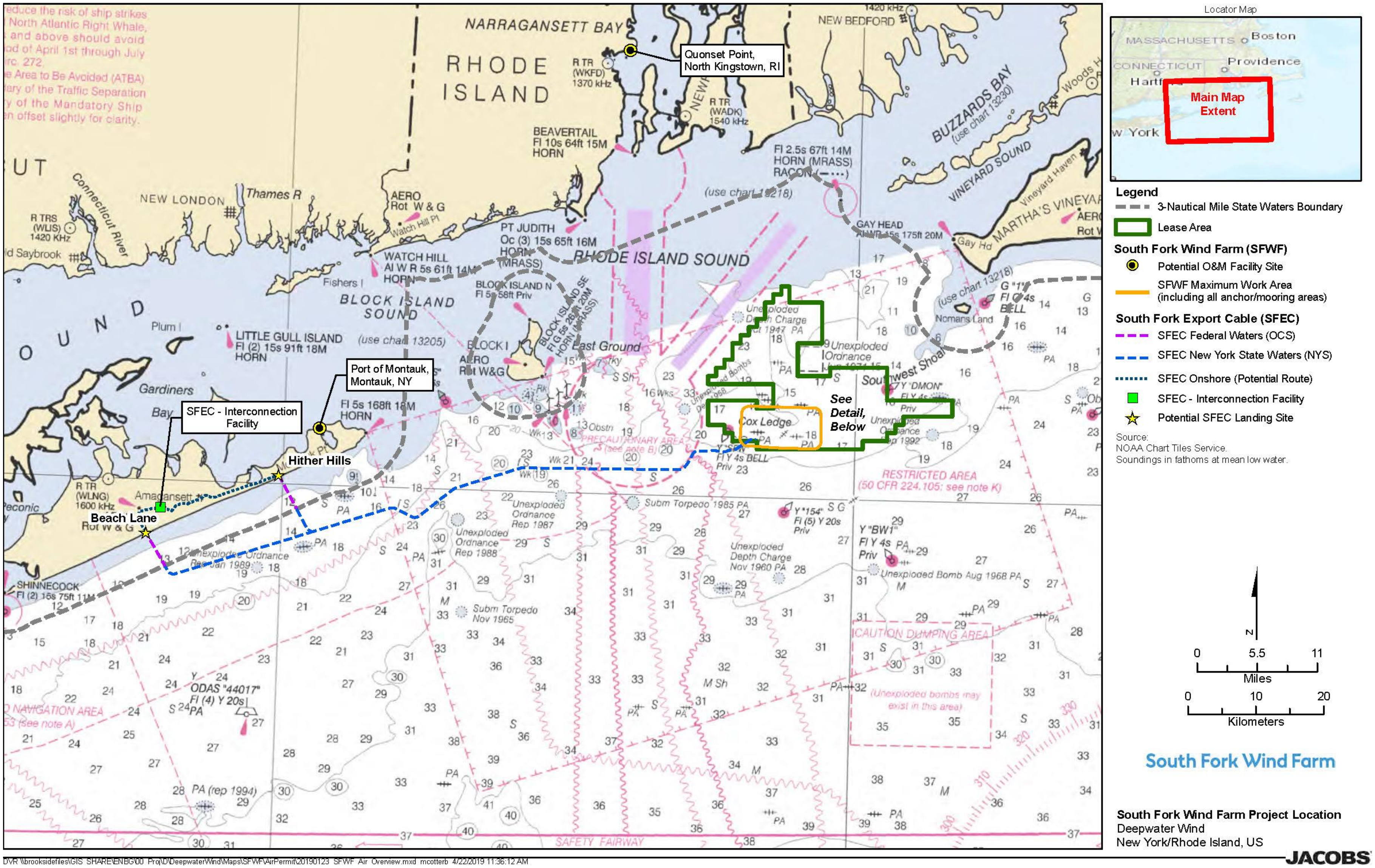

Figure 1. South Fork Wind Farm and South Fork Export Cable Location Plot

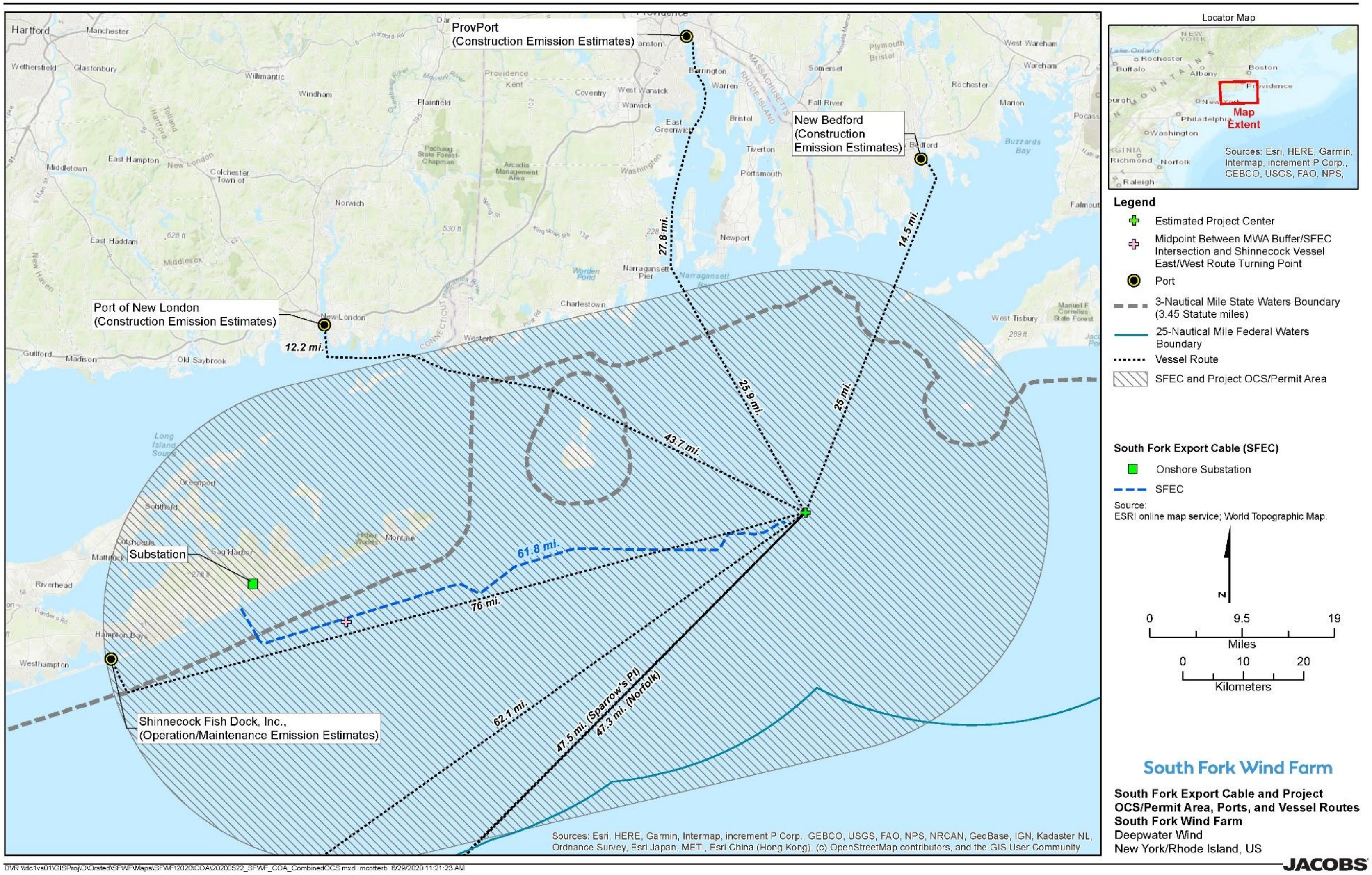

Figure 2. Distances from South Fork Wind Farm Centroid to Close Proximity Ports considered for the Air Emissions Inventory

1.2 Project Description

The SFWF includes the following components, all of which are located on the OCS within the area of Renewable Energy Lease Number OCS-A 0517:

- Up to 15 WTGs and associated foundations
- One OSS, constructed on similar foundation as the WTG
- Inter-array cables connecting the WTGs and the offshore substation

The SFEC is an alternating current electric cable that will connect the SFWF to the existing mainland electric grid in East Hampton, New York and contains the following components:

- An offshore cable buried to a target depth of 4 to 6 feet (1.2 to 1.8 meters [m]) in the seabed.
- An onshore underground segment of the export cable will be located in East Hampton, New York.
- A sea-to-shore transition where the offshore and onshore cables will be spliced together.
- A new interconnection facility where the SFEC will connect with the Long Island Power Authority electric transmission and distribution system in East Hampton, New York (DWSF, 2018, 2019a, 2019b).

Ports at the following locations are anticipated to be used to support the various O&M activities.

- New Bedford, Massachusetts
- Port of Providence (ProvPort), Rhode Island
- Quonset, Rhode Island
- Port of New London, Connecticut
- Shinnecock Fish Dock, New York

It is not known how the vessel traffic will be allocated at this time, as different vessels may originate from different points depending on several logistical factors.

Three additional ports may be used, but only sparingly, if at all:

- Sparrow Point, Maryland
- Paulsboro Marine Terminal, New Jersey
- Norfolk, Virginia

The transit routes modeled as part of this analysis, and the rationale are discussed further in Section 3.8.

1.3 Emission Sources During Routine Operations and Maintenance

The Project's air emissions sources are mostly due to combustion engines used to power vessels or equipment on vessels during O&M at the Project's offshore sites. There is a continuous evolution of wind turbine technologies as well as construction techniques and methods for the turbines, cables, and auxiliary equipment. As BOEM recognized in its National Offshore Wind Strategy, the "Envelope" concept allows for project optimization after permitting is complete while ensuring a comprehensive review of the project by regulators and stakeholders. Through the "Envelope" concept, DWSF is defining and bracketing Project characteristics for environmental review while maintaining a reasonable degree of flexibility regarding final design and construction and O&M logistics. For all modeled activities, DWSF has identified the most likely and yet conservative scenario where multiple options/vessel profiles exist. Additionally, DWSF has provided estimates of source parameters (exit velocity, stack diameter, stack exit temperature) for the types of ships that may be used for the activities described below. This general modeling conservatism is consistent with the "Envelope" concept and allows for a demonstration of compliance with the applicable standards. Final construction, operation, and maintenance methods may differ as the Project is optimized.

Emission sources during O&M that are subject to the OCS Air Permit will include:

- Crew transport vessels (CTV)
- Feeder barge vessels
- Jack-up crane barges
- Generators used for site power
- Emergency generator (OSS only)

The OSS may contain a 268 brake horsepower (bhp) (or 200 kw) diesel emergency generator to provide backup power to critical systems if the Project's offshore cable system fails. This emergency generator will only operate for emergencies and less than 200 hours per year of reliability testing, anticipated to be 30 minutes per month each.

During work tasks at the WDA, there may be a need for a generator located at the site to power equipment to be used. For modeling purposes, it was assumed that a generator similar in size to the OSS emergency generator was used.

During routine daily O&M, the WTGs and offshore substation will be routinely inspected. In addition, proactive replacement of parts and other preventative maintenance will be conducted. For routine O&M, one crew transport vessel will frequently transport crew to the WDA for inspections, routine maintenance, and minor repairs. A second CTV may be necessary depending on the nature of the work required. Other larger support and work vessels, such as feeder barges and jack-up barges, may be used infrequently for some routine operations, maintenance, and repairs. When these vessels are within the defined OCS area, their air emissions are included in the Project's potential emissions.

Similar to the activities during construction, O&M activities are subject to change based on operational needs. Therefore, the modeling represents operational activities that are reasonably expected to occur simultaneously and represent a conservative estimate of O&M emissions and impacts. The operational scenarios modeled are described in Section 3.4.

The remainder of this protocol is organized in three additional sections. Section 2 describes the federal air quality regulations applicable to the modeling analysis and presents the applicable air quality standards. Section 3 describes background air quality data and the proposed air quality modeling methodology for the compliance demonstration. Section 4 provides the references used in this protocol.

2. Regulatory Requirements

Section 328(a) of the Clean Air Act requires that EPA establish air pollution control requirements for OCS sources located within 25 miles of states' seaward boundaries that are the same as onshore requirements. This includes state and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and reporting.

OCS sources located within 25 miles of a States' seaward boundaries are subject to the federal requirements set forth in 40 CFR 55.13 and the federal, state, and local requirements of the COA set forth in 40 CFR 55.14. As the designated COA, the Project will be subject to the applicable requirements of the most current Commonwealth of Massachusetts air regulations (310 Code of Massachusetts Regulations [CMR] 6.00 - 8.00).

2.1 Prevention of Significant Deterioration Review

The PSD program, as set forth in 40 CFR 52.21 is incorporated by reference into the OCS Air Regulations 40 CFR 55.13(d). PSD applies to OCS sources located within 25 miles of Massachusetts (the COA) seaward boundary per 40 CFR 52, Subpart W. The PSD program applies to new major sources of criteria pollutants or major modifications to existing sources in areas designated as being in attainment with or unclassifiable with the ambient air quality standards. The SFWF project is considered "major" since it emits or has a potential to emit (PTE) of 250 tons per year (tpy) or more of a regulated New Source Review pollutant per 40 CFR 52.21.

