EMPIRE OFFSHORE WIND:
EMPIRE WIND PROJECT (EW 1 and EW 2)

CONSTRUCTION AND OPERATIONS PLAN

VOLUME 2a: PHYSICAL RESOURCES

Prepared for

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PROJECT QUICK REFERENCE GUIDE

Key Project Term	Description
Cable protection	Measures to protect cable in instances where sufficient burial is not feasible and/or at existing submarine asset crossings, which can include placement of material, typically stone or rocks on and around the cable.
Empire	Empire Offshore Wind LLC.
Empire Wind 1	The portion of the Project and Lease Area that will be considered a single wind farm dedicated to the Gowanus Point of Interconnection for provision of power to New York State. Also referred to as "EW 1."
Empire Wind 2	The portion of the Project and Lease Area that will be considered a single wind farm dedicated to the Oceanside Point of Interconnection for provision of power to New York State. Also referred to as "EW 2."
Export cable landfall	Area where the submarine export cables are brought onshore.
Export cable route	The linear path of the export cables from the offshore substation in the Lease Area to the Point of Interconnection in New York.
Foundation	Structure required to secure the wind turbine generator, offshore substation, and other offshore structures vertically.
Interarray cable	66-kilovolt (kV) high-voltage alternating-current (HVAC) submarine cables interconnecting the wind turbines and offshore substation. The cable consists of a three-core copper conductor with a fiber-optic cable integrated into the cable; the cable is protected by one or more layers of armoring.
Interconnection Cable	345 kV HVAC onshore cables connecting the onshore substation to the POI.
J-tubes	Metal tubes that route and protect cables against sea and wind forces as they travel from the seabed, up the foundation to the base of the wind turbine tower or offshore substation topside.
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0512).
Lease Area	BOEM-designated Renewable Energy Lease Area OCS-A 0512.
Metocean facilities	Floating light detection and ranging buoys (floating LiDARs), wave and met buoy, and subsurface current meter installed in the Lease Area.
Offshore substation	Structure that receives the power from the wind turbines through the interarray cables. One offshore substation will serve EW 1 and one offshore substation will serve EW 2. Each offshore substation will include transformers to increase the voltage of the power received from the wind turbines so the electricity can be efficiently transmitted to the grid.
Onshore construction corridor	Onshore export cable corridor and additional area required for construction to install the onshore export cables from landfall to the onshore substation, as well as the interconnection cables from the onshore substation to the Point of Interconnection.

PROJECT QUICK REFERENCE GUIDE (continued)

Key Project Term	Description
Onshore export cable	230 kV HVAC cables connecting the transition bay at the onshore landfall location to the onshore substation. The cable circuits consist of a single-core copper or aluminum conductor. Fiber optic cables for communication and temperature measurements will also be installed alongside the onshore export cable.
Onshore substation	The facility where power is collected and transformed to the appropriate voltage in order to be injected into the Point of Interconnection substation for distribution.
Point of Interconnection (POI)	The substation where the project is interconnected to distribute power into the grid. For EW 1: Location where the EW 1 Project interconnects into the New York State Transmission System is operated by the New York Independent System Operator at ConEdison’s Gowanus Substation in Brooklyn, New York. For EW 2: Location where the EW 2 Project interconnects into the New York State Transmission System is operated by the New York Independent System Operator at the Oceanside Substation in Oceanside, New York.
Project	The offshore wind project for OCS A-0512 proposed by Empire Offshore Wind LLC consisting of Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2).
Project Area	Lease Area, submarine export cable routes, and onshore project facility locations including the onshore export and interconnection cables, and onshore substations.
Project Design Envelope (PDE)	The range comprising all development activities potentially associated with the Lease Area including potential onshore grid connection corridors and infrastructure, submarine export cable siting corridors, and the offshore Wind Farm Development Area. This excludes any onshore third-party that may be required for the Project to be interconnected (e.g., grid upgrades, Point of Interconnection substation upgrades).
Scour protection	Material, typically stone or rocks, placed around/on top of a structure, if required, to prevent seabed sediment from being flushed away as a result of water flow.
Seabed penetration	Valid for the monopile or jacket foundation; the value specifies the required penetration depth of original seabed for the monopile or piled jacket foundations.
Seabed preparation	Preparation of the seabed to account for scour. For gravity base structure (GBS) and monopiles, this may include a gravel pad and scour protection. For pre-piled jacket foundations, only a gravel pad is expected.
Submarine export cable	230-kV HVAC cables connecting the offshore substation to the transition bay at the export cable landfall location. The cable consists of a three-core copper conductor with a fiber-optic cable integrated into the cable; the cable is protected by one or more layers of armoring.
Submarine export cable siting corridor	Offshore cable corridor from the Lease Area to the export cable landfall, which will be temporarily disturbed during installation activities.

PROJECT QUICK REFERENCE GUIDE (continued)

Key Project Term	Description
Transition piece	The portion of the foundation that forms the interface between the wind turbine tower and the foundation, which can also serve secondary purposes including housing electrical and communication equipment and mounting ancillary components such as boat access facilities, main access platforms, and J-tubes.
Wind turbine generator (wind turbine)	A machine consisting of a rotor with three blades connected to the nacelle that contains an electrical generator and other equipment. Wind turbines transform the kinetic energy created by the rotation of the blades (due to wind energy) into electricity.

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
AADT	Average Annual Daily Traffic
ac	acre
ACHP	Advisory Council on Historic Preservation
ACPARS	Atlantic Coast Port Access Route Study
AD	Anno Domini
ADLS	Aircraft Detection Lighting System
AGL	above ground level
AIS	Automatic Identification System
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ANSI	American National Standards Institute
APE	area of potential effect
AQCR	Air Quality Control Region
ASCE	American Society of Civil Engineers
ASMFC	Atlantic States Marine Fisheries Commission
AVEHP	Analysis of Visual Effects to Historic Properties
AWOIS	Automated Wreck and Obstruction Information System
BACT	Best Available Control Technology
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Bureau of Land Management
BMPs	best management practices
BOEM	Bureau of Ocean Energy Management
CAA	Clean Air Act
CAFRA	Coastal Area Facility Review Act
Call	Call for Information and Nomination
CBRA	Cable Burial Risk Assessment
CCTV	closed-circuit television
CD	Coastal Zone Consistency Determination
CE	concrete extender
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
CMECS	Coastal and Marine Ecological Classification Standard
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	Carbon dioxide equivalent
COA	Corresponding Onshore Area
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
ConEd	Consolidated Edison
COP	Construction and Operations Plan
COTP	Captain of the Port
CP-29	CP-29 Environmental Justice and Permitting
CPIP	Comprehensive Port Improvement Plan
CPT	Cone Penetration Test
CRIS	Cultural Resource Information System
CSO	combined sewer overflow
CTV	Crew Transfer Vessels
CVA	Certified Verification Agent
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act of 1972
DAS/DVS	Distributed Acoustic/Vibration Sensing
dB	decibel
dBA	decibels, A-scale
DF	Direction Finding
DMA	Dynamic Management Area
DMR	Division of Marine Resources
DoD	U.S. Department of Defense
DOI	Department of Interior
DP	dynamic positioning
DPS	Distinct Population Segment
DZ/RA	Danger Zone/Restricted Area
E.O. 23	Executive Order No. 23
EA	Environmental Assessment
ECL	New York Environmental Conservation Law
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	Environmental Impact Statement

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
EMF	electric and magnetic fields
ENGO	environmental nongovernmental organizations
EPA	U.S. Environmental Protection Agency
Equinor Wind	Equinor Wind US LLC
ERAP	Emergency Response Action Plan
ERC	Emission Reduction Credit
ERP	Emergency Response Plan
ESA	Endangered Species Act of 1973
EW	Empire Wind
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act
FDR	Facility Design Report
FEMA	Federal Emergency Management Agency
FHA	Flood Hazard Area
FHWG	Fisheries Hydroacoustic Working Group
FIR	Fabrication and Installation Report
FLO	Fisheries Liaison Officer
FMC	Fishery Management Council
FMP	Fishery Management Plan
FOIA	Freedom of Information Act
FR	Federal Register
ft	feet
ft^2	square feet
gal	gallon
GARFO	Greater Atlantic Regional Fisheries Office
GBS	gravity base structure
GHG	greenhouse gas
GPS	global positioning system
GRR	General Reevaluation Report
GW	gigawatt
ha	hectare
HAP	hazardous air pollutant
HAPC	Habitat Area of Particular Concern
HARS	Historic Area Remediation Site
HAT	Highest Astronomical Tide
HDD	horizontal directional drilling