"Potential to emit" is defined as the maximum capacity of a source to emit a pollutant under its operational design. 40 CFR 55 defines "potential emissions" from OCS sources similarly. The broad definition of "OCS source" provided in the OCS Air Regulations requires that certain emissions associated with construction equipment and vessels are to be included in the "potential to emit" of an OCS source for PSD review. The Project's potential air emissions during construction exceed the 250 tpy PSD threshold; therefore, the Project is subject to PSD review.

Table 1 presents a PSD major source threshold analysis for the Project for those pollutants with applicable PSD emission criteria. The emissions were determined from the construction phase of the Project, which has the higher of the potential annual emissions when compared to O&M. Though the construction may take one or two years to complete, the total construction emissions are aggregated into a single year to provide DWSF flexibility during Project buildout.

Table 1. Prevention of Significant Deterioration Regulatory Threshold Evaluation

Pollutant	Project Annual Emissions[a] (tpy)	PSD Significant Emission Rate (tpy)	PSD Review Applies
NO_x	477.6	40	Yes
VOCs (ozone precursor)	10.5	40	No
CO	72.8	100	No
SO_2	3.2	40	No
PM_{10}	16.0	15	Yes
$PM_{2.5}$	15.4	10	Yes
Lead	0.002	0.6	No
GHGs (as CO_2e)	31,385	75,000	No
Sulfuric Acid Mist	None expected	7	No

Table 1. Prevention of Significant Deterioration Regulatory Threshold Evaluation

Pollutant	Project Annual Emissions[a] (tpy)	PSD Significant Emission Rate (tpy)	PSD Review Applies
Hydrogen Sulfide	None expected	10	No
Total reduced sulfur	None expected	10	No
Reduced sulfur compounds	None expected	10	No

[a] Emissions determined with New London as Port of Call.

CO = carbon monoxide

CO_2e = carbon dioxide equivalent

GHG = greenhouse gas

NO_x = nitrogen oxides

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound(s)

A PSD permit application must show that emissions from construction or operation of a source will not cause or contribute to exceedances in applicable air quality standards.

2.2 Ambient Air Quality Standards

There are two applicable sets of ambient air quality standards for this project, NAAQS and PSD increments. Table 2 list the applicable standards for seven criteria air contaminants.

The NAAQS primary standards are intended to protect human health while secondary standards are intended to protect public welfare from anticipated adverse effects associated with the presence of air pollutants. NAAQS have been developed for various averaging periods corresponding to durations of exposure.

PSD increments are the maximum allowable increase in concentration that is acceptable above a baseline concentration for a pollutant. EPA has established increment standards for nitrogen dioxide (NO_2), PM_{10}, and $PM_{2.5}$, which are relevant to this project. The PSD increment for $PM_{2.5}$ is tracked on a county-wide basis in Massachusetts and PM_{10} and NO_2 are tracked at the municipality level. The PSD regulations define “minor source baseline date” in 40 CFR 52.21(b)(14)(ii) as “the earliest date after the trigger date on which… a major modification subject to 40 CFR 52.21…submits a complete application”.

Class I increments are intended to be protective of Class I areas and are discussed in the modeling protocol submitted to EPA by DWSF to assess construction emissions. Class II areas comprise most of the United States and only Class II air quality standards are discussed in this protocol.

Table 2. National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$) Primary	NAAQS ($\mu g/m^3$) Secondary	Class II PSD Increments ($\mu g/m^3$)
CO	1-Hour	40,000[a]	Same	None
	8-Hour	10,000[a]	Same	None
Lead	Rolling 3-month average	0.15[b]	Same	None
NO_2	1-Hour	188[c]	None	None
	Annual	100[d]	Same	25[b]
Ozone	8-Hour	137.4[e]	Same	None
$PM_{2.5}$	24-Hour	35[f]	Same	9[a]
	Annual	12[g]	15[g]	4[b]
PM_{10}	24-Hour	150[a]	Same	30[a]
	Annual	None	None	17[a]
SO_2	1-Hour	196.0[h]	None	None
	3-Hour	None	1,310[a]	512[a]
	24-Hour	None	None	91[a]
	Annual	None	None	20[b]

[a] Not to be exceeded more than once per year

[b] Not to be exceeded

[c] 98th percentile of 1-hour daily maximum concentrations averaged over 3 years

[d] Annual mean

[e] Annual fourth-highest daily maximum ozone concentration, averaged over 3 years

[f] 98th percentile, averaged over 3 years

[g] Annual mean, averaged over 3 years

[h] 99th percentile of 1-hour daily maximum concentrations averaged over 3 years

$\mu g/m^3$ = micrograms per cubic meter

In order to facilitate this analysis, EPA historically has relied upon Significant Impact Levels (SILs) that represent thresholds of insignificant modeled source impacts. EPA has recommended specific SILs for comparison to the NAAQS and a separate set of recommended SILs for comparison to the PSD increment. Table 3 summarizes the Class II increments SILs.

As the Project also triggers Nonattainment New Source Review for ozone, the Project triggers a requirement for NO_x off-sets, therefore no modeling is required for ozone. The Project does not trigger PSD review for SO_2.

Exceeding the PSD increment SIL would require the Project to perform a cumulative source analysis that would account for any sources that have consumed the PSD increment within the significant impact area since the baseline date, if any. The recommended Class II SILs proposed for use in the Project are in Table 3, including the recommended SILs for NAAQS.

Table 3. National Ambient Air Quality Standards and Class II Prevention of Significant Deterioration Increment Significant Impact Levels

Pollutant	Averaging Period	Recommended SIL for NAAQS Analyses ($\mu g/m^3$)	Class II PSD SIL Increments ($\mu g/m^3$)
CO	1-Hour	2,000a	2,000a
	8-Hour	500a	500a
Lead	Rolling 3-Month	None	None
NO_2	1-Hour	7.5[b]	None
	Annual	1	1[a]
Ozone	8-Hour	1.96[c]	None
$PM_{2.5}$	24-Hour	1.2[d]	1.2[d]
	Annual	0.2[e]	0.2[e]
PM_{10}	24-Hour	5[a]	5[a]
	Annual	1[a]	1[a]
SO_2	1-Hour	7.8[b]	None
	3-Hour	None	25[a]
	24-Hour	None	5[a]
	Annual	None	1[a]

[a] Concentration not to be exceeded

[b] Highest 1-hour modeled concentration averaged over 5 years

[c] Annual 4th highest daily maximum 8-hour concentration averaged over 5 years

[d] Highest 24-hour modeled concentration averaged over 5 years

[e] Highest annual modeled concentration averaged over 5 years

2.3 Ambient Air Quality Analysis for Operations and Maintenance Activities

Operations and maintenance emissions from the Project will be much lower than emissions during construction. As the Project will be assessed under PSD requirements for NO_x, PM_{10}, and $PM_{2.5}$, the Project will require an ambient air quality analysis that demonstrates compliance with the SILs, NAAQS, and PSD increments through air quality dispersion modeling for the operational period only.

Annual emission estimates for criteria pollutants during O&M appear in Table 4. During O&M, OCS sources are only expected to be located within the WDA. There will not be any OCS sources located along the SFEC during the Project's operational period.

Table 4. Emissions During Operations and Maintenance

	OCS Air Permit Emissions[a]					
	NO_X	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2
Annual Emissions (tpy)	27.2	0.5	5.4	0.9	0.9	0.1

[a] Assumes one Crew Transport from Shinnecock, New York, and other vessel transport from New London, Connecticut.

2.4 Significant Impact Levels

A preliminary analysis will be performed in order to determine if the source will have a "significant impact" on air pollutant concentrations and establish whether a NAAQS or PSD increment modeling analysis will be necessary. The SILs were previously reported in Table 3. Modeling will be done for a worst-case O&M scenario that is envisaged by DWSF over the lifetime of the Project. These operational scenarios are described further in Section 3.4.

The Project will also need to address impacts of direct $PM_{2.5}$ emissions and/or $PM_{2.5}$ precursor emissions using the approach described in Section 2.5.

2.5 Secondary Particulate Formation

Additional particulate matter can form due to primary emissions of sulfur oxide (SO_x) and NO_x from a source and subsequent conversion into condensed phase nitrates and sulfates. This secondary particulate matter formation will be accounted for in the modeling using a method consistent with the EPA guidance found in *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* (EPA, 2019). Both primary and secondary impacts of $PM_{2.5}$ were accounted for using the Offshore and Coastal Dispersion (OCD) model and the draft MERP guidance for both NO_x and SO_x emissions.

EPA has developed guidance centered on using the MERPs approach as a Tier 1 screening approach (EPA, 2019). The Project will rely upon the most conservative (lowest) illustrative MERP values (in tpy) by precursor presented for two hypothetical sources in the northeastern United States. These are the same sources to be used for the construction emission secondary impact assessment. The higher of the two secondary impacts as summarized in Table 5 will be used for the analysis. Annual operational emissions for the Project are 27.2 tpy of NO_x and 0.09 tpy of SO_2.

Table 5. Summary of Secondary Particulate Formation for Daily and Annual Maximum Sulfur Oxide and Nitrogen Oxide Emissions from Hypothetical Sources 3 (Norfolk) and 4 (Franklin)

Source	OCS O&M Emission Rate (tpy)	Norfolk – Maximum Added Secondary Particulate at 500 tpy (µg/m^3)	Franklin – Maximum Added Secondary Particulate at 500 tpy (µg/m^3)	Contribution to secondary $PM_{2.5}$ Concentration (µg/m^3) from SFWF OCS Sources	Total Secondary Contribution (µg/m^3)	Percentage of Class II $PM_{2.5}$ SIL
Daily SO_x	0.09	**0.137262**	0.105416	2.5E-5	1.75E-3	0.15% of 1.2
Daily NO_x	27.2	0.030532	**0.031641**	1.7E-3		
Annual SO_x	0.09	**0.004964**	0.004214	9E-7	1.1E-4	<0.1% of 0.2
Annual NO_x	27.2	0.00128	**0.002076**	1.1E-4		

Source: EPA 2020a.

For $PM_{2.5}$ the direct and secondary impacts will be added together to compare to the SIL, if impacts are greater than the SIL, a NAAQS and/or PSD increment analysis will be completed for $PM_{2.5}$.

2.6 National Ambient Air Quality Standards Assessment

If impacts from the Project's operational emissions are above the SILs for the NAAQS, a comparison will be done to the NAAQS as listed in Table 2. As part of the modeling analysis, background concentrations from a representative monitor will be added to the modeling results to compare against the NAAQS. The background data proposed for this analysis are described in Section 3.1 and Table 8. NAAQS comparisons will be done for the worst-case operational scenario discussed in Section 3.2.

If $PM_{2.5}$ is greater than the SIL, the direct $PM_{2.5}$ Project emissions will be modeled using OCD. Secondary impacts would be accounted for using the MERP approach described in Section 2.5 along with background concentrations for comparison to the $PM_{2.5}$ NAAQS.

2.7 Prevention of Significant Deterioration Increment Assessment

If impacts from the Project's operational emissions are above the Class II SILs, the PSD increment consumption will be modeled. The specific Class II PSD increments are included in Table 2. A cumulative modeling assessment would typically include additional sources in the PSD increment analysis to reflect changes made since the minor source baseline date. However, if the minor source baseline date has not been triggered for any of the pollutants of concern, no other sources will consume increment, and only Project emission sources would consume increment in the area of the WDA.

2.8 Cumulative Source Modeling

If impacts from the Project's operational emissions are above the PSD Class II SILs, cumulative source modeling will not be performed if the significant impact area does not extend beyond 50 km and only the Project's operational impacts will be considered against the PSD Class II increments.

If impacts from the Project's operational emissions are above the NAAQS SILs, cumulative source modeling may be necessary. The 50 km modeling domain comprises mainly overwater locations, with the domain encompassing Block Island the west northwest and the southwest tip of Martha's Vineyard to the northeast. Review of Operating Permits issued by the Massachusetts Department of Environmental Protection reveals that no major sources exist in the 50 km modeling domain and therefore no additional on-land sources will be included in the NAAQS assessment, as necessary.

Vineyard Wind has submitted an OCS permit application to EPA in 2019 for a WDA southeast of the SFWF WDA. The center of Vineyard WDA is more than 50 km from the approximate center of the SFWF WDA. Additionally, it is unlikely that the O&M scenario resulting in worst-case emissions for both Projects (turbine repairs requiring jack-up barges) would occur simultaneously. Therefore, it is not proposed that Vineyard Wind O&M emissions be included in SFWF's cumulative assessment, if necessary.

Any other major sources in the region overland within 50 km of the WDA are already included in the background air quality monitoring data being proposed for the NAAQS analysis. Further, these overland background concentrations are likely conservative estimates of contaminant concentrations overwater in the vicinity of the SFWF WDA.

2.9 Class II Air Quality Related Values Assessments

2.9.1 Visibility

The Lye Brook Wilderness Area in southern Vermont is the closest Class I area to the WDA. Lye Brook is located approximately 270 km to the northwest of the Project WDA. A Q/D (where Q is the sum worst-case annual emissions of NO_x, SO_2, sulfuric acid mist, and PM_{10} in tons; and D is the distance from the WDA to the Class I area in km) screening analysis will be done to confirm that this screening value is less than 10 and therefore not likely to impact visibility or any other air quality related values at the Class I area. Based on preliminary emissions and distance to the nearest Class I location, it is not expected that impacts from the Project will have an adverse effect on visibility in the Class I area.

A screening visibility analysis will be conducted for Class II vistas using the EPA VISCREEN model. The assessment will likely include assumed vistas to and from Block Island and Martha's Vineyard, with the emissions from the WDA O&M emissions plume perpendicular to this potential vista.

2.9.2 Soils and Vegetation

PSD regulations require analysis of air quality impacts on sensitive vegetation types with significant commercial or recreational value or sensitive types of soil. Evaluation of impacts on sensitive vegetation will be performed by comparison of predicted Project impacts with screening levels presented in *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals* (EPA, 1980). These procedures specify that predicted impact concentrations used for comparison account for Project impacts and ambient background concentrations.

Most of the designated vegetation screening levels are equivalent to or exceed NAAQS and/or PSD increments, so that satisfaction of NAAQS and PSD increments assures compliance with sensitive vegetation screening levels.

2.9.3 Growth

The Project must assess the impact of emissions from secondary growth during O&M. This assessment is described further in Section 3.11.

2.10 State Requirements

OCS sources located within the Offshore Project Area are subject to the federal, state, and local requirements of the COA set forth in 40 CFR 55.14. In the Project's Notice of Intent (NOI), DWSF identified Massachusetts as the COA for the Project Area since EPA did not receive a request from any neighboring state's air pollution control agencies to be designated as the COA within 60 days.

The relevant Massachusetts regulations on air modeling center on documenting that the Massachusetts Ambient Air Quality Standards (MAAQS) are not being violated. MAAQS are codified in 310 CMR 6.00 and generally follow the NAAQS but have not yet been updated to reflect the EPA's recent revisions to some of the NAAQS. The MAAQS are described in Table 6.

Table 6. Massachusetts Ambient Air Quality Standards

Pollutant	Averaging Period	MAAQS ($\mu g/m^3$)	
		Primary	Secondary
NO_2	Annual[a]	100	100
	1-hour	None	None
SO_2	Annual[a]	80	None
	24-hour[b]	365	None
	3-hour[b]	None	1300
	1-hour	None	None
$PM_{2.5}$	Annual	None	None
	24-hour	None	None
PM_{10}	Annual	50	50
	24-hour[b]	150	150
CO	8-hour[b]	10,000	10,000
	1-hour[b]	40,000	40,000
Ozone	1-hour[b]	240	240
Lead	3-month[a]	1.5	1.5

[a] Not to be exceeded

[b] Not to be exceeded more than once per year.

2.11 Summary of Modeling Requirements

Table 7 describes the various modeling requirements applicable to the Project's emissions during construction and O&M.

Table 7. Summary of Modeling Requirements

Modeling Requirement	Temporary Construction Emissions		O&M Emissions
	WDA	Export Cable	
PSD Class I SIL Analysis (at 50 km)	Yes	Yes	No
Secondary Formation of $PM_{2.5}$	Yes	Yes	Yes
Ozone Analysis	No	No	No
SIL Analysis for NAAQS and PSD Class II Areas	No	No	Yes
NAAQS Cumulative Source Modeling	No	No	If necessary
PSD Increment Analysis	No	No	If necessary
Visibility Assessment	No	No	Yes
Soils and Vegetation	No	No	Yes
Growth	No	No	Yes

3. Air Quality Impact Analysis

The air quality analysis of Project emissions during the O&M phase are discussed in this section. Impacts of criteria emissions will be modeled for comparison to ambient air quality standards discussed in Section 2.

The dispersion modeling analysis is separated into two distinct components (EPA, 1990)

1) the preliminary (SIL) analysis, and
2) a full impact analysis (NAAQS and PSD increment).

In the preliminary analysis, the emissions of a pollutant from the O&M activities are modeled. The results of this analysis are used to determine which criteria pollutants require a full impact analysis; and which receptors are to be included in the cumulative analysis (as necessary). If the results of the preliminary analysis indicate the emissions from the anticipated O&M activities and resulting emissions will not increase ambient concentrations by more than pollutant-specific SILs (see Table 3), no further modeling is required.

3.1 Background Air Quality Data

If impacts are greater than the SIL, modeled concentrations due to emissions from the Project will be added to ambient background concentrations to obtain total concentration impacts at receptors. These total concentrations will be compared to the NAAQS and MAAQS. To estimate background pollutant levels representative of the area, the most recent air quality monitor data available via the EPA website were used (EPA 2020b).

Background concentrations were determined from the closest and most representative monitoring stations to the SFWF. The most representative monitoring site for $PM_{2.5}$ is also the closest monitoring site, which is located at the EPA Laboratory in Narragansett, Rhode Island, approximately 42 km from the SFWF. The most representative monitoring site for CO is in East Providence, Rhode Island at the Francis School, approximately 78.4 km from the SFWF. The most representative monitoring site for NO_2 is located in Providence, Rhode Island near Hayes and Park Street School, approximately 77.8 km from the SFWF. The most representative monitoring station for PM_{10} is located at the Community College of Rhode Island Liston Campus rooftop in Providence, Rhode Island, approximately 75.4 km from the SFWF. The most representative monitoring station for SO_2 is located in Fall River, Massachusetts, approximately 61 km from the SFWF.

Given the rural environment of the SFWF, utilization of these predominantly urban and suburban monitoring locations for the background concentrations are anticipated to be conservative in nature. A summary of the background air quality concentrations based on the 2017-2019 data are presented in Table 8.

Table 8. Observed Ambient Air Quality Concentrations and Selected Background Levels

Pollutant	Averaging Period	2017	2018	2019	Background Level	NAAQS/ MAAQS
CO (µg/m^3)	1-Hour[a]	1,501	1,438	1,803	1,803	40,000
	8-Hour[a]	1,031	917	1,031	1,031	10,000
NO_2 (µg/m^3)	1-Hour[b]	93.3	93.0	98.6	95.0	188
	Annual[c]	34.0	32.4	32.6	34.0	100
PM_{10} (µg/m^3)	24-Hour[d]	26.0	23.0	23.0	26.0	150
	Annual[e]	11.0	11.0	10.3	11.0	50

Table 8. Observed Ambient Air Quality Concentrations and Selected Background Levels

Pollutant	Averaging Period	2017	2018	2019	Background Level	NAAQS/ MAAQS
$PM_{2.5}$ (µg/m^3)	24-Hour[f]	13.1	16.8	12.8	14.2	35
	Annual[g]	5.1	5.4	3.9	4.8	12
SO_2 (µg/m^3)	1-Hour[h]	29.3	10.0	7.9	15.7	196
	3-Hour[i]	23.3	8.9	7.1	23.3	1,300
	24-hour[d]	12.2	3.9	3.3	12.2	365
	Annual[e]	3.4	2.8	2.2	3.4	80

Note: Conversion factors of 1 part per million = 2,620 µg/m^3 SO_2; = 1,146 µg/m^3 CO; and =1,882 µg/m^3 NO_2 used.

Source: EPA 2020b.

[a] Background level for 1-hour CO and 8-hour CO is the highest-second-high value.

[b] Background level for 1-hour NO_2 is the average concentration of the 98th percentile over 3 years.

[c] Background level for Annual NO_2 is the highest concentration of 3 years.

[d] Background level for 24-hour PM_{10} and SO_2 is the highest-second-high value.

[e] Background level for annual PM_{10} and SO_2 is the highest value of 3 years.

[f] Background level for 24-hour $PM_{2.5}$ is the average concentration of the 98th percentile over 3 years.

[g] Background level for Annual $PM_{2.5}$ is the average concentration of 3 years.

[h] Background level for 1-hour SO_2 is the average concentration of the 99th percentile for 3 years.

[i] Background level for 3-hour SO_2 is the highest-second-high value

3.1.1 Justification to Use Significant Impact Levels

The use of SILs are appropriate if the difference in background concentrations for a specific pollutant and averaging period and the applicable NAAQS are greater than the applicable SIL. Table 9 summarizes the difference between the NAAQS and the monitored background concentration. As shown in Table 9, all averaging periods for each pollutant have differences between the monitored value and the NAAQS, which is greater than the respective SIL; therefore, the use of the SILs pollutants are appropriate as screening criteria as a project impact equal to or less than the SIL will result in a concentration less than the NAAQS.

Table 9. Difference between the Monitored Air Quality Concentrations and the National Ambient Air Quality Standards in Comparison to the Significant Impact Levels

Pollutant	Averaging Period	Background Level (µg/m^3)	NAAQS (µg/m^3)	Difference (NAAQS-Background) (µg/m^3)	Significant Impact Level (µg/m^3)
CO	1-Hour	1,803	40,000	38,197	2,000
	8-Hour	1,031	10,000	8,969	500
NO_2	1-Hour	95.0	188	93.0	7.5
	Annual	34.0	100	66.0	1
$PM_{2.5}$	24-Hour	14.2	35	20.8	1.2
	Annual	4.8	12	7.2	0.2
PM_{10}	24-Hour	33.0	150	117.0	5
	Annual	15.6	50	34.4	1

Table 9. Difference between the Monitored Air Quality Concentrations and the National Ambient Air Quality Standards in Comparison to the Significant Impact Levels

Pollutant	Averaging Period	Background Level (µg/m³)	NAAQS (µg/m³)	Difference (NAAQS-Background) (µg/m³)	Significant Impact Level (µg/m³)
SO_2	1-Hour	15.7	196	180.3	7.8
	3-Hour	23.3	1,300[a]	1276.7	25
	24-Hour	12.2	365[a]	352.8	5
	Annual	3.4	80[a]	76.6	1

[a] Revoked

3.2 Air Quality Model Selection and Options

The offshore and coastal dispersion (OCD) model is a near field air dispersion model, appropriate for evaluating impacts at a distance up to 31 miles (50 km, 27 nm) from a source. The OCD model is currently the preferred model for overwater applications per Appendix W to 40 CFR 51 (EPA 2017). OCD is a straight-line Gaussian model that incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline.

The OCD model was selected because it is currently the only EPA-approved model for over-water conditions.

3.3 Meteorological Data for Modeling

Meteorological data for the air dispersion modeling were extracted from three consecutive years of Weather Research and Forecasting (WRF) prognostic model data (2013 to 2015) obtained from EPA Region 1. The Mesoscale Model Interface program (MMIF; Version 3.4) was used to extract the necessary meteorological parameters. A detailed analysis of the meteorological data developed for the OCD modeling study is presented within the construction emission modeling protocol, which is being submitted to EPA separately (see Section 3.8 and Appendix B of that protocol). These same data are to be used for the O&M emissions impact study as well.

The data developed for this dispersion modeling extends 3 years and would reasonably provide all combinations of meteorological conditions that would give rise to worst-case modeled impacts. The data used are recent and any changes in local climatology since the 2013 to 2015 period would be insignificant. Therefore, the meteorological dataset previously developed and discussed in the construction emissions modeling protocol remain representative of the OCS permit area and will be used for this assessment.

3.4 Modeling Methodology

For all modeled activities, DWSF has attempted to identify the most conservative scenario, generally choosing the scenario with more and larger air emissions sources where multiple options exist. Additionally, DWSF has attempted to determine representative source parameters (exit velocity, stack diameter, stack exit temperature) for the types of vessels that may be used for the various O&M scenarios described in the following sections. Final construction and O&M methods may differ as the Project design and logistical factors progress and implementation plans are refined. However, the scenario emissions are conservative; therefore, the modeled impacts of the various scenarios/activities are not likely to be underestimated. The activities described as follows occur in the WDA.

3.5 Operations and Maintenance Activities

The air modeling will focus on the routine anticipated O&M activities occurring within the WDA and along the transit lines between the Ports of Call and the WDA. Infrequent maintenance and repair activities are included in the assessment, although they are anticipated to occur only a few times over the life of the SFWF. Large-scale turbine or cable rehabilitation is not considered in the modeling as these activities are neither anticipated or routine and the labor, schedule duration, or vessel requirements cannot be known at in advance.

Table 10 lists the typical O&M activities that are anticipated to occur annually and the number of days each vessel is expected to be used for the activities. For modeling against annual criteria air contaminant standards, the expected number of days of usage are incorporated into the emission estimates. For short-term averaging periods, it is conservatively assumed that vessels are operating continuously over that period of time (1 hour or 24 hours).

It is not expected that testing of the emergency generator located at the OSS will occur simultaneously with the usage of other equipment and will last only 30 minutes or less per month, although 200 hours of use per year are assumed for annual averages. During WTG or OSS repair procedures, it is expected that a power source may be required for various purposes such as to operate power tools. For modeling purposes, it was assumed that a generator similar in size to the OSS emergency generator listed in Table 10 would be used for that purpose. This generator is expected to be transported from on-land with the rest of the required equipment. This generator was assumed to run continuously for short-term averages and was scaled by 200 hours of usage per year for annual averages.

Table 10. Annual Vessel Use during Operations and Maintenance

Purpose/Scenario	Type of Equipment/ Emission Source Description (list others as needed)	Number of Each Type of Vessel	Total Engine Rating (hp)	Usage per year
Daily inspection or cable inspection/ repair	Crew Transport Vessel(s)	1-2	1,239	320 days per year
WTG and OSS O&M – Main component exchange service	Floating/Jack-up Crane Barge	1	22,000	14 days per year
	Crew Transport Vessel	1	1,239	14 days per year
	Feeder Barge	2	9,500	14 days per year
	Generator – 268 HP	1	268	200 hours per year
Emergency generator testing	OSS emergency Generator	1	268	200 hours per year

hp = horsepower

A description of each of the O&M scenarios and vessels involved are presented in the following sections.

3.5.1 Wind Turbine Generator and Offshore Substation Repair Operations and Maintenance

O&M for the WTGs is anticipated to include activities such as inspection of components and equipment, and replacement of components and gear box oil as necessary. Most O&M repair activities will require only the use of a single crew transport vessel and will occur approximately 5 to 10 times through the lifetime of the Project. The duration of these repair projects can last as many as 8 days.