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
HDPE	high density polyethylene
HF	High frequency
hr	hour
HRG	high-resolution geophysical
HVAC	high-voltage alternating-current
HVDC	high-voltage direct-current
Hz	hertz
IALA	International Association of Marine Aids
IBA	Important Bird Area
IC	interconnection cable
IFR	instrument flight rule
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
in	inch
IP	Island Park
IPaC	Information for Planning and Conservation
IPS	Intermediate Peripheral Structure
ISO	International Organization for Standardization
ITP	Incidental Take Permit
kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometer
km/h	kilometer per hour
km^2	square kilometers
KOP	Key observation point
kV	kilovolt
l	liter
LAER	Lowest Achievable Emission Rate
lb	pound
LB	Long Beach
Ldn	day-night sound level
Leq	equivalent sound level
Lease Area	designated Renewable Energy Lease Area OCS-A 0512
LF	Low frequency
LiDAR	light detection and ranging

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
LIPA	Long Island Power Authority
LIRR	Long Island Rail Road
LNM	Local Notice to Mariners
LOA	Letter of Authorization
Lp	sound pressure level
LPK	peak sound pressure levels
m	meters
m/s	meters per second
m^2	square meters
m^3	cubic meters
MAFMC	mid-Atlantic Fishery Management Council
MARCO	Mid-Atlantic Regional Ocean Council
MBTA	Migratory Bird Treaty Act of 1918
MEC	munitions and explosives of concern
MF	mid-frequency
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MGN	United Kingdom Maritime Guidance Note
mi	statute mile
mL	milliliter
MLLW	mean lower low water
mm	millimeter
mm^2	square millimeter
MMPA	Marine Mammal Protection Act of 1972
MOA	Memorandum of Agreement
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act
MSL	mean sea level
MVA	minimum vectoring altitude
MW	megawatt
N.J.A.C.	New Jersey Administrative Code
N.J.S.A.	New Jersey Statues Annotated
NAAQS	National Ambient Air Quality Standard
NAVD88	North American Vertical Datum of 1988
NDAA	National Defense Authorization Act
NDZ	No-Discharge Zone
NEFMC	New England Fishery Management Council

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
Neptune cable	Neptune Regional Transmission System
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act of 1966
NJ HPO	New Jersey State Historic Preservation Office
NJDEP	New Jersey Department of Environmental Protection
NLCD	National Land Cover Data
nm	nautical mile
NO	nitric oxide
NO_X	nitrogen oxides
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration's National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NSA	noise sensitive areas
NSR	New Source Review
NSRA	Navigation Safety Risk Assessment
NVIC	Navigation and inspection Circular
NWI	National Wetlands Inventory
NY DPS	New York State Department of Public Service
NY SHPO	New York State Historic Preservation Office
NYCDEP	New York City Department of Environmental Protection
NYCEDC	New York City Economic Development Council
NYCRR	New York Codes, Rules and Regulations
NYISO	New York Independent System Operator
NYNJ	New York New Jersey
NYPA	New York Power Authority
NYS WQS	New York State Water Quality Standards
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
NYSERDA	New York State Energy Research and Development Authority
O&M	operations and maintenance
OBIS	Ocean Biogeographic Information System
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OFLR	Onboard Fisheries Liaison Representative
OGS	New York State Office of General Services
OPAREA	Operating Area
OREI	Offshore Renewable Energy Installations
OSHA	Occupational Health and Safety Act of 1970
OSRP	Oil Spill Response Plan
OW	Otariids Underwater
PAH	polycyclic aromatic hydrocarbon
PAM	Passive Acoustic Monitoring
PANYNJ	Port Authority of New York and New Jersey
PAPE	preliminary area of potential effect
PARS	Port Access Route Study
PATON	Private Aids to Navigation
PCB	polychlorinated biphenyl
PDE	Project Design Envelope
PM10	particulate matter less than 10 microns in diameter
PM2.5	particulate matter less than 2.5 microns in diameter
POI	Point of Interconnection
Poseidon	Poseidon Transmission
ppt	parts per thousand
Project	The development and operation of the Project Area for the generation of offshore wind energy and its transmission to interconnections onshore. The Project will consist of Empire Wind 1 and Empire Wind 2.
PSN	Proposed Sale Notice
PSO	Protected Species Observer
PTS	permanent threshold shift
PW	Phocids Underwater
QMA	Qualified Marine Archaeologist
Raritan Bay Loop	Transco Raritan Bay Loop natural gas pipeline
RFI	Request for Interest
ROD	record of decision

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
RODA	Responsible Offshore Development Alliance
ROMS	Regional Ocean Modeling System
ROSA	Responsible Offshore Science Alliance
ROW	right-of-way
RSZ	rotor swept zone
SAP	Site Assessment Plan
SAR	search and rescue
SAV	submerged aquatic vegetation
SCADA	Supervisory Control and Data Acquisition
SEL	sound exposure level
SELcum	cumulative sound energy level
SESC	Standards for Soil Erosion and Sediment Control
SF_6	sulfur hexafluoride
SGCN	species of greatest conservation need
SHPO	State Historic Preservation Office
SMA	Seasonal Management Area
SMS	Safety Management System
SO2	sulfur dioxide
SOLAS	International Convention for the Safety of Life at Sea
SOV	service operations vessel
SPCC	Spill Prevention, Control, and Countermeasures
SPDES	State Pollutant Discharge Elimination System
SPI	sediment profile imagery
SPL	Sound Pressure Level
SSBMT	Sustainable South Brooklyn Marine Terminal
SSER	South Shore Estuary Reserve
SWPPP	Stormwater Pollution Prevention Plan
TDWR	Terminal Doppler Weather Radar
TECQ	Texas Commission on Environmental Quality
the Collaborative	the NY Offshore Wind Collaborative
TP	transition piece
tpy	tons per year
TRACON	Terminal Radar Approach Control Facilities
Transco Inc.	Transco
TSS	traffic separation scheme
TTS	temporary threshold shift

ACRONYMS AND ABBREVIATIONS (continued)

Acronym	Definition
U.S.C.	United States Code
UKHO	United Kingdom Hydrographic Office
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordnance
VDEQ	Virginia Department of Environmental Quality
VFR	Visual Flight Rule
VHF	Very High Frequency
VIA	Visual Impact Assessment
VMS	Vessel Monitoring System
VOC	volatile organic compound
VRM	Visual Resource Management
VTR	Vessel Trip Reports
Wall-LI	Wall, New Jersey to Long Island
WCS	Wildlife Conservation Society
WEA	Wind Energy Area
WFDA	Wind Farm Development Area
WHOI	Woods Hole Oceanographic Institute
WI/PWL	Waterbody Inventory/Priority Waterbodies List
WNS	white-nose syndrome
WTA	Weapons Training Area
XLPE	cross-linked polyethylene
yd^2	square yards
yd^3	cubic yards
µm	micrometer
µPa	micropascal

4. PHYSICAL RESOURCES

4.1 Physical and Oceanographic Conditions

4.1.1 Physical Oceanography and Meteorology

This section describes the oceanographic and meteorological environment in the Project Area, including a discussion of circulation and current patterns, temperature, and winds. In addition to the tidal and wind-driven circulation and wave processes occurring during normal conditions, extreme oceanographic and meteorological conditions are expected to impact the Project Area during strong weather events. Strong weather events include, but are not limited to, hurricanes and tropical storms in the warmer months and Nor'easters during the winter months. Additionally, this section details how the construction, operations, and decommissioning of the Project facilities may affect or be affected by oceanographic and meteorological conditions in the Project Area.

Other resources and assessments detailed within this COP that are related to physical and oceanographic conditions include:

- Geological Conditions (Section 4.1.2);
- Public Health and Safety (e.g. extreme weather events, Section 8.12); and
- Metocean Design Basis (Appendix I).

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the offshore waters and coastlines within and in the vicinity of the Lease Area and the EW 1 and EW 2 submarine export cable routes (see **Figure 4.1-1**).

This section relied upon the following data sources:

[redacted]

- NOAA National Data Buoy Center assets (NOAA 2018a, b, c); and
- NOAA National Oceanographic Data Center World Ocean Atlas 2013 (NOAA 2013).

In December 2018, Empire deployed a floating LiDAR buoy, a metocean and wave buoy, and a subsea current meter (Metocean Facilities) in accordance with a BOEM-approved SAP. The Metocean Facilities were deployed for two years and collected directional waves, meteorological conditions, sea water temperature, currents, and conductivity data. Data collected will be used to inform siting and design of the Project, and will be included as an additional metocean analysis in the Facility Design Report (FDR).

In addition, in accordance with 30 CFR § 585.701, preliminary metocean analysis is included as **Appendix I Metocean Design Basis** in support of the Project's basis of design. A detailed metocean analysis will be submitted with the FDR prior to construction.