Other O&M activities will require additional equipment due to the nature of the work, such as cable repairs and replacements or other underwater maintenance. These O&M activities may include the use of a crew transport vessel, a jack-up vessel, and perhaps a feeder barge (or similar) and are anticipated to be infrequent and occur only approximately 2 to 3 times over the lifetime of the Project. The duration of these maintenance and repair excursions could last from 14 to 31 days (about 2 to 4 weeks). Because of the nature of this work, it is expected that an exclusion zone would be set up when a jack-up vessel is present to prevent the public from having access to the immediate area around the vessel, although having public in the area would be highly unlikely regardless.

The vessels and air emission sources involved in WTG larger scale repair O&M projects are assumed to include the following as a worst-case:

- One (1) crew transport vessel with 1,239 hp engine(s)
- One (1) jack-up vessel with 22,000 hp engine(s)
- Possibly one or two Feeder/Lift barges with 9,500 hp engine(s)
- Possibly a 268 hp (200 kw) generator for power needs of the repair work

The exact size and nature of the vessels and equipment to be used could vary based on availability and the work required. However, the emissions and modeling are based on the number of vessels and size of engines as listed above and in Table 10. These are conservative estimates of total engine horsepower-hours and fuel usage that will actually be used and therefore will lead to conservative estimates of Project impacts. This work activity will be one of two scenarios that will be modeled. It includes emissions from most expected vessel types and therefore will likely have the highest impact of any of the other scenarios. A figure depicting a typical layout for air modeling purposes of the WTG O&M scenario is included in Appendix A. Additional O&M activities are discussed below.

Short-term emissions assume continuous use of the CTV main and auxiliary engines using maneuvering power. The Jackup and feeder barges emissions assume simultaneous use of auxiliary engines under maneuvering power, and the generator assumes continuous full load use.

3.5.2 Cable Inspection and Repair

O&M for the offshore cable system includes surveys to monitor cable exposure and/or the depth of burial of the cabling. This activity is anticipated to occur the first year after construction completion, another 2 to 3 years after construction, and another 5 to 8 years after construction. Surveys thereafter will occur at a frequency dependent on the findings of the preliminary surveys as well as site seabed dynamics and seabed soil conditions. It is estimated each trip last as much as 4 to 7 days. This activity involves the use of a multi-role survey vessel.

The vessel and air emission sources involved in cable inspection and repairs are assumed to include the following:

- One or two multi-role survey vessels of similar size to a crew transport vessel

This O&M activity will be modeled using two (2) CTVs at the WDA site. This scenario is similar to the daily O&M scenario discussed in Section 3.5.3.

3.5.3 Daily and Miscellaneous Operations and Maintenance

For daily O&M, one or two crew transport vessels will be frequently used to transport crew to the Offshore Project Area for inspections, routine maintenance, and minor repairs. The crew transport vessels would each make daily trips to the WDA for approximately 70 to 90 percent of the year (about 320 days per year).

Two CTVs at the WDA are modeled as part of the Cable Inspection and Repair scenario discussed in Section 3.5.2. Transit emissions for all vessels moving between the WDA and the Ports will not be modeled for short-term averaging periods as they will not remain in one place long enough to significantly impact any single receptor over that averaging period. Transit emissions of the crew transport and other vessels will be modeled for annual averaging periods only. For annual averages, the usage of the CTVs corresponding to the daily O&M scenario will be used, as it will lead to higher emissions that the “Cable Inspection and Repair” scenario, which is expected to occur less frequently. The short-term emissions are identical between the two scenarios as both are modeled assuming two CTVs located and dynamically positioning at the repair/inspection site. Emissions assume continuous use of both the main and auxiliary engines using maneuvering power.

3.5.4 Operation of the Engines Located on the Offshore Substation and Wind Turbine Generators

Likely as part of routine O&M discussed in Section 3.5.3, the engines located on the OSS will be tested routinely for approximately 30 minutes every month. There are no emergency engines currently anticipated in the WTG platform design. This engine will operate intermittently during testing and no more than 200 hours in a year. However, generators are also anticipated to be needed for various power tool usage at the site, mostly during larger scale repairs (Section 3.5.1). Therefore, that engine will be modeled annually for 200 hours per year and will also be assumed to run continuously for shorter-term averages.

The emission and source parameters associated with these generators will be included in the O&M repairs scenario discussed in Section 3.5.1.

3.6 Nitrogen Oxide Conversion

The preliminary modeling will assume total conversion of NO_x to NO_2 (Tier 1). If this method shows NO_2 concentrations at receptors above the SIL, a Tier 2 ambient default NO_2/NO_x ratio of 0.90 will be applied to the annual model results for comparison to the annual NO_2 criteria. For 1-hour NO_2 impacts (and possibly further refinement of annual NO_2 concentrations), NO_2 concentrations will be scaled according to a representative empirical relationship of ambient NO_2 to NO_x ratios that was supplied by EPA Region 1 (EPA, 2020, private email communication). These NO_2/NOx ratios will be applied to OCD model predicted hourly NO_2 concentrations on an hour-to-hour basis. The hourly varying ambient ratio will be bounded by a minimum ratio of 0.5 to a maximum of 0.9.

3.7 Receptor Locations

During use of a jack-up vessel, it is assumed that an exclusion zone will be established that will preclude public access to the immediate vicinity near the vessel. For the purposes of modeling, it is assumed that the jack-up barge is located at the center of the receptor grid and the exclusion zone is 25 m in all directions from this barge. For modeling of O&M emissions, a polar grid of receptors will be utilized in which receptors are placed in 10 degree increments around the ring.

Receptor ring spacing will be 25 m out to 500 m, 250 m out to 1,000 m, 500 m out to 5,000 m, 2.5 km out to 10 km, and 5 km out to 50 km. This receptor layout produces 1,404 receptors in total over 39 receptor ring distances.

The center of the work area will be placed at a point corresponding to the northern-most WTG, similar to the point source used in the construction emissions modeling (See Table 11 of the construction emissions modeling protocol submitted by DWSF). Figure 3 shows the polar receptor grid to be used for this study. The nearby receptors are over water with no residences and where the public is extremely unlikely to remain for any extended period of time.

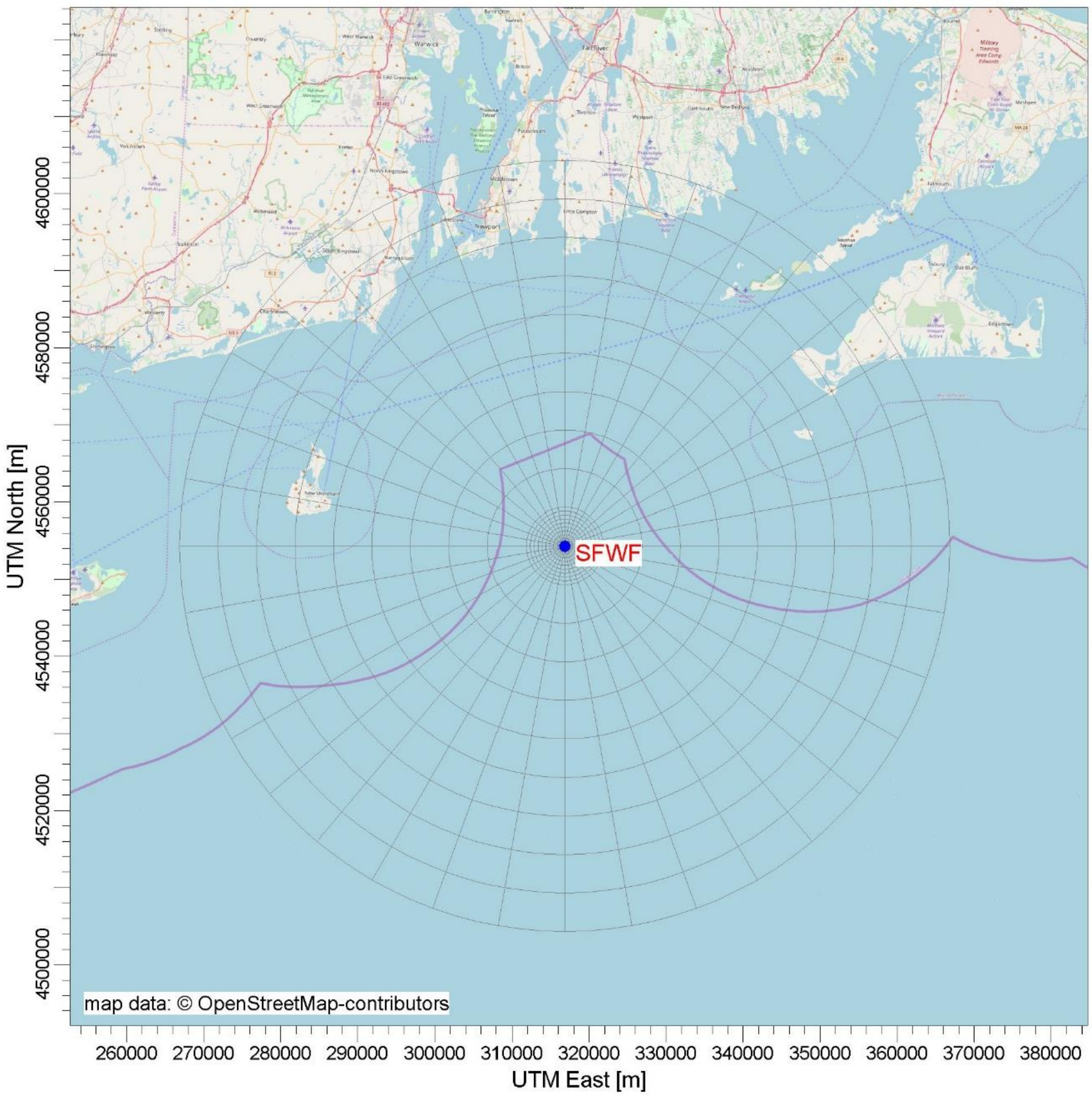

Figure 3. Receptors Used in Operations and Maintenance Modeling

3.8 Modeling Layout of Operations and Maintenance Repair Scenario

The O&M activities will not occur on a set schedule and will depend on weather conditions and other factors. The vessels will visit each of the 16 positions (15 WTG and 1 OSS) and survey the interarray and export cables, but the timing and sequence of those visits will vary. The vessels' position will not be the same for each visit as some inspections will involve disembarkment while others will be done visually from the vessels by onboard personnel. Similarly, the OCD model can only assess impacts at stationary receptors. The most impacted nearby receptors are entirely in locations where there cannot possibly be any residences, and where the public is unlikely to remain in one location for any extended period.

For modeling purposes, the layout of the scenario is considered typical for the activity being undertaken. The modeling of moving vessels and the assessment of over-water receptors using the OCD model requires the use of more conservative assumptions than a traditional assessment of stationary sources on land. There are two O&M scenarios (Larger scale O&M repairs and Daily O&M) that will be modeled and will include the vessels and equipment listed in Table 10 and as described in Section 3.5. Modeling of these scenarios implicitly assesses possible impacts other smaller O&M scenarios, such as routine inspections, cable inspections, and emergency generator testing. These smaller O&M tasks would likely use fewer vessels with lower overall engine capacity than the modeled scenario, and therefore would likely have lower overall modeled impacts.

The two modeled scenarios are summarized below:

Scenario 1 – two (2) CTVs at a typical WDA site;

Scenario 2 – one (1) jack-up barge, one (1) CTV, two (2) feeder barges and one (1) 268 HP generator at a typical WDA site.

As mentioned, the typical WDA site modeled is the location corresponding to the northmost point of the WDA area. This location is consistent with the northmost point source discussed in the construction modeling protocol. The emissions associated with each of these scenarios are presented in Appendix B.

O&M supply routes may originate from:

- ProvPort or Quonset, Rhode Island
- New London, Connecticut
- New Bedford, Massachusetts
- Shinnecock, New York
- Sparrow Point, Maryland
- Paulsboro Marine Terminal, New Jersey
- Norfolk, Virginia

The first four transit lines are shown in Appendix A. For modeling, it is assumed that the route the delivery vessels take from the within the OCS area to the SFWF work area will be similar whether they originate in ProvPort or Quonset; thus, the model only accounts for a single transit line for both of these Ports. The emissions from the supply routes from the last three ports of the list above will not be modeled because, due to the distance of these ports from the WDA, they are much less likely to be used and if used, will be used only sparingly. These Ports are included in the list of possible Ports to provide flexibility to DWSF during O&M and construction. Travel routes from ProvPort/Quonset, New London, and New Bedford are modeled assuming 100 percent of traffic originates from each of the three ports listed, and as such, are conservative estimates of emissions along these routes. Shinnecock, New York will be used for the crew transport vessels associated with daily inspection O&M activities only.

The specific usage percentage of each port is not known at this time, as it will depend on vessel availability and a number of other logistical factors. Therefore, the three model transit line locations are meant to represent a worst-case yet unlikely scenario where a single port handles all of the supply trips to the SFWF work area. The different locations of the vessel transit lines will be modeled to determine which represents the highest impact.

Travel routes will be modelled for annual averaging periods only as these emissions correspond to emissions that are transitory in nature, continuously moving (albeit with varying frequency) to and from the Port of Call and WDA, and therefore would not significantly impact any single receptor over periods of 24 hours or less. There are three Ports and supply routes that are proposed to be used for vessel such as jack-up barges and feeder barges, and these include New London, New Bedford, and ProvPort/Quonset. The Port at Shinnecock, New York will be the origin of most daily crew vessel O&M excursions. The annual average transit lines will run to and from the center of the WDA.