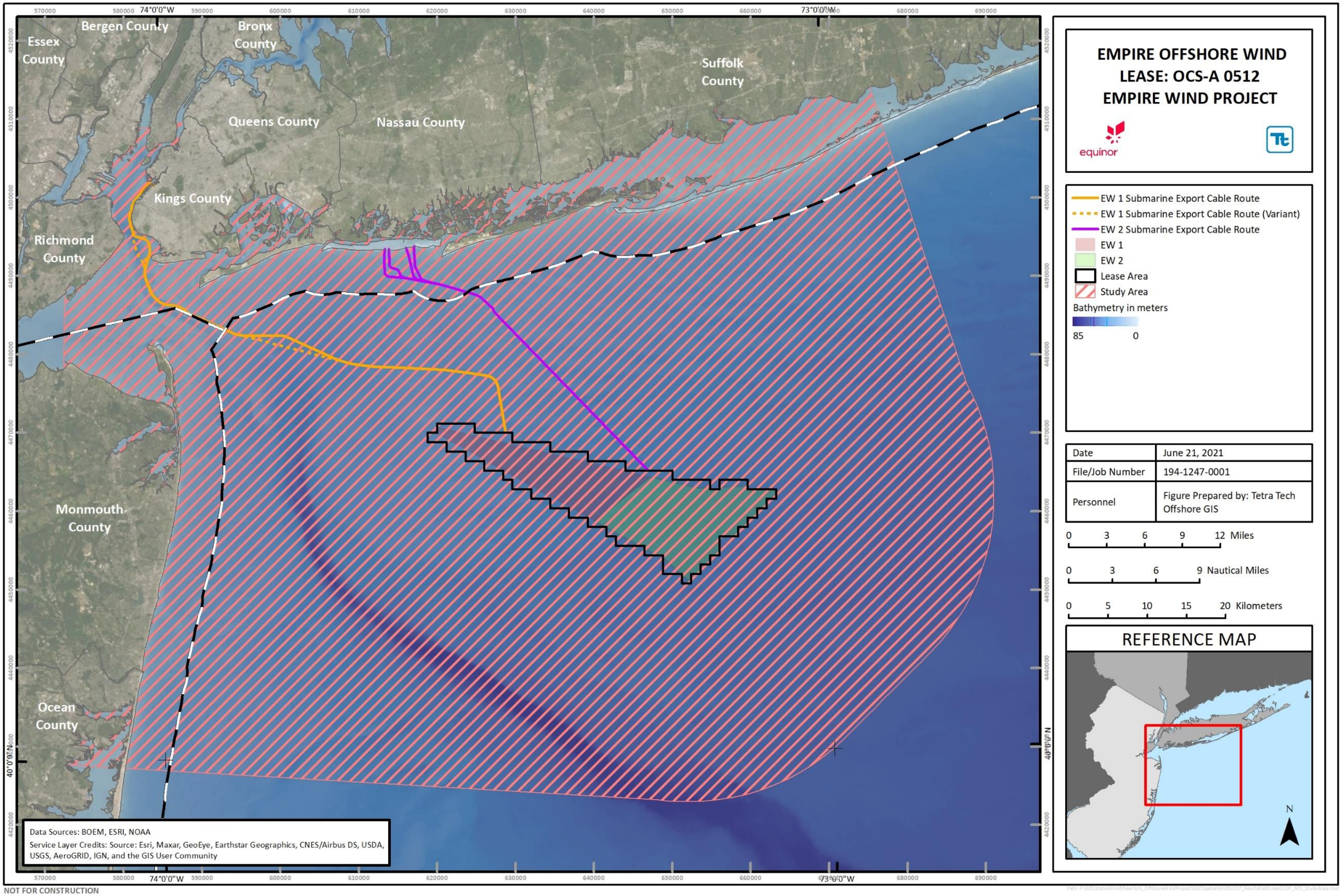


Figure 4.1-1 Physical Oceanography and Meteorology Study Area

4.1.1.1 Affected Environment

The affected environment is defined as the coastal and offshore areas in the New York Bight that have the potential to directly or indirectly affect the construction, operations, and decommissioning of the Project. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

Wind

Normal conditions wind data included in **Appendix I** utilized in support of the Project was taken from [redacted] **Figure 4.1-2**).

Hurricane wind data included in **Appendix I** utilized in support of the Project was taken from [redacted]

[redacted]

[redacted]

Waves

Wave data included in **Appendix I** utilized in support of the Project was taken from [redacted]

[redacted]

[redacted]

[redacted]

Currents

Current data included in **Appendix I** utilized in support of the Project was taken from [redacted]

[redacted]

[redacted]

Water Level

Extreme weather events, such as tropical storms and hurricanes, have historically caused storm surges along coastal New York and New Jersey. Most recently (2012), Hurricane Sandy created a storm surge considered to be more severe than a 100-year extreme event. Storm surges during Hurricane Sandy reached heights up 11 ft (3.5 m) relative to MSL. Flood maps of the EW 1 and EW 2 export cable landfall sites are found in **Figure 4.1-9** and **Figure 4.1-10**. Additionally, **Figure 4.1-11** depicts past hurricane tracks in the Project Area, while **Figure 4.1-12** depicts a heat map of tropical cyclone exposures in the Project Area.