The locations of the layout for the two O&M scenarios site work are shown in Appendix A. Theses layout are anticipated to be representative of typical vessel locations but it should be emphasized that these vessels will rarely be at the same location at each of the turbine or OSS for each visit. The locations of the work vessels at a typical WDA location (such as a WTG or the OSS) are shown in Appendix A.

A summary of the modeling scenario is summarized in Table 11.

Table 11. Summary of Sources for the Modeling Scenarios

Source	Number	Averaging Period		
		Annual	24-hour	1-hour
Scenario 1 – Daily O&M activities and routine repairs				
Crew Transport Vessel	2	√	√	√
Shinnecock Transit Source[a]	1	√	No	No
Scenario 2 – Larger Scale OSS and WTG Repairs				
Jack-up Barge	1	√	√	√
Feeder/Lift Barge	2	√	√	√
Crew Transport Vessel	1	√	√	√
Generator[b]	1	√	√	√
Shinnecock Transit Source	1	√	No	No
New Bedford/New London/ProvPort Transit[c]	1	√	No	No

[a] Crew transport vessel emissions, both vessels for Scenario 1 and one vessel for scenario 2

[b] Worst-case annual emissions assume 200 hours per year. Short-term emissions assume continuous use.

[c] The worst-case impact of the three transit lines will be modeled for the final annual average model run, which will include the WDA site sources.

The emission rates and stack parameters associated with the various sources are shown in Appendix B.

3.9 Visibility

The Lye Brook Wilderness Area is the nearest Class I area, which is 166 miles (268 km) northwest from the approximate central point of the SFWF area. A Q/D screening assessment will be presented to determine whether the ratio is less than 10. Based on preliminary O&M emissions and distance to the nearest Class I location, the Q/D screening value will be much less than 10 and it is not expected that impacts from the Project will have an adverse effect on visibility in the Class I area.

A visibility analysis will be conducted using the EPA VISCREEN model for Class II vistas at Block Island and Martha's Vineyard. The worst-case annual emission rates for NO_x and particulate matter will be used for the analysis.

A Level 1 screening in the VISCREEN model is designed to provide a conservative estimate of visual impacts from the emission plume(s). This conservatism is achieved by assuming worst-case meteorological conditions: extremely stable (F) atmospheric conditions, coupled with a very low wind speed (1 meter per second) persisting for 12 hours, with a wind that would transport the plume directly adjacent to the observer. The observer is located at the closest location of the Class II areas (Block Island, Martha's Vineyard) to the proposed source per VISCREEN guidance (EPA 1988).

3.10 Soils and Vegetation

PSD regulations require analysis of air quality impacts on sensitive vegetation types with significant commercial or recreational value or sensitive types of soil. Although the O&M activities are overwater and a several miles from the nearest land area, an evaluation of impacts on sensitive vegetation will be performed by comparison of predicted Project impacts with screening levels presented in *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals* (EPA 1980). These procedures specify that predicted impact concentrations used for comparison account for project impacts and ambient background concentrations.

Most of the designated vegetation screening levels are equivalent to or exceed NAAQS and/or PSD increments, so that satisfaction of NAAQS and PSD increments ensures compliance with sensitive vegetation screening levels.

3.11 Growth

An analysis will be provided that assesses the impact of emissions from secondary growth during O&M. The analysis will qualitatively discuss expected jobs, growth, expansion, and the possible impacts it may have on the local infrastructure and supply chains, and whether this secondary growth will cause significant impacts.

4. References

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Appendix A
Air Quality Modeling Layout Figures

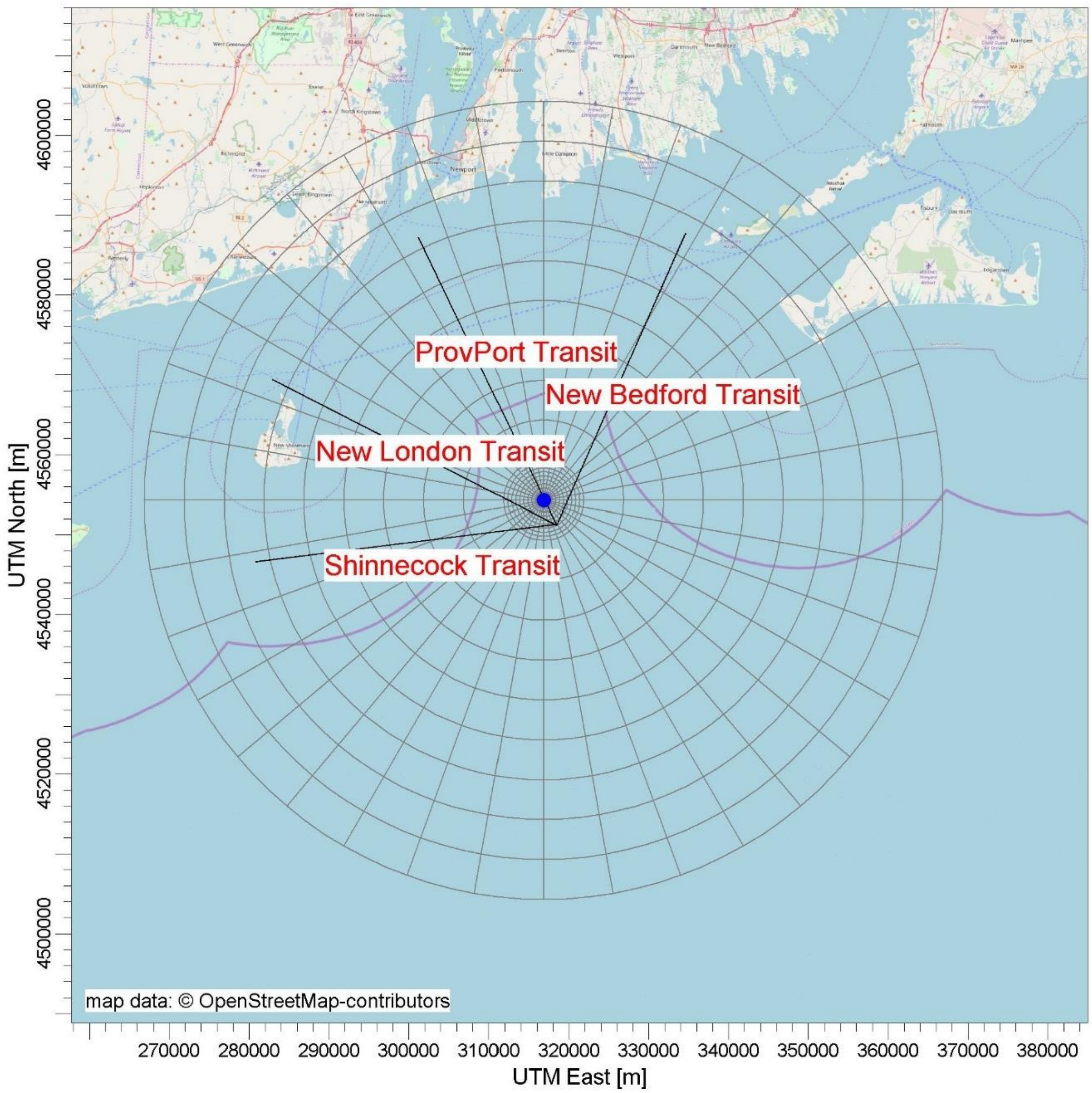

Figure A-1. Transit Line Layout for Annual Average Modeling

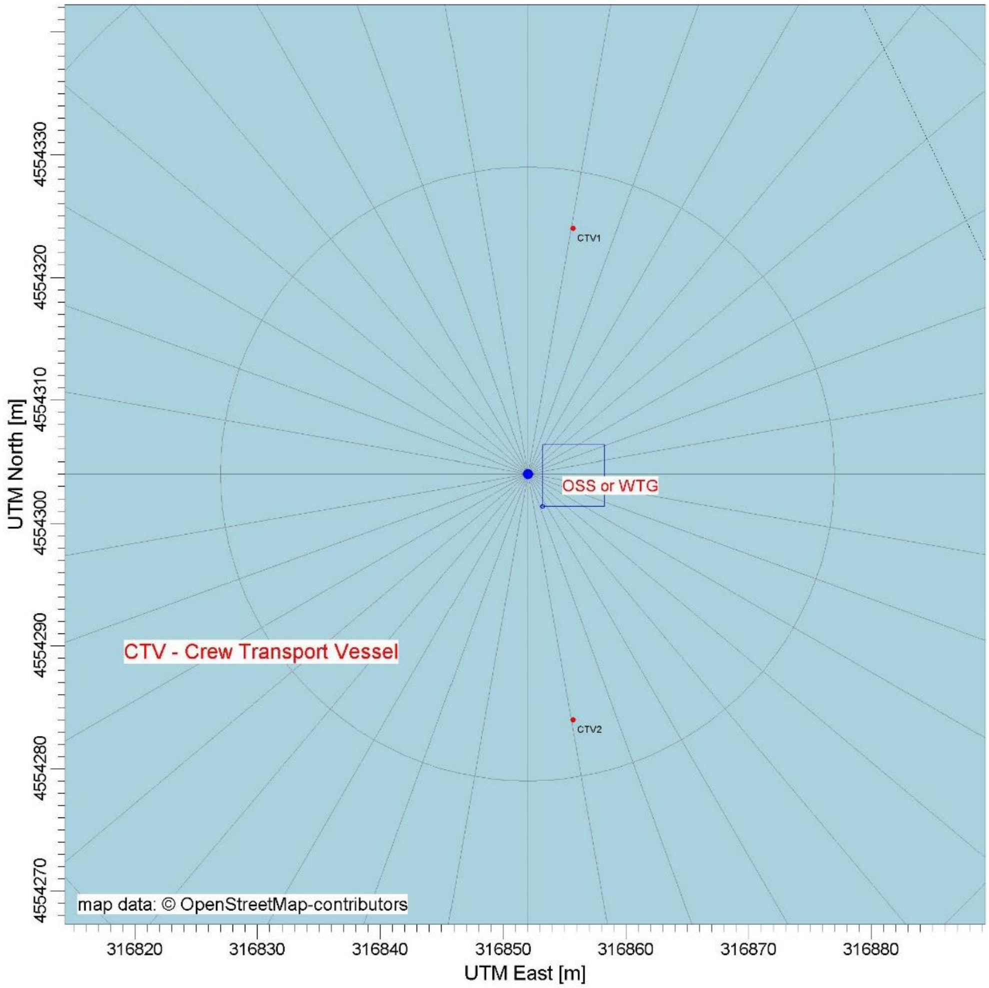

Figure A-2. Typical Daily Operations and Maintenance Scenario Modeling Layout (Scenario 1)

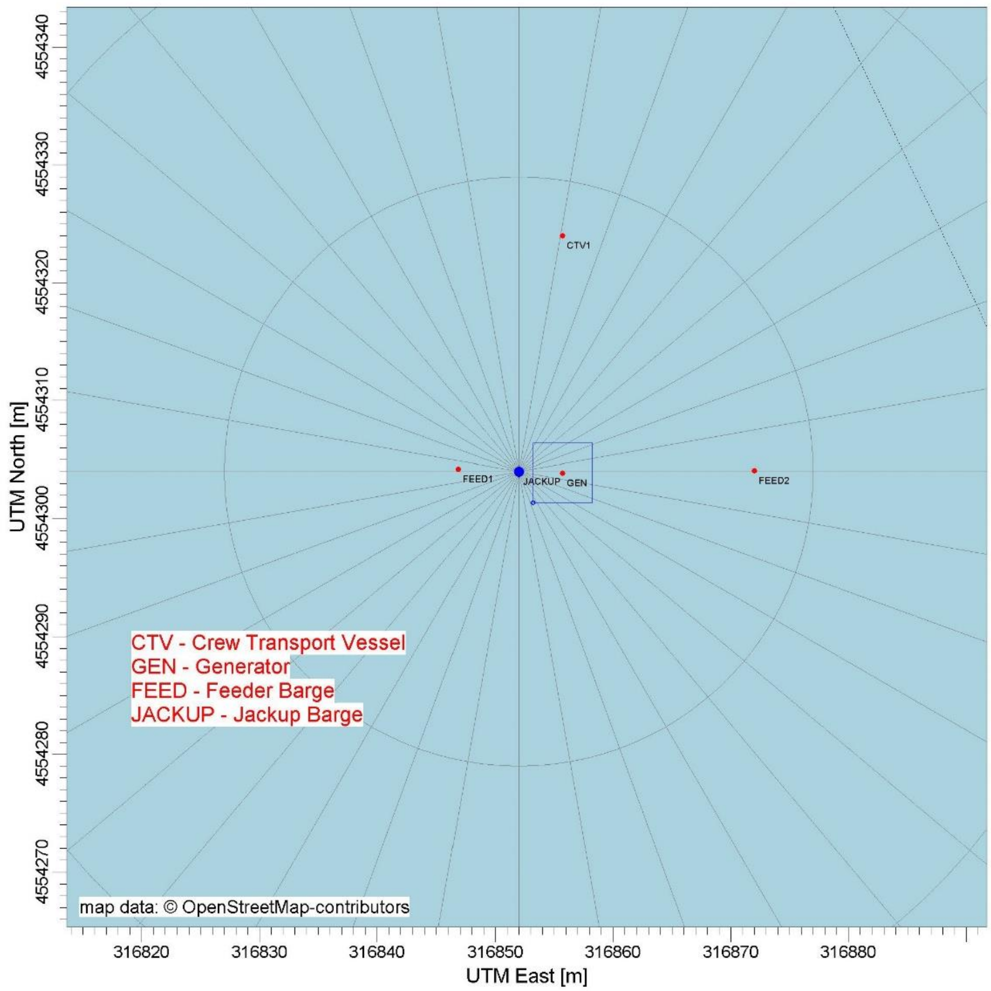

Figure A-3. Typical Operations and Maintenance Repair Scenario Modeling Layout (Scenario 2)