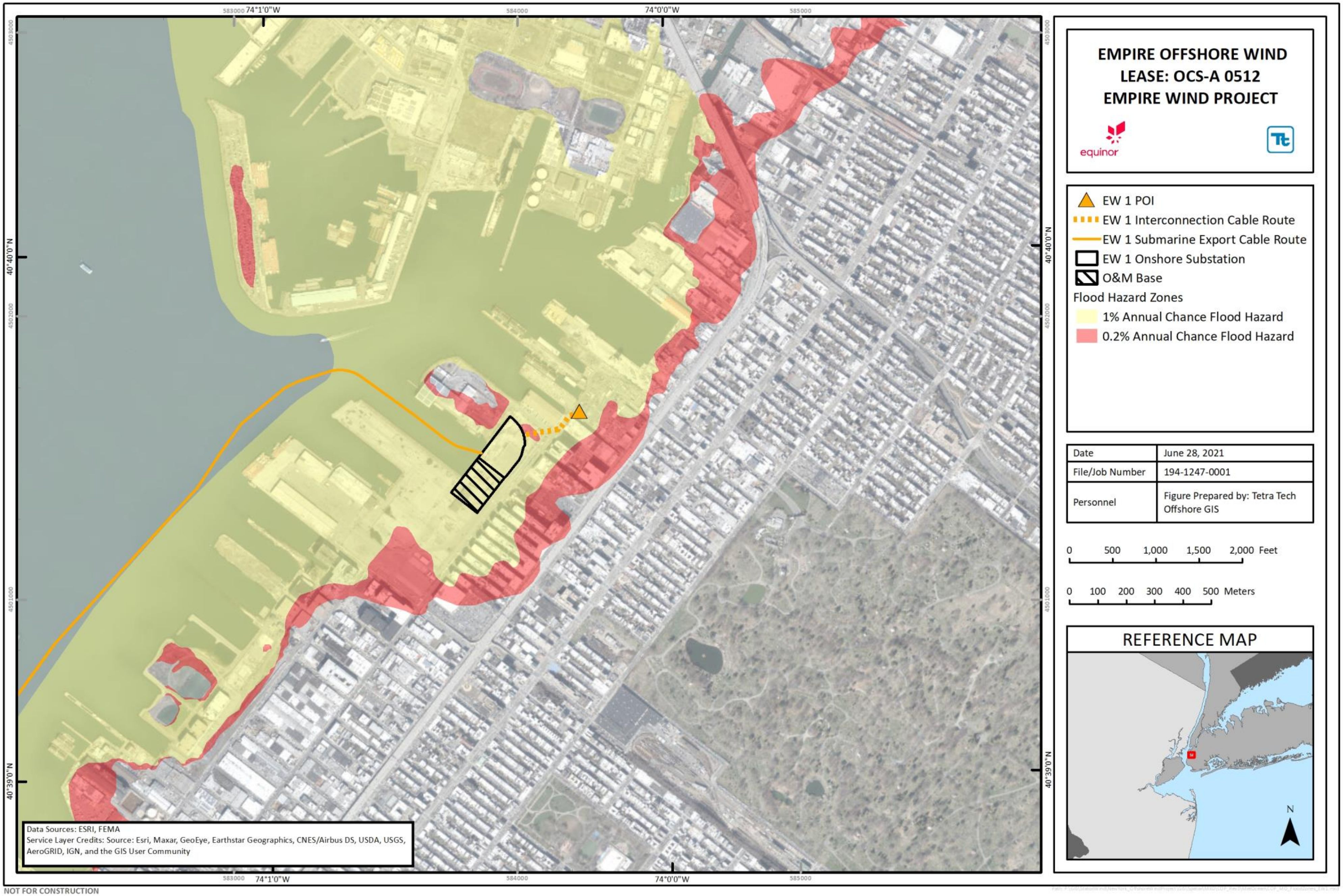


Figure 4.1-9 Flood Zones at the EW 1 Export Cable Landfall Site

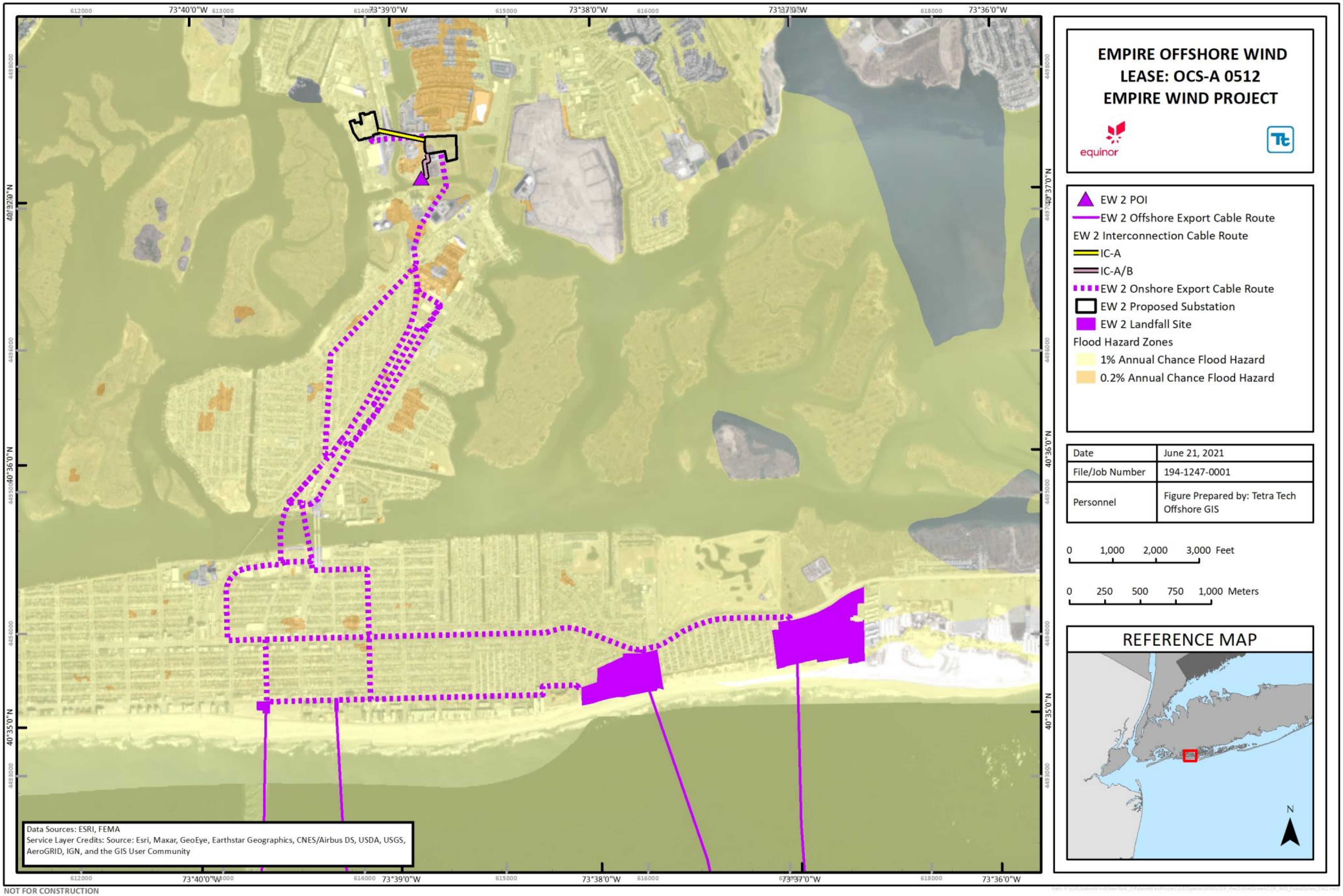
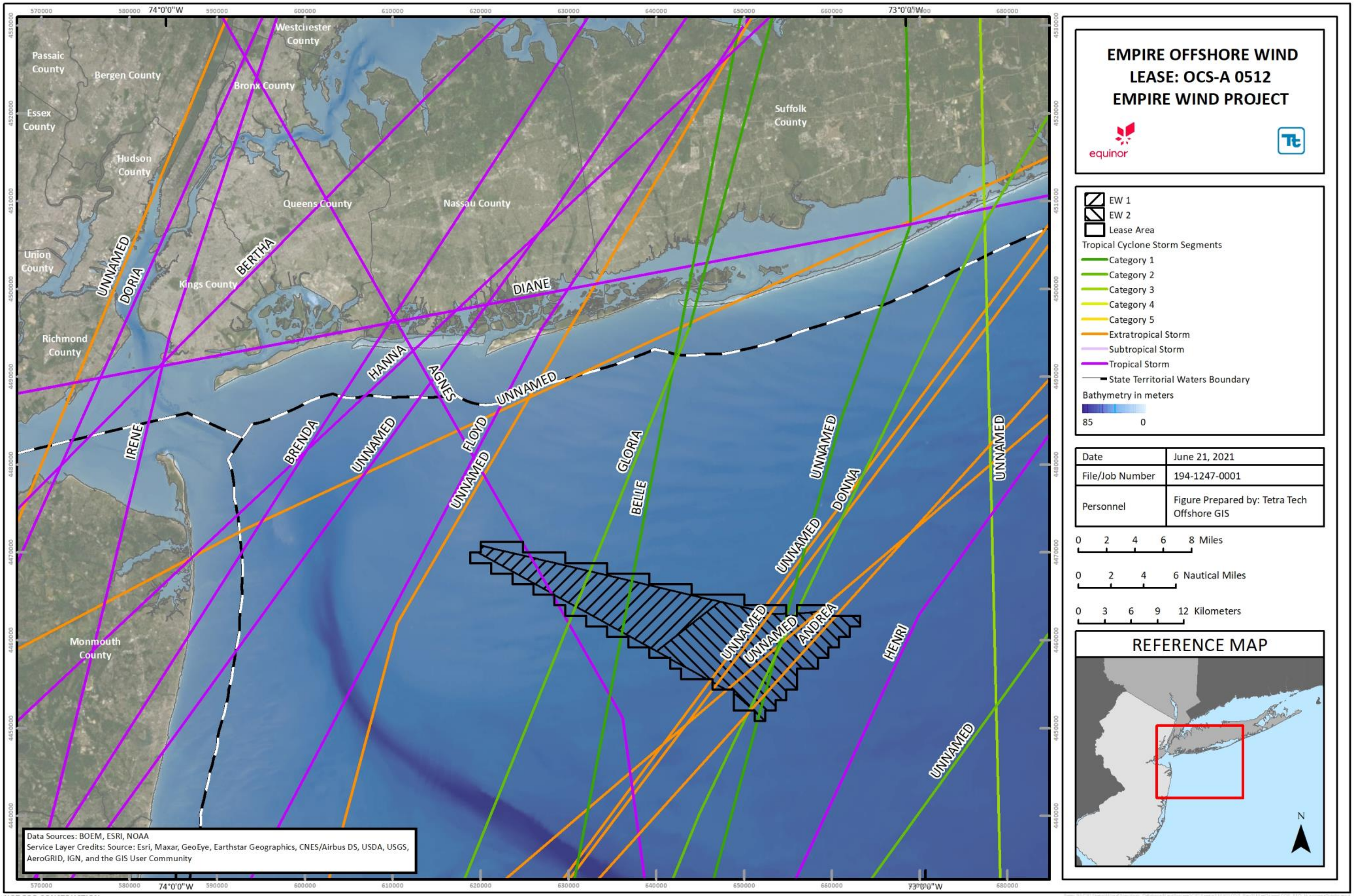


Figure 4.1-10 Flood Zones at the EW 2 Export Cable Landfall Site



NOT FOR CONSTRUCTION

Figure 4.1-11 Hurricane Track Lines in the Project Area

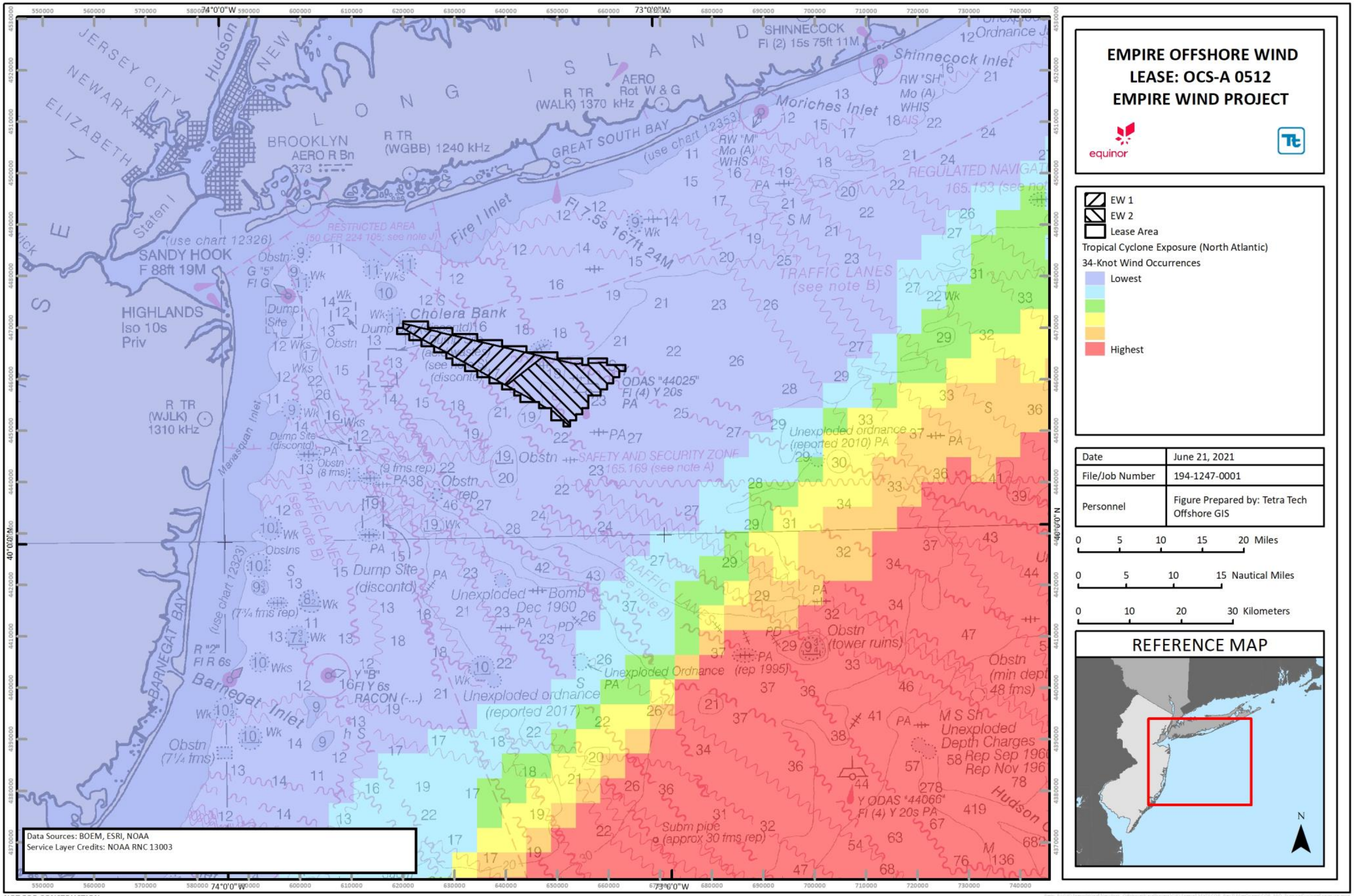


Figure 4.1-12 Tropical Cyclone Exposure Heat Map in the Project Area

Sea Temperature

Sea temperature in the Study Area was collected from [redacted]. Water near the surface is consistently warmer than deeper water. Surface waters experience the most variation in temperature, with bottom waters maintaining more consistent temperatures.

[redacted]

Additionally, sea temperatures taken at 3 ft (1 m) below the surface at NOAA NDBC buoys 44065 and 44025 were analyzed (**Figure 4.1-14** and **Figure 4.1-15**). Data from Buoy 44065 indicates sea temperatures averages ranging from 40 to 75 °F (4.5 to 24 °C), with higher temperatures during the summer months. Data analysis at Buoy 44025 showed very similar results, with averages ranging from 40 to 74 °F (5 to 23.5 °C) and higher temperatures during the summer months.

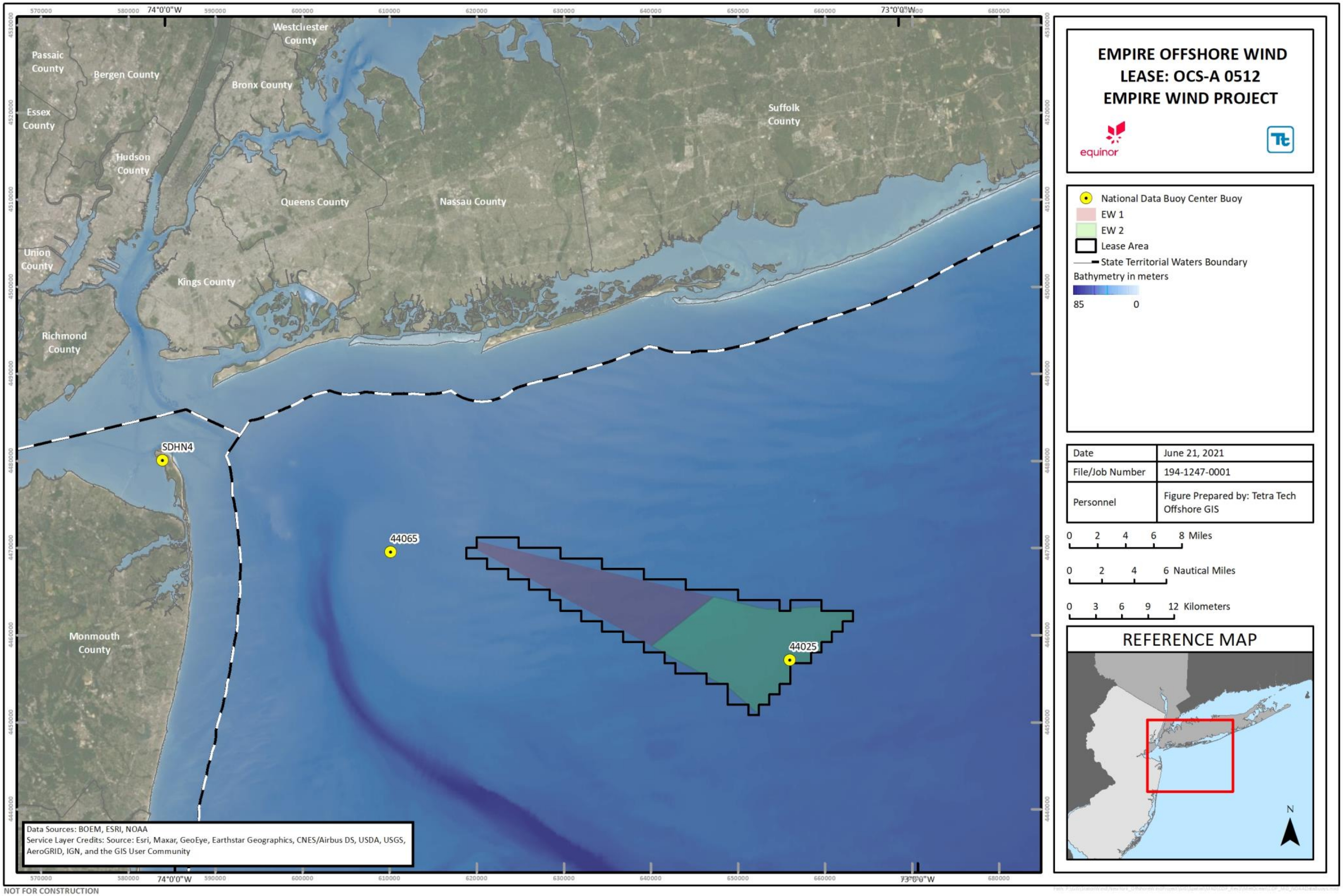


Figure 4.1-14 NOAA NDBC locations for buoys SDHN4, 44065, and 44025

Average Sea Temperature in ° C													
Buoy	Years	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
44065	2008-2018	6.29	4.66	5.08	7.63	12.85	18.29	23.09	24.02	22.14	18.19	13.05	9.21
44025	2007-2018	7.23	5.29	5.21	7.55	12.04	17.96	22.62	23.47	21.12	17.74	13.79	10.48

Figure 4.1-15 Average Sea Temperature in °C at NDBC buoys in the Study Area

Air Temperature

Air temperatures in the Study Area were analyzed based on data from the NOAA NDBC buoys 44025 and 44065 (**Figure 4.1-16**). Results at buoy 44065 show temperatures ranging from 32 to 75 °F (0 to 24 °C), with higher temperatures during the summer months. Results at buoy 44025 are much the same, with temperatures ranging from 32 to 75 °F (0 to 24 °C) and higher temperatures during the summer months.