Appendix B
Source Parameters and Emissions

Table B-1. Source Parameters and Emissions During Operations and Maintenance Repair Scenario

Vessel	Count	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
Jack-up vessel	1	20	1.0	3.3	555
Crew Transport Vessels 1 and 2	2	10	0.33	20	555
Feeder Barge/Main Repair Vessel/Liftboat	2	30	0.6	6.6	800
268 hp Generator	1	10[a]	0.33	39.38	758
New Bedford/ProvPort/New London Lines[b]	[c]	10	2	5.5	350
Shinnecock Transit Line[d]	[c]	10	0.33	20	555

[a] Situated on OSS or WTG deck (approximate)

[b] Same parameters as construction line sources assumed

[c] Point source every 1-5 km of line distance

[d] Parameters same as crew transport vessel

K = Kelvin

m/s = meters per second

Table B-2. Short-Term Emissions During Operations and Maintenance

Vessel	Scenario 1 Count	Scenario 2 Count	CO (g/s)	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)	SO_2 (g/s)
Jack-up Vessel / Survey Vessel [a,b]	0	1	0.0	1.732	0.048	0.046	0.0009
Daily O&M Crew Transport Vessel [a]	1	1	0.113	0.472	0.016	0.015	0.0003
Crew Transport Vessel [a]	1	1	0.113	0.518	0.016	0.015	0.0006
Daily O&M Crew Transport Vessel [b]	1	1	0.029	0.123	0.0042	0.0040	0.0001
Crew Transport Vessel [b]	1	1	0.056	0.263	0.0080	0.0077	0.0002
Feeder Barge/Main Repair Vessel/Liftboat [a,b,c]	0	2	0.0	0.781	0.020	0.019	0.0004
268 hp Generator [a,b]	0	1	0.111	0.331	0.006	0.006	0.0003
Shinnecock Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA	NA
New London/ProvPort/New Bedford Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA	NA

[a] 1-hour emissions

[b] 24-hour emissions

[c] Emissions shown per vessel or generator

g/s = grams per second

NA = not applicable

Table B-3. Annual Emissions During Operations and Maintenance Repair Scenario

Vessel	Count	CO (g/s)	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)	SO_2 (g/s)
Jack-up Vessel / Survey Vessel	1	0.0000	0.0179	0.0005	0.0005	0.0000
Daily O&M Crew Transport Vessel	1	0.026	0.108	0.0036	0.0035	0.0001
Crew Transport Vessel	1	0.0017	0.0070	0.0002	0.0002	0.0000
Feeder Barge/Main Repair Vessel/Liftboat[a]	2	0.0000	0.0085	0.0002	0.0002	0.0000
268 hp Generator	1	0.0025	0.0076	0.00014	0.00014	0.00001
Shinnecock Transit (Entire Line)[b]	Point sources spaced every 1-5 km	0.0968	0.411	0.0138	0.0134	0.0003
New London Transit (Entire Line)[b]	Point sources spaced every 1-5 km	0.0299	0.215	0.0067	0.0064	0.0023
New Bedford Transit (Entire Line)[b]	Point sources spaced every 1-5 km	0.0171	0.123	0.0038	0.0036	0.0013
ProvPort/Quonset Transit (Entire Line)[b]	Point sources spaced every 1-5 km	0.0177	0.127	0.0039	0.0038	0.0013

[a] Emissions shown per vessel or generator

[b] Total line source emissions.

Table B-4. SFWF Operations and Maintenance Annual Emission Summary

	Areas Where Emissions Occur	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New Bedford, Massachusetts												
1	**Emissions within OCS Area**	**1615**	**0.01**	**0.1**	**0.6**	**5.0**	**24.0**	**0.8**	**0.8**	**0.1**	**0.00011**	**0.4**
	Transit emissions	1240	0.01	0.1	0.5	4.0	18.6	0.6	0.6	0.1	0.00009	0.3
	Onsite maneuvering [a]	347	0.00	0.0	0.1	1.0	5.2	0.2	0.2	0.0	0.00003	0.1
	Onsite generator	29	0.00	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.00000	0.0
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of Providence, Rhode Island												
1	**Emissions within OCS Area**	**1623**	**0.01**	**0.1**	**0.6**	**5.0**	**24.2**	**0.8**	**0.8**	**0.1**	**0.00011**	**0.4**
	Transit emissions	1248	0.01	0.1	0.5	4.0	18.7	0.6	0.6	0.1	0.00009	0.3
	Onsite maneuvering [a]	347	0.00	0.0	0.1	1.0	5.2	0.2	0.2	0.0	0.00003	0.1
	Onsite generator	29	0.00	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.00000	0.0
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New London, Connecticut												
1	**Emissions within OCS Area**	**1790**	**0.01**	**0.1**	**0.7**	**5.4**	**27.2**	**0.9**	**0.9**	**0.1**	**0.00012**	**0.5**
	Transit emissions	1415	0.0	0.1	0.5	4.4	21.8	0.7	0.7	0.1	0.00010	0.4
	Onsite maneuvering [a]	347	0.0	0.0	0.1	1.0	5.2	0.2	0.2	0.0	0.00003	0.1
	Onsite generator	29	0.00	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.00000	0.0

[a] All vessels in total

Note: Units in tpy

CH_4 = methane

N2O = nitrous oxide

Table B-5. SFWF Operations and Maintenance 24-hour Emission Summary

	Areas Where Emissions Occur	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New Bedford, Massachusetts												
1	**Emissions within OCS Area**	26	0.0002	0.0012	0.0087	0.0292	0.4241	0.0116	0.0113	0.0002	0.0000	0.0052
	Transit emissions (Shinnecock)[a]	3	0.0000	0.0002	0.0011	0.0105	0.0447	0.0015	0.0015	0.0000	0.0000	0.0007
	Onsite maneuvering [b]	19	0.0001	0.0009	0.0071	0.0082	0.3479	0.0095	0.0092	0.0002	0.0000	0.0042
	Onsite generator	3	0.0000	0.0002	0.0004	0.0106	0.0316	0.0006	0.0006	0.0000	0.0000	0.0004
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of Providence, Rhode Island												
1	**Emissions within OCS Area**	26	0.0002	0.0012	0.0087	0.0292	0.4241	0.0116	0.0113	0.0002	0.0000	0.0052
	Transit emissions (Shinnecock) [a]	3	0.0000	0.0002	0.0011	0.0105	0.0447	0.0015	0.0015	0.0000	0.0000	0.0007
	Onsite maneuvering [b]	19	0.0001	0.0009	0.0071	0.0082	0.3479	0.0095	0.0092	0.0002	0.0000	0.0042
	Onsite generator	3	0.0000	0.0002	0.0004	0.0106	0.0316	0.0006	0.0006	0.0000	0.0000	0.0004
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New London, Connecticut												
1	**Emissions within OCS Area**	26	0.0002	0.0012	0.0087	0.0292	0.4241	0.0116	0.0113	0.0002	0.0000	0.0052
	Transit emissions (Shinnecock) [a]	3	0.0000	0.0002	0.0011	0.0105	0.0447	0.0015	0.0015	0.0000	0.0000	0.0007
	Onsite maneuvering [b]	19	0.0001	0.0009	0.0071	0.0082	0.3479	0.0095	0.0092	0.0002	0.0000	0.0042
	Onsite generator	3	0.0000	0.0002	0.0004	0.0106	0.0316	0.0006	0.0006	0.0000	0.0000	0.0004

[a] Not modeled for 24-hour averages

[b] All vessels in total

Note: Units in tons per 24 hours.

Table B-6. SFWF Operations and Maintenance 24-hour Emission Summary

	Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$	SO_2
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New Bedford, Massachusetts					
1	**Emissions within OCS Area**	4.45	0.12	0.12	0.00
	Transit emissions (Shinnecock) [a]	0.47	0.02	0.02	0.00
	Onsite maneuvering [b]	3.65	0.10	0.10	0.00
	Onsite generator	0.33	0.01	0.01	0.00
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of Providence, Rhode Island					
1	**Emissions within OCS Area**	4.45	0.12	0.12	0.00
	Transit emissions (Shinnecock) [a]	0.47	0.02	0.02	0.00
	Onsite maneuvering [b]	3.65	0.10	0.10	0.00
	Onsite generator	0.33	0.01	0.01	0.00
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New London, Connecticut					
1	**Emissions within OCS Area**	4.45	0.12	0.12	0.00
	Transit emissions (Shinnecock) [a]	0.47	0.02	0.02	0.00
	Onsite maneuvering [b]	3.65	0.10	0.10	0.00
	Onsite generator	0.33	0.01	0.01	0.00

[a] Not modeled for short-term averages

[b] All vessels in total

Note: Units in (g/s).

Table B-7. SFWF Operations and Maintenance 1-hour Emission Summary

	Areas Where Emissions Occur	CO_2	CH_4	N_2O	Black Carbon	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New Bedford, Massachusetts												
1	**Emissions within OCS Area**	20	0.0001	0.0010	0.0084	0.0485	0.3702	0.0114	0.0109	0.0041	0.0000	0.0098
	Transit emissions [a]	19	0.0001	0.0009	0.0080	0.0472	0.3518	0.0109	0.0104	0.0041	0.0000	0.0096
	Onsite maneuvering [b]	1	0.0000	0.0000	0.0004	0.0009	0.0170	0.0005	0.0005	0.0000	0.0000	0.0002
	Onsite generator	0.14	0.0000	0.0000	0.0000	0.0004	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of Providence, Rhode Island												
1	**Emissions within OCS Area**	20	0.0001	0.0010	0.0084	0.0485	0.3702	0.0114	0.0109	0.0041	0.0000	0.0098
	Transit emissions [a]	19	0.0001	0.0009	0.0080	0.0472	0.3518	0.0109	0.0104	0.0041	0.0000	0.0096
	Onsite maneuvering [b]	1	0.0000	0.0000	0.0004	0.0009	0.0170	0.0005	0.0005	0.0000	0.0000	0.0002
	Onsite generator	0.1	0.0000	0.0000	0.0000	0.0004	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New London, Connecticut												
1	**Emissions within OCS Area**	20	0.0001	0.0010	0.0084	0.0485	0.3702	0.0114	0.0109	0.0041	0.0000	0.0098
	Transit emissions [a]	19	0.0001	0.0009	0.0080	0.0472	0.3518	0.0109	0.0104	0.0041	0.0000	0.0096
	Onsite maneuvering [b]	1	0.0000	0.0000	0.0004	0.0009	0.0170	0.0005	0.0005	0.0000	0.0000	0.0002
	Onsite generator	0.1	0.0000	0.0000	0.0000	0.0004	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000

[a] Not modeled for short-term averages

[b] All vessels in total

Note: Units in tons per hour.

Table B-8. SFWF Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur		NO_X	PM_{10}	$PM_{2.5}$	SO_2
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New Bedford, Massachusetts					
1	**Emissions within OCS Area**	93.3	2.9	2.7	1.0
	Transit emissions [a]	88.7	2.8	2.6	1.0
	Onsite maneuvering [b]	4.284	0.120	0.116	0.003
	Onsite generator	0.331	0.006	0.006	0.000
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of Providence, Rhode Island					
1	**Emissions within OCS Area**	93.3	2.9	2.7	1.0
	Transit emissions [a]	88.7	2.8	2.6	1.0
	Onsite maneuvering [b]	4.284	0.120	0.116	0.003
	Onsite generator	0.331	0.006	0.006	0.000
WTG O&M based on Shinnecock, New York; Major Component Setup based on Port of New London, Connecticut					
1	**Emissions within OCS Area**	93.3	2.9	2.7	1.0
	Transit emissions [a]	88.7	2.8	2.6	1.0
	Onsite maneuvering [b]	4.284	0.120	0.116	0.003
	Onsite generator	0.331	0.006	0.006	0.000

[a] Not modeled for short-term averages

[b] All vessels in total

Note: Units in g/s.

EPA'S COMMENTS ON THE AUGUST 2020 DRAFT AIR QUALITY IMPACT MODELING PROTOCOL FOR OPERATIONS AND MAINTENANCE EMISSIONS FOR THE SOUTH FORK WIND FARM (SFWF) OUTER CONTINENTAL SHELF PERMIT

1. The protocol states that the "emergency generator [on the OSS] will only operate for emergencies and less than 200 hours per year of reliability testing, anticipated to be 30 minutes per month each." The Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (40 CFR 60 subpart IIII) allow emergency engines a maximum of 100 hours per calendar year for maintenance checks and readiness testing, including 50 hours per year of non-emergency use. *See* 40 CFR 60.4211(f)(2)&(3)(i). Under these rules, there is no time limit for running the engine during emergencies, and the source may petition EPA for additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency engines beyond 100 hours per calendar year. Please adjust the text to clarify that whether and to what extent the 200 hours estimated includes allowed nonemergency versus emergency use.

2. Please provide supporting information for the emissions rates and other emissions parameters for vessels proposed for use in the modeling analysis. Please include information about how the emissions rates were derived and why they are deemed appropriate as inputs to the modeling analysis, i.e., are they based on actual emissions reports versus standard emissions factors, and do they represent the highest emitting devices proposed for inclusion in the air permit.