Average Air Temperature in ° C													
Buoy	Years	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
44065	2008-2018	1.67	2.59	4.21	8.14	13.73	18.91	23.29	23.90	20.94	15.52	9.50	5.63
44025	2007-2018	3.32	3.72	5.27	8.35	12.96	18.59	22.94	23.32	20.34	15.85	10.59	6.54

Figure 4.1-16 Average Air Temperature in °C at NDBC buoys in the Study Area

Ice and Fog

The New York Bight region experiences cold air temperatures during the winter months, resulting in the potential of icing of equipment and materials used for the Project. Potential for icing exists as a result of a number of factors, including atmosphere icing and icing from sea spray (NYSERDA 2010). Atmospheric icing encompasses ice formed by rain that freezes upon contact with a surface as well as ice formed by the rapid freezing of fog upon contact with a surface (NYSERDA 2010). Predictions of atmospheric icing in the New York Bight region are low, at less than 0.1 percent, and impacts from atmospheric icing are nearly negligible, with the exception of the potential for ice shedding. Ice shedding occurs when ice accumulation on the wind turbine blades begins to melt due to change in temperature or falls due to other forces (Afzal and Virk 2018). The conditions which are most likely to cause icing of the wind turbine blades include low wind speeds, high relative humidity, and sub-zero temperatures (Hudecz et al. 2014). The likelihood of combination of these conditions occurring in the Project Area is low, based on data collected at NOAA National Data Buoy Center Buoy 44025 (NOAA 2018c). Data collected at Buoy 44025 from 1985 to 2008 identify approximately seven percent of air temperature readings occurring at sub-zero temperatures, and approximately five percent of wind speed readings occurring at 3 knots or less (NOAA 2018c). The NOAA National Buoy Data Center Buoy 44025 did not collect humidity data; however, the low occurrence of sub-zero temperatures and low wind speeds indicate the low likelihood that all three conditions will be present simultaneously, and therefore the low likelihood that icing of the wind turbine blades will occur. Icing from sea spray occurs at elevations below 52 ft (16 m) and will not pose any risk to wind turbine blades (NYSERDA 2010).

4.1.1.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts during the construction, operations, and decommissioning of the Project, as it relates to meteorological and oceanographic conditions in the Project Area, is the potential for damage or disruption of the Project during EW 1 and EW 2. Therefore, the maximum design scenario would be an impact during EW 1 and/or EW 2 or to any component of the Project from meteorological and oceanographic conditions, with special consideration to the possibility of extreme weather events. The Project is not anticipated to impact physical and oceanographic conditions such as water level, temperature, and ice and fog and is therefore not discussed further.

4.1.1.2.1 Construction

The construction phase of the Project will involve personnel, crew, and contractors on site within the Project Area. The safety of all personnel, crew, and contractors are an absolute priority to Empire. Safety plans for extreme weather conditions will be established prior to the commencement of any construction activities. Any weather conditions that could impact the safety of the crew will be assessed and necessary precautions will be taken. All offshore construction activity will be stopped in lightning storms and any wind and sea states that exceed the operational limits of the Project. Additionally, any activity restrictions due to weather defined by equipment manufacturers will be followed and assumed to be included in the operational limitations of the Project. Furthermore, all personnel, crew, and contractors will secure Project-related construction equipment and components during any extreme weather event, to the extent practicable, to minimize and reduce losses; safety will remain the utmost priority. Post-event surveys will also be conducted in the Project Area to collect equipment or components that may have been lost.

4.1.1.2.2 Operations and Maintenance

Infrastructure design for the Project, both onshore and offshore, will take into consideration the extreme weather conditions that the Project Area has the potential to experience. All infrastructure will be designed to withstand projected weather conditions through the duration of Project operations and mitigate damage or disruption resulting from extreme weather conditions.

Any onshore infrastructure erected for the operation of the Project will adhere to 2015 International Building Code, American Society of Civil Engineers (ASCE) Standard 7-10, ASCE 113, ASCE 24-14, any relevant Institute of Electrical and Electronics Engineers standards, and state-implemented building codes of New York in order to mitigate any potential negative impacts resulting from the construction of Project-related onshore facilities.

Offshore facilities will be designed with consideration of physical oceanographic and meteorological conditions. Wind turbine foundations will be installed at a distance wide enough such that impacts to ocean currents in the Project Area are not anticipated. Additionally, scour protection will be applied where appropriate, which will further mitigate any impact to and from ocean currents in the Project Area. While the offshore facilities will not have any significant impacts to the affected environment, it should be noted that localized negligible downstream changes in direction and intensity may occur in a phenomenon known as the wake effect. Offshore facilities will compare plans to the International Electrotechnical Commission 614003-1 design code, which does not apply to offshore facilities in the United States but will provide guidelines for building offshore facilities and incorporates considerations for tropical weather events.

4.1.1.2.3 Decommissioning

Impacts during decommissioning are expected to be similar or less than those experienced during construction, as described in Section 4.1.1.2.1. It is important to note that advances in decommissioning methods/technologies are expected to occur throughout the operations phase of the Project. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts and safety concerns will be re-evaluated at that time.

Additionally, safety for all project personnel will remain the top priority to Empire throughout decommissioning efforts. Safety plans for extreme weather conditions will be established prior to commencement of any decommissioning activities. Any weather conditions that could impact the safety of the crew will be assessed and necessary precautions will be taken. All offshore decommissioning activities will be stopped in lightning storms and any wind and sea states that exceed the operational limits of the Project. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.1.1.3 Summary of Avoidance, Minimization, and Mitigation Measures

In order to mitigate the potential impacts from physical oceanographic and meteorological conditions, Empire will require that all personnel, crew, and contractors complete training and are familiar with the safety plans developed for extreme weather conditions. Additionally, the Project will be designed with consideration of conditions in the Project Area.

As no impacts to physical oceanographic and meteorological conditions are anticipated as a result of the Project or Project-related activities, additional measures for avoidance, minimization, and mitigation should not be required.

4.1.2 Geological Conditions

This section describes the geological conditions within the Project Area, including both onshore and offshore conditions. Additionally, this section details how the construction, operations, and decommissioning of the Project facilities may affect or be affected by geological conditions in the Project Area.

Other resources and assessments detailed within this COP that are related to Geological Conditions include:

- Natural and Anthropogenic Hazards (Section 4.1.3);
- Marine Archaeological Resources (Section 6.1);
- Marine Site Investigation Report (Appendix H); and
- Marine Archaeological Resources Assessment (Appendix X).

Data Relied Upon and Studies Completed

For the purposes of this section, the Offshore Study Area includes the offshore waters and coastlines within and in the vicinity of the Lease Area and the EW 1 and EW 2 submarine export cable routes (see **Figure 4.1-17**). The Onshore Study Area includes a 0.25-mi (0.4-km) buffer around the EW 1 and EW 2 onshore export and interconnection cable routes, the onshore substations, O&M Base, and the POIs (see **Figure 4.1-18** and **Figure 4.1-19**)[1].

In accordance with 30 CFR § 585.626, this section relies on several sources of data and information in its assessment of natural and anthropogenic hazards that may be present in the Project Area. These include both publicly available information and data collected throughout the geophysical and geotechnical survey efforts.

Empire has completed extensive geophysical and geotechnical campaigns across the Lease Area and along the submarine export cable routes. **Table 4.1-1** details the scope and timeline for these campaigns as well as the timing for availability of data. Empire believes that information acquired during the campaigns provides BOEM with sufficient information to initiate COP review, including BOEM's initial consultation under Section 106 of the National Historic Preservation Act. Additional detail is provided in **Appendix H Marine Site Investigation Report**.

[1] While the O&M Base will serve both EW 1 and EW 2, the base will be located at SBMT, adjacent to the EW 1 onshore substation, and will therefore be included within the EW 1 Onshore Study Area for the purposes of this analysis.

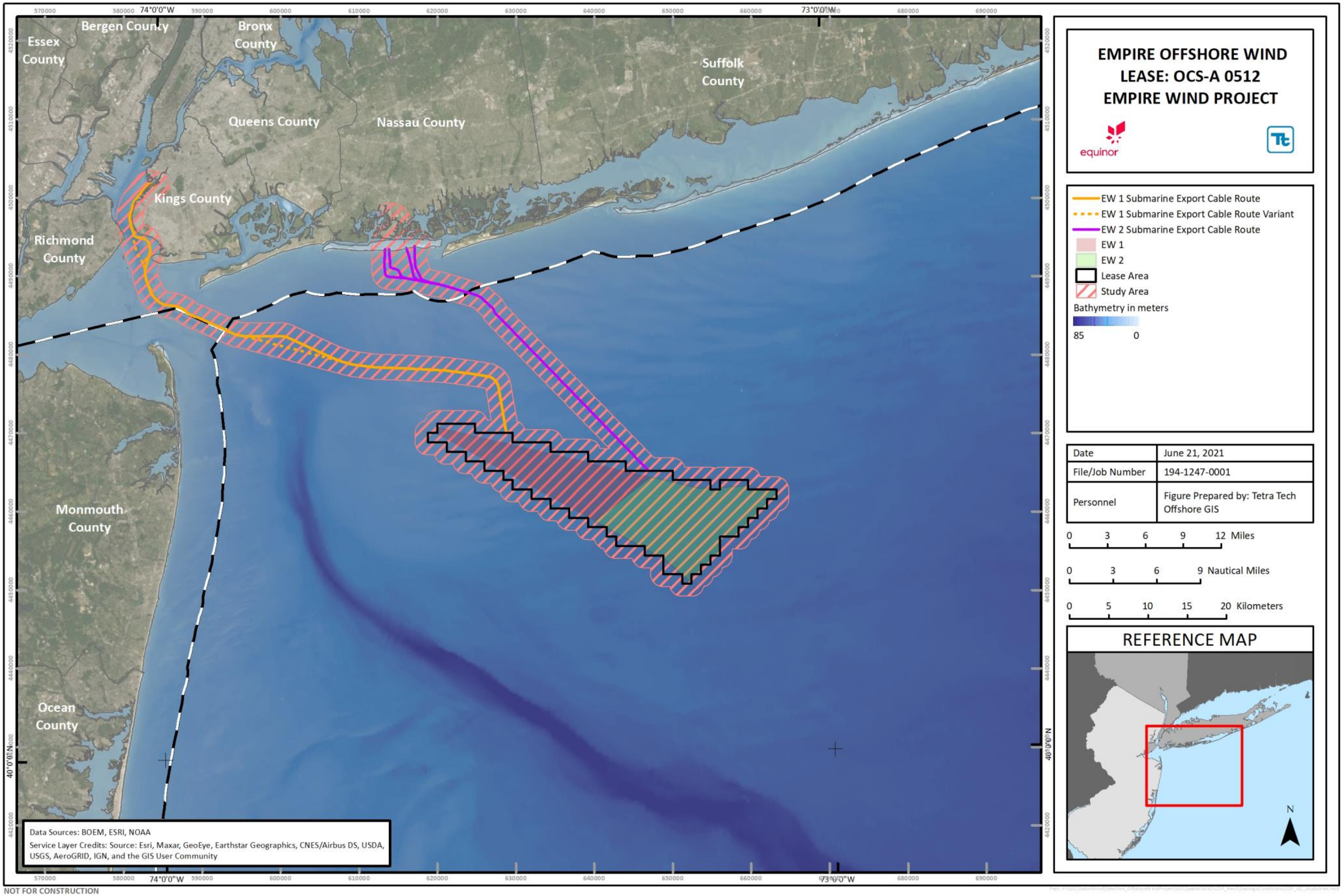


Figure 4.1-17 Geological Conditions Offshore Study Area

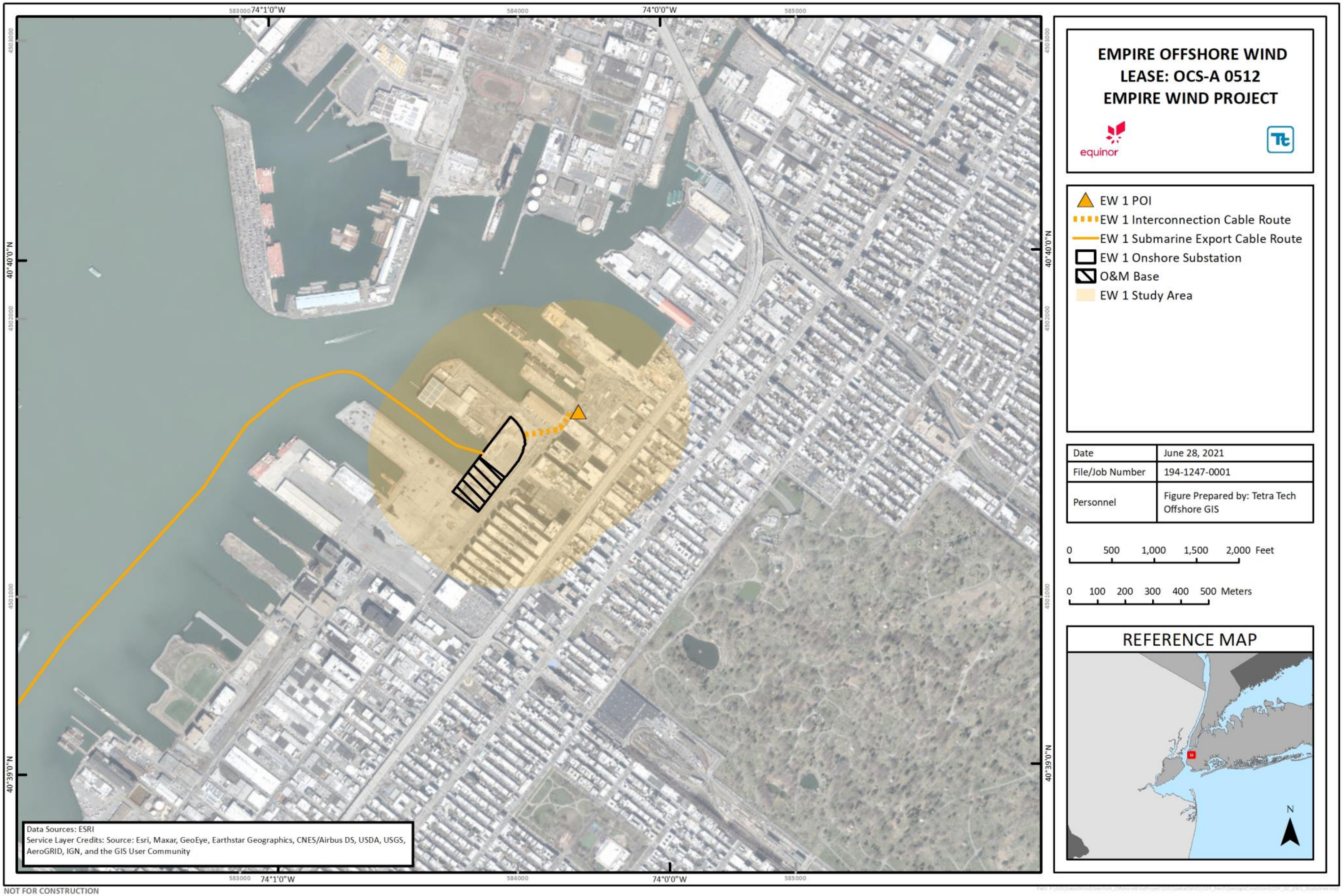


Figure 4.1-18 EW 1 Geological Conditions Onshore Study Area

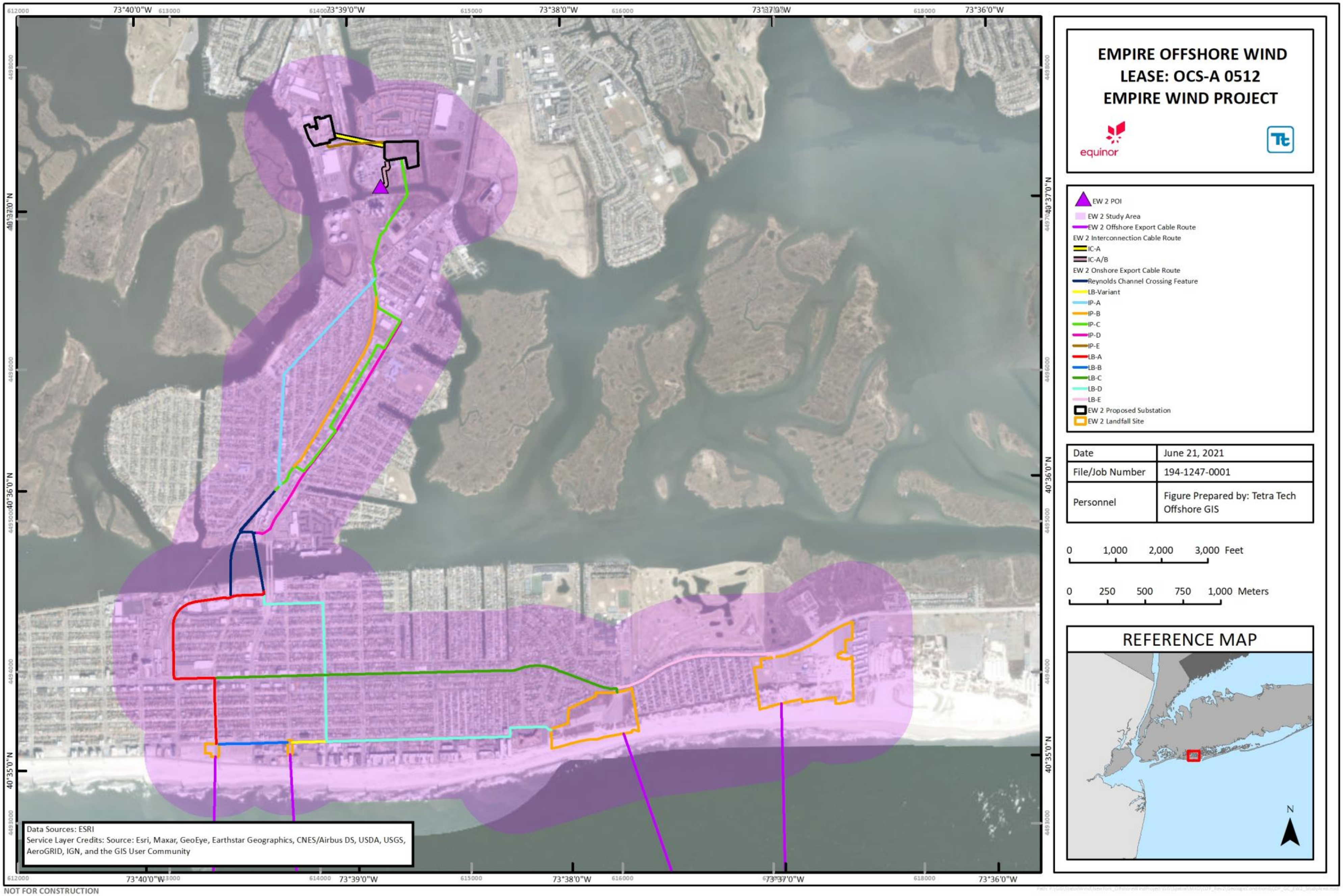


Figure 4.1-19 EW 2 Geological Conditions Onshore Study Area

Table 4.1-1 Completed Geophysical and Geotechnical Campaigns

Survey Plan	Scope	Dates	Timeline for Data Delivery to BOEM
[redacted]			