3. In the analysis of Class I air quality related values described in section 2.9.1, in addition to consulting with the Forest Service for Lye Brook Wilderness, please also apply the described Q/D analysis to the Brigantine Wilderness area and conduct appropriate consultation with the US Fish & Wildlife Service. In the Q/D analysis, the emissions (Q) should represent the annual emissions based on 24-hour maximum allowable emissions, rather than the annual potential to emit to be included in the permit.

4. Section 2.9 of the protocol should be modified to include an analysis for PSD increment for Class I areas. EPA recommends using the results of OCD modeling at a nominal 50-km distance to screen for impacts at the nearest Class I area (Lye Brook Wilderness, 260+ km).

5. EPA requests that additional information be provided in Section 2.8 about under what circumstances the cumulative analysis will be performed and how decisions will be made about which potentially interactive sources would be included in such an analysis if it is necessary. EPA notes that any nearby source with a significant concentration gradient within the South Fork Wind Farm's significant impact area, or which consumes available PSD increment in the area, should be included in such an analysis. In particular, EPA suggests that Deepwater Wind assess whether the permitted air impacts and PSD increment consumption for the Vineyard Wind project should be included.

6. Please clarify under what conditions the “turbine repair requiring jack-up barges” scenario would exist, and whether those conditions would increase the likelihood that multiple repairs would occur at nearby offshore wind farms as well. EPA encourages you to include nearby facilities for the annual standards to the extent that significant impact areas would overlap (see comment #4 above).

7. Please provide additional detail for the Soils, Vegetation, and Growth analyses described in sections 3.10 and 3.11 of the protocol.

8. The Guideline on Air Quality Models (40 CFR part 51, Appendix W; the *Guideline*) specifies that building downwash shall be included in modeling assessments of stationary sources (see sections 4.2.2 and 7.2.2). Please list any structures that will be included in the downwash analysis and provide their dimensions and schematic information.

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South Fork Wind (SFW) Responses to EPA comments on the August 2020 Draft Air Quality Modeling Protocol for Operations and Maintenance Emissions for the South Fork Wind Farm (SFWF) Outer Continental Shelf Permit

September 25, 2020

South Fork Wind (SFW) is providing the enclosed information in response to the United States Environmental Protection Agency (EPA) comments on the August 2020 Draft Air Qualty Modeling Protocol for Operations and Maintenance Emissions for the South Fork Wind Farm (SFWF) Outer Continental Shelf Air Permit.

Please see below specific agency comments in italic text followed by SFW responses in plain text:

1. *The protocol states that the "emergency generator [on the OSS] will only operate for emergencies and less than 200 hours per year of reliability testing, anticipated to be 30 minutes per month each." The Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (40 CFR 60 subpart IIII) allow emergency engines a maximum of 100 hours per calendar year for maintenance checks and readiness testing, including 50 hours per year of non-emergency use. See 40 CFR 60.4211(f)(2)&(3)(i). Under these rules, there is no time limit for running the engine during emergencies, and the source may petition EPA for additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency engines beyond 100 hours per calendar year. Please adjust the text to clarify that whether and to what extent the 200 hours estimated includes allowed nonemergency versus emergency use.*

The report will be revised to state that the OSS emergency generator will operate a total of 100 hours per year for emergency and readiness testing. However, it is anticipated that during some maintenance activities, there will be a generator transported from onshore that will be used to power some equipment to conduct the repairs. This generator is anticipated to be used 200 hours per year at most and is likely the same size as the OSS generator (200 kw). The draft protocol states that the emissions associated with generator use will be included in the modeling Scenario 2 (Section 3.5) at 200 hours per year, which conservatively accounts for the impacts of the emergency OSS generator during testing. The emergency generator testing will not occur simultaneously with maintenance generator use.

2. *Please provide supporting information for the emissions rates and other emissions parameters for vessels proposed for use in the modeling analysis. Please include information about how the emissions rates were derived and why they are deemed appropriate as inputs to the modeling analysis, i.e., are they based on actual emissions reports versus standard emissions factors, and do they represent the highest emitting devices proposed for inclusion in the air permit.*

Background information regarding emission calculations for various operations and maintenance (OM) activities are provided in Attachment 1 of this supplementary memo. The emissions were derived using default BOEM emission factors as shown in Table 9 of Attachment 1.

The exact size and nature of the vessels and equipment to be used could vary based on availability and the specific nature of the work required. However, the emissions and modeling are based on the number of vessels and size of engines as listed above and in Table 10 Section 3.5 of the Modeling Protocol. The vessels and associated engine horsepower estimates were based on input from South Fork Wind LLC (SFW) and were based on other projects with similar work scope. A scenario that includes all of the equipment listed in Table 10 of Section 3.5 of the Protocol would provide appropriate estimates of total engine horsepower-hours and fuel usage that would actually be used and therefore will lead to conservative estimates of Project impacts. For example, it is unlikely that two feeder barges will be necessary for a large-scale repair project, but both were included in the proposed model scenario 2 to provide that flexibility to SFW.

3. *In the analysis of Class I air quality related values described in section 2.9.1, in addition to consulting with the Forest Service for Lye Brook Wilderness, please also apply the described Q/D analysis to the Brigantine Wilderness area and conduct appropriate consultation with the US Fish & Wildlife Service. In the Q/D analysis, the emissions (Q) should represent the annual emissions based on 24-hour maximum allowable emissions, rather than the annual potential to emit to be included in the permit*.

Correspondence has been sent to both USFS (Lye Brook) and the FWS (Brigantine) on September 18, 2020, which describes the project, and lists the annualized worst-case 24-hour emissions, along with the Q/D screening value for those emissions. No formal responses have been received from the FLMs as of September 30, 2020. Relevant correspondence will be included in the Air Quality modeling report for OM emissions.

4. *Section 2.9 of the protocol should be modified to include an analysis for PSD increment for Class I areas. EPA recommends using the results of OCD modeling at a nominal 50-km distance to screen for impacts at the nearest Class I area (Lye Brook Wilderness, 260+ km)*.

The report will include an assessment of Class I impacts due to worst-case OM emissions and impacts. This assessment will be conducted by comparing the OCD model-predicted impacts at the 50 km receptors with the Class I PSD significant impacts levels.

5. *EPA requests that additional information be provided in Section 2.8 about under what circumstances the cumulative analysis will be performed and how decisions will be made about which potentially interactive sources would be included in such an analysis if it is necessary. EPA notes that any nearby source with a significant concentration gradient within the South Fork Wind Farm's significant impact area, or which consumes available PSD increment in the area, should be included in such an analysis. In particular, EPA suggests that Deepwater Wind assess whether the permitted air impacts and PSD increment consumption for the Vineyard Wind project should be included*.

According to 40 CFR Appendix W to Part 51, additional cumulative sources may have to be considered in a cumulative impact assessment if emissions from those sources create a "significant concentration gradient" in the vicinity of the modeled source (EPA, 2011 and 2017). A concentration gradient is the rate of change of concentration with distance, in both the longitudinal and lateral gradients. Significant concentration gradients in the vicinity of the source implies that the nearby source's potential interaction with the proposed source's impacts will not be well represented by the monitored concentrations at a specific location (for a NAAQS assessment). Concentration gradients are generally largest between the source and the location of the maximum ground-level impacts. This guidance suggests focusing on nearby sources within 10 kilometers of a proposed source in most cases.

A review was conducted of on-land sources with operating permits within 50 kilometers of a central point within the SFWF WDA. This review included both Massachusetts and Rhode Island sources. There were no sources with valid and current operating permits identified within 50 km of the WDA. These finding were confirmed by both Rhode Island DEM and Massachusetts DEP via email. Therefore, no additional on-land cumulative sources are proposed to be included in the NAAQS assessment as there are no sources that could have a significant concentration gradient in proximity to the Project sources. Similarly, since no major sources exist on-land within 50 km of the WDA, no on-land sources were included in the PSD cumulative assessment as there are no sources that would consume significant amounts of increment in the vicinity of the WDA.

Vineyard Wind (VW) has submitted an OCS permit application to EPA in 2019 for a wind development project southeast of the SFWF WDA. The center of VW WDA is more than 50 km from the approximate center of the SFWF WDA. The maximum significant impact radius for the Vineyard Wind was shown to be 1.5 kilometers or less (Vineyard Wind, 2019) for the modeled contaminants for 24-hour average impacts and all receptors were less than the applicable SIL for annual averages. Preliminary modeling shows that SFWF Project's significant impact radius is 4.5 kilometers or less for all short-term average impacts and zero for all annual-average impacts. Therefore, VW O&M emissions were not included in SFWF's NAAQS or PSD cumulative assessments. Should final modeling shows overlap of VW and SFWF significant impact areas, SFW will discuss with EPA an appropriate course of action.

Any other minor sources contributing to overall contaminant concentrations are included in the representative background air quality monitoring data being proposed for the NAAQS analysis, as discussed in Section 3.1 of the modeling protocol. Further, these overland background concentrations are likely conservative estimates of contaminant concentrations overwater in the vicinity of the SFWF WDA, which is far removed from various residential and most transportation emissions.

6. *Please clarify under what conditions the "turbine repair requiring jack-up barges" scenario would exist, and whether those conditions would increase the likelihood that multiple repairs would occur at nearby offshore wind farms as well. EPA encourages you to include nearby facilities for the annual standards to the extent that significant impact areas would overlap (see comment #4 above).*

The large-scale turbine (or OSS) repairs may occur as a result of unusual wear and premature failure of key electrical, structural, or mechanical components of the turbine equipment. These large-scale repairs are only anticipated perhaps 5-10 times over the life of the Project (25 to 30 years), and not every repair will require a jackup barge. If a severe weather event were to cause damage to several turbines at both the SFWF and Vineyard Wind (VW) sites, the repair schedule would be based on a number of logistical factors, including weather, vessel and work crew availability etc., and the likelihood of simultaneous repair scenarios is still small.

VW reported in their supplementary information memorandum (Vineyard Wind, 2019) that their modeled significant impact radii were 1.0 km for 1-hour NO_2, 0.5 km for 24-hour PM_{10} and 1.5 km for 24-hour $PM_{2.5}$ (Table 5-1 of the VW memo). Vineyard Wind also reported that there were no receptors above the SIL for any annual averaging periods. Preliminary modeling of the SFWF also shows that there are no modeled contaminants with impacts above the SIL for annual averages. Therefore, based on these preliminary results, it is not deemed necessary to include VW emission impacts as cumulative sources to SFWF model predicted annual averages. Should the final SFWF model results show a significant increase in predicted annual average results resulting in overlap of the VW work area, EPA will be consulted, and an appropriate course of action discussed.

7. *Please provide additional detail for the Soils, Vegetation, and Growth analyses described in sections 3.10 and 3.11 of the protocol*.

A component of the PSD documentation requires an analysis of potential air quality impacts on sensitive vegetation types that may be present near the Project. The evaluation of potential impacts on vegetation will be conducted in accordance with EPA's *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA 1980). Model predicted air quality concentrations of various pollutants from the Project will added to ambient background concentrations and compared to applicable screening concentrations to determine whether there exists the potential for adversely impacting vegetation with significant commercial or recreational value. The worst-case project impacts are entirely over water with the nearest land being Block Island approximately 19 miles east northeast of the WDA and therefore this comparison is conservative.

For growth, a qualitative assessment will be provided that summarizes project-related activities and infrastructure that could potentially result in direct or indirect impacts to population, economy, and employment resources. A summary of a socioeconomic analysis performed by Navigant Consulting Inc and provided in the SFW Construction and Operations Plan (SFW, 2020) will be provided in the modeling report. That analysis assessed impact-producing factor such as the socioeconomic factors population, economy, and employment, coastal land uses, and tourism. A statement of the potential impacts of secondary growth on air emissions will be provided.

8. *The Guideline on Air Quality Models (40 CFR part 51, Appendix W; the Guideline) specifies that building downwash shall be included in modeling assessments of stationary sources (see sections 4.2.2 and 7.2.2). Please list any structures that will be included in the downwash analysis and provide their dimensions and schematic information*.

Structure downwash will be incorporated into the OCD model by specifying a structure height and width that are nearby a specific source and could influence dispersion from that source. The building downwash due to platform influence is treated in OCD using a revised platform downwash algorithm based on laboratory experiments, where dispersion coefficients are enhanced, and final plume rise is reduced as a result of downwash effects (DiCristofaro and Hanna, 1989). The main structure for scenarios that could influence dispersion is the OSS structure. The final design of the OSS structure has not yet been determined but based on information provided by SFW in the COP (SFW, 2020), the height of the OSS structure above water level can be 45.7 to 61 m high, a typical value of 50 m height was assumed. This structure will sit on a single monopile foundation once it is erected. The maximum lateral distance is estimated at approximately 50 meters. The structure dimensions and associated downwash are conservative in that it assumes a solid foundation down to sea level, instead of the OSS being several meters above sea level on the monopile foundation.

These downwash dimensions will be assigned to the jackup barge and the feeder barges as these vessels will be likely attached or near the OSS structure during large scale repairs and therefore be potentially influenced by its wake effects. The power generator may be located on top of the OSS platform and therefore may be subject to its influence as well. The CTVs are assumed to be moving and away from the platform such that its emissions release is mostly independent of the platform wake, and therefore downwash effects were not assigned to these vessels.

The solid structures on the vessels (superstructure, vessel hulls) themselves are considerably smaller than those of the OSS and therefore downwash from these on-vessel structures are anticipated to be minor compared to the influence of the OSS. Also, the exact dimensions of the various vessels to be used will likely change each visit, and therefore modeling a single vessel "layout" for downwash purposes is not appropriate.

References

DiCristofaro, D., and S.R. Hanna 1989. "OCR: The Offshore and Coastal Dispersion Model, Volume I: User's Guide". Prepared for the U.S. Department of the Interior, Minerals Management Service. November 1989

South Fork Wind LLC (SFW), LLC. 2020 *South Fork Wind Farm Construction and Operations Plan. Revision 3.* Submitted to the Bureau of Ocean Energy Management. February.

EPA. 2011. "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard". March 1.

EPA. 2017. Appendix W to 40 CFR 51. *Guideline on Air Quality Models*. January.

Vineyard Wind, LLC. 2019. Memorandum to Leiran Biton, US EPA Region 1. Subject: Vineyard Wind Project, Supplemental Information Request by EPA Region 1, Construction and O&M Stage Modeling, from J. Sabato, and AJ Jablonowski, Epsilon Associates, Inc., April 22.

Attachment 1 - Background Information on Emission Estimates

Tables in this attachment summarize the source parameters and emissions.

Table 1. Source Parameters and Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
Jack-up Vessel	1	20	1.0	3.3	555
CTVs 1 and 2	2	10	0.33	20	555
Feeder Barge, Main Repair Vessel, and Liftboat	2	30	0.6	6.6	800
268-bhp (200-kW) Generator	1	53[a]	0.33	39.38	758
New Bedford, ProvPort, New London Lines[b]	[c]	10	2	5.5	350
Shinnecock Transit Line[d]	[c]	10	0.33	20	555

[a] Assume located on top of OSS or WTG deck (approximate).

[b] Same parameters as construction line sources assumed.

[c] Point source every 0.6-3.1 miles (1-5 km) of line distance.

[d] Parameters same as CTV

Notes:

bhp = break horsepower

CTV = crew transport vehicle

K = Kelvin

km = kilometer(s)

kW = kilowatt(s)

m = meter(s)

m/s = meter(s) per second

OSS = offshore substation

ProvPort = Port of Providence, Rhode Island

WTG = wind turbine generator

Table 2. Short-term Emissions during Operations and Maintenance

Vessel	Scenario 1 Count	Scenario 2 Count	Annual Hours of Use[d]	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	0	1	112	0.0221[a]	0.048[b]	0.046[b]
Daily O&M CTV	1	0	2002	0.472[a]	0.0042[b]	0.0040[b]
CTV	1	1	168	0.0099[a]	0.008[b]	0.0077[b]
Feeder Barge, Main Repair Vessel, Liftboat [a,b,c]	0	2	112	0.0677[a]	0.169[b]	0.158[b]
268-bhp (200-kW) Generator [a,b]	0	1	200	0.0076[a]	0.0061[b]	0.0061[b]
Shinnecock Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA
New London, ProvPort, New Bedford Transit (Entire Line)	Not modeled for short-term average	Not modeled for short-term average	NA	NA	NA	NA

[a] 1-hour emissions.

[b] 24-hour emissions.

[c] Emissions shown per vessel or generator.

[d] Anticipated number of hours of use onsite (not including transit time) applied to 1-hour NOx emissions

Notes:

g/s = gram(s) per second

NA = not applicable

NOx = nitrogen oxide

O&M = operations and maintenance

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

Table 3. Annual Emissions during Operations and Maintenance Repair Scenario

Vessel	Count	NO_x (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Jack-up or Survey Vessel	1	0.0179	0.0005	0.0005
Daily O&M CTV	1	0.108	0.0036	0.0035
CTV	1	0.0070	0.0002	0.0002
Feeder Barge, Main Repair Vessel, Liftboat[a]	2	0.115	0.0037	0.0034
268-bhp (200-kW) Generator	1	0.0076	0.00014	0.00014
Shinnecock Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.411	0.0138	0.0134
New London Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.215	0.0067	0.0064
New Bedford Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.123	0.0038	0.0036
ProvPort Transit (Entire Line)[b]	Point sources spaced every 0.6-3.1 miles (1-5 km)	0.127	0.0039	0.0038

[a] Emissions shown per vessel or generator.

[b] Total line source emissions.

Table 4. South Fork Wind Farm Operations and Maintenance Annual Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**27.4**	**0.9**	**0.9**
Transit emissions	18.6	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area - ProvPort	**27.6**	**0.9**	**0.9**
Transit emissions	18.7	0.6	0.6
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0
Total Emissions within OCS Area – New London	**30.6**	**1.0**	**1.0**
Transit emissions	21.8	0.7	0.7
Onsite maneuvering [a]	8.6	0.3	0.3
Onsite generator	0.3	0.0	0.0

[a] All vessels in total.

Notes:

Units in tpy.

OCS = Outer Continental Shelf

tpy = ton(s) per year

Table 5. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_x	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area - New Bedford	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock)[a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area - ProvPort	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006
Emissions within OCS Area – New London	**1.2834**	**0.0400**	**0.0378**
Transit emissions (Shinnecock) [a]	0.0447	0.0015	0.0015
Onsite maneuvering [b]	1.2072	0.0379	0.0357
Onsite generator	0.0316	0.0006	0.0006

[a] Not modeled for 24-hour averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per 24 hours.

Table 6. South Fork Wind Farm Operations and Maintenance 24-hour Emission Summary

Areas Where Emissions Occur	NO_x	PM_{10}	$PM_{2.5}$
Total Emissions within OCS Area – New Bedford	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area - ProvPort	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01
Total Emissions within OCS Area – New London	**13.48**	**0.42**	**0.40**
Transit emissions (Shinnecock) [a]	0.47	0.02	0.02
Onsite maneuvering [b]	12.68	0.40	0.38
Onsite generator	0.33	0.01	0.01

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table 7. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area New Bedford	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area - ProvPort	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000
Emissions within OCS Area – New London	**0.4060**	**0.0126**	**0.0120**
Transit emissions [a]	0.3518	0.0109	0.0104
Onsite maneuvering [b]	0.0528	0.0017	0.0016
Onsite generator	0.0013	0.0000	0.0000

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in tons per hour.

Table 8. South Fork Wind Farm Operations and Maintenance 1-hour Emission Summary

Areas Where Emissions Occur	NO_X	PM_{10}	$PM_{2.5}$
Emissions within OCS Area – New Bedford	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – ProvPort	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006
Emissions within OCS Area – New London	**102.3**	**3.2**	**3.0**
Transit emissions [a]	88.7	2.8	2.6
Onsite maneuvering [b]	13.307	0.418	0.394
Onsite generator	0.331	0.006	0.006

[a] Not modeled for short-term averages.

[b] All vessels in total.

Notes:

Emissions in table are not scaled by hours of use per year.

Units in g/s.

Table 9. Transit and Maneuvering Emission Factors

Engine	Type	Units	Emission Factors										
			CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Main	Anchor Handling Tugs	g/kW/h	6.36E+02	4.00E-03	3.10E-02	2.54E-01	2.16E+00	9.26E+00	3.44E-01	3.30E-01	7.87E-02	4.03E-05	2.39E-01
Main	Barge	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	1.36E+01	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.31E-01	2.30E+00	9.15E+00	3.10E-01	3.00E-01	6.24E-03	4.65E-05	1.37E-01
Main	Jack-up	g/kW/h	6.47E+02	4.00E-03	3.10E-02	2.29E-01	2.30E+00	1.00E+01	3.08E-01	2.98E-01	1.27E-02	4.51E-05	1.44E-01
Main	Research and Survey	g/kW/h	6.38E+02	4.00E-03	3.10E-02	2.51E-01	2.25E+00	9.86E+00	3.39E-01	3.26E-01	6.57E-02	4.15E-05	2.21E-01
Main	Tug	g/kW/h	6.44E+02	4.00E-03	3.10E-02	2.43E-01	2.29E+00	9.52E+00	3.27E-01	3.16E-01	3.33E-02	4.48E-05	1.77E-01
Main	Cable Laying	g/kW/h	6.35E+02	4.00E-03	3.10E-02	2.52E-01	2.20E+00	9.49E+00	3.41E-01	3.27E-01	8.51E-02	3.88E-05	2.46E-01
Main	Dredging	g/kW/h	6.31E+02	4.00E-03	3.10E-02	2.63E-01	2.13E+00	9.60E+00	3.57E-01	3.41E-01	1.12E-01	3.70E-05	2.85E-01
Main	Shuttle Tanker	g/kW/h	5.89E+02	4.00E-03	3.10E-02	3.23E-01	1.40E+00	9.05E+00	4.50E-01	4.20E-01	3.62E-01	1.18E-05	6.30E-01
Main	Supply Ship	g/kW/h	6.45E+02	4.00E-03	3.10E-02	2.38E-01	2.29E+00	9.44E+00	3.20E-01	3.09E-01	2.77E-02	4.45E-05	1.67E-01
Main	Ice Breaker	g/kW/h	6.11E+02	4.00E-03	3.10E-02	2.90E-01	1.78E+00	9.92E+00	3.99E-01	3.77E-01	2.30E-01	2.48E-05	4.48E-01
Auxiliary	Anchor Handling Tugs	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.88E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Barge	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.26E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Crew	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Jack-up	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.15E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Research and Survey	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.02E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Tug	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Cable Laying	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.89E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Dredging	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.85E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Shuttle Tanker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	9.80E+00	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01
Auxiliary	Supply Ship	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	0.00E+00	1.04E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01

Table 9. Transit and Maneuvering Emission Factors

Engine	Type	Units	Emission Factors										
			CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Auxiliary	Ice Breaker	g/kW/h	6.48E+02	4.00E-03	3.10E-02	2.39E-01	2.48E+00	1.01E+01	3.20E-01	3.10E-01	6.00E-03	4.80E-05	1.40E-01

Engine Loading Factor:	**BOEM Tool default loading factors are used.**	**Propulsion Engine**	**Auxiliary Engine**	**Maneuvering**
		0.82	1	0.2
Vessel Emissions (tons) =	***Engine Power Rating (kW) x Loading Factor x Activity Hours (hours) x Emission Factor (g/kW/h) x (1 lb / 454 g) x (1 ton / 2,000 lb) x (No. of Sources)***			

Notes:

BOEM = Bureau of Ocean Energy Management

CH_4 = methane

CO = carbon monoxide

CO_2 = carbon dioxide

g = gram(s)

g/kW/h = gram(s) per kilowatt per hour

kW = kilowatt(s)

lb = pound(s)

N_2O = nitrous oxide

No. = number

NOx = nitrogen oxides

$PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

PM_{10} = particulate matter less than 10 micrometers in aerodynamic diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

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Table 10. Annual Emission Estimate for Transit in Offshore and Coastal Dispersion Model Area

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours for Transit Within OCS Area	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, New York						**14.29**	**0.48**	**0.47**
CTV	Crew	1	881	43	1,837.7	14.29	0.48	0.47
Port of New Bedford, Massachusetts based						**4.27**	**0.13**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	13.6	2.15	0.06	0.06
CTV	Crew	1	881	43	24.6	0.19	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	10.9	1.93	0.06	0.06
ProvPort, Rhode Island based						**4.43**	**0.14**	**0.13**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	14.1	2.23	0.07	0.06
CTV	Crew	1	881	43	25.4	0.20	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	11.3	2.00	0.06	0.06
Port of New London, Connecticut based						**7.47**	**0.23**	**0.22**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	23.7	3.76	0.11	0.11
CTV	Crew	1	881	43	42.9	0.33	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1119	19.0	3.38	0.11	0.10

Notes:

Units are tpy.

Transit emissions assume load factor of 0.82 for all main engines, and 1 for auxiliary engines.

Table 11. South Fork Wind Farm Onsite Emergency Generator

Type	Units	Emission Factors									
		CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Offshore emergency generator	g/kW/h	6.5E+02	4.0E-03	3.1E-02	8.5E-02	2.0E+00	6.0E+00	1.1E-01	1.1E-01	6.0E-03	7.0E-02
Emission calculation: *Generator Emissions (tpy) =*	*Engine Power Rating (kW) x Activity Hours (hours/year) x Emission Factor (g/kW/h) x (1 lb /454 g) x (1 ton / 2000 lb) x (No. of Sources)*										

Type of Equipment and Emission Source Description (list others as needed)	No. of equipment	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - annual testing and run time	NO_x	PM_{10}	$PM_{2.5}$
Generator (268 bhp [200 kW])	1	200		200.0	0.263	0.005	0.005

Notes:

Units are tpy.

Table 12. Annual Emission Estimate for Onsite Maneuvering

Type of Equipment and Emission Source Description (list others as needed)	Vessel Type in BOEM Tool for Emission Factor Selection	No. of Each Type of Vessel	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Hours - Maneuvering Onsite	NO_x	PM_{10}	$PM_{2.5}$
Shinnecock, New York						**3.75**	**0.13**	**0.12**
CTV	Crew	1	881	43	2002.3	3.75	0.13	0.12
Port of New Bedford, Massachusetts based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
PortProv, Rhode Island based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12
Port of New London, Connecticut based						**4.85**	**0.15**	**0.14**
Floating or Jack-up Crane Barge	Jack-up	1	13,699	2,699	90.6	0.62	0.02	0.02
CTV	Crew	1	881	43	129.2	0.24	0.01	0.01
Feeder Barge: Monco 335	Barge	2	5,966	1,119	94.9	3.98	0.13	0.12

Notes:

For onsite maneuvering, CTVs and feeder barges assume load factor of 0.2 for both main and auxiliary engines; jack-up barge assumes load factor of 0.2 for the auxiliary engine only.

Emission units are tpy.

Attachment 2 - Figure of Typical OSS Structure