The results and interpretations of the geophysical and geotechnical datasets collected to date were incorporated into a comprehensive site-specific "ground model" and provided as part of **Appendix H**. The ground model is a three-dimensional representation of the geological and stratigraphic conditions within the offshore portions of the Project Area, with a focus on the factors that pertain to Project design and engineering. As additional surveys and assessments are completed, Empire will update the ground model. The information produced by the ground model has and will continue to inform the Project's understanding of geological conditions within the Project Area and support Project siting and design including identification of avoidance, minimization, and mitigation measures.

The data and interpretation information used to describe the submarine export cable routes within Section 4.1.2.1 was collected from the surveys previously conducted for the Project. Additional surveys commenced in the summer and fall of 2020, and continues into 2021, to collect data and interpretation information for the new submarine export cable route variants. This section will be amended in accordance with an agreed-upon schedule with BOEM.

4.1.2.1 Affected Environment

The affected environment is defined as the offshore areas and onshore areas that have the potential to directly or indirectly affect the construction, operations, and decommissioning of the Project. For the purposes of this section, the affected environment includes the offshore components, including the foundations and submarine export and interarray cables, and onshore components, including onshore export and interconnection cables, onshore substations, O&M Base, and the POIs. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

Offshore Baseline Conditions

Lease Area: The geology and geomorphology in the New York Bight region is diverse with glacial deposits as a result of the Pleistocene Epoch sea level falls and rises, and more recent Flandrian transgression of sea level (Messina and Stoffer 1996). Analysis of geophysical and geotechnical survey data collected across the Lease Area indicates the current geological conditions underlying the Lease Area are generally flat. Water depths vary within the Lease Area from 78 ft (24 m) to 144 ft (44 m) (NAVD88), with deeper water depths in the southeast portion of the Lease Area. Slope gradient across the Lease Area is typically less than 1 degree. The seabed in the northwestern portion of the Lease Area has been interpreted to have undulating character. Objects identified on the seabed have been addressed in **Section 4.1.3 Natural and Anthropogenic Hazards**.

[redacted]

[redacted]

[redacted]

EW 1: The EW 1 submarine export cable route exits the Lease Area from the northwestern edge of the Lease Area and will travel northwest through Raritan Bay to the EW 1 landfall in Brooklyn, New York. [redacted]

[redacted]

[redacted]

[redacted]

The EW 1 submarine export cable route variants include a slight deviation in federal waters to remain straight and a deviation in state waters to avoid traversing a proposed realignment of an anchorage area in Gravesend Bay. Seabed conditions within these deviations are not expected to vary significantly from the EW 1 submarine export cable route. Additional surveys commenced in the summer and fall of 2020 and will continue into 2021 to collect data and interpretation information for the new EW 1 submarine export cable route variants. This section will be amended in accordance with an agreed-upon schedule with BOEM.

Stratigraphic layers of the EW 1 submarine export cable route are depicted in **Figure 4.1-21**, referenced by Kilometer Post.

[redacted]

EW 2: The EW 2 submarine export cable route exits the Lease Area from the central portion of the Lease Area and travels in a northwestern direction in a relatively straight line until turning north to the EW 2 landfall in Long Beach, New York. [redacted]

[redacted]

[redacted]

Additional surveys commenced in the summer and fall of 2020, and will continue into 2021, to collect data and interpretation information for the EW 2 submarine export cable route. This section will be amended in accordance with an agreed-upon schedule with BOEM.

Details of the stratigraphic layers along the EW 2 submarine export cable route that are interpreted at this time can be found in **Figure 4.1-22**, referenced by Kilometer Post (KP).

Onshore Baseline Conditions

EW 1 and EW 2 lie in a boundary region between glaciated and proglacial terrains. Long Island was glaciated several times, while Asbury Park and Neptune Township, New Jersey did not experience any glaciations during the Pleistocene. The most recent glacial period in the U.S., called the Wisconsinan glaciation, stretched from approximately 30,000 to 19,000 years ago. During this time, the Laurentide Ice Sheet covered most of northern North America, and its margin terminating just north of the survey area. This is evident in a series of glacial end moraines located on the north side of Long Island, Martha´s Vineyard and Nantucket. To the north of the moraines are dense basal tills (initially deposited beneath and immediately in front of the glacier) overlying the bedrock. The moraines consist of sandy till with variable sorting and drainage and at times mixed with stratified sands (Caldwell 1989). The onshore portion of the Project is underlain by Precambrian crystalline bedrock. On Manhattan, rock outcrops are at the surface but rapidly slope to the south and are overlain by a massive edge of Cretaceous sand and gravel deposits.

[redacted]

EW 1: The EW 1 onshore export and interconnection cable routes and onshore substation and O&M Base are located on the northern side of the moraine and the site is underlain by glacial till that overlies the bedrock to depths of up to 200 ft (60 m). This till consists of unsorted variable texture of clay, silt, sand, and bolder clay of low permeability.

EW 2: Deposits underlying the EW 2 onshore export and interconnection cable routes and onshore substation are made up of fluvial sand and gravel, which form a barrier island deposited by ocean currents and are associated with dunes. The sand and gravel make up the landfall site and overlie glacial outwash deposits. Further to the north at Island Park the beach deposits are replaced by surface outwash deposits consisting of coarse to fine well-rounded stratified gravel and sand fining away from the moraine, and are up to 60 ft (18 m) thick. At the EW 2 onshore substation sites, bedrock depths may be greater than 1,000 ft (304 m).

The areas surrounding EW 1 and EW 2 have undergone significant man-made and construction-related modifications. Artificial fills and rip-rap seawalls have been utilized to modify the original topography to accommodate significant amounts of anthropogenic activities. This has resulted in the Natural Resource Conservation Service identifying these areas as Urban or as Udorthents (made land over loose sandy and gravelly glaciofluvial deposits and/or firm coarse-loamy basal till derived from granite and gneiss) (SoilWEB 2019).

In depth geologic and geotechnical evaluations will be conducted once a final location for the export cable landfall and onshore substation is identified. The decision on location will account for the underlying geology of the area, avoiding any areas at which the geological conditions pose a risk to the Project. Additionally, the design and construction methods will account for any necessary special circumstances based on the geological conditions of the area chosen.

4.1.2.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts during the construction, operations, and decommissioning of the Project, as it relates to geological conditions identified within the Project Area, is the potential for damage or disruption of the Project during EW 1 and EW 2. The maximum design scenario, as described in **Table 4.1-3**, represents the greatest potential for damage or disruption to the Project as a result of geological conditions, and includes the foundation and cable installation, both offshore and onshore. The parameters provided in **Table 4.1-3** represent the maximum design scenario associated with full build-out of the Lease Area of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations) with both submarine export cable routes to EW 1 and EW 2.

Table 4.1-3 Summary of Maximum Design Scenario Parameters for Geological Conditions

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations): EW 1: 71 wind turbines and 1 offshore substation EW 2: 103 wind turbines and 1 offshore substation	Representative of the maximum number of structures for EW 1 and EW 2.

Table 4.1-3 Summary of Maximum Design Scenario Parameters for Geological Conditions (continued)

Parameter	Maximum Design Scenario	Rationale
Submarine export cables	Based on full build-out of EW 1 and EW 2. EW 1: 40 nm (74 km) EW 2: 26 nm (48 nm)	Representative of the maximum length of new submarine export cables to be installed.
Interarray cables	Based on full build-out of EW 1 and EW 2, with the maximum number of structures (174 wind turbines and 2 offshore substations) to connect. EW 1: 116 nm (214 km) EW 2: 144 nm (267 nm)	Representative of the maximum length of interarray cables to be installed.
Wind turbine foundation Horizontal disturbance	GBS	Representative of the foundation that would result in the maximum horizontal area of sediment disturbance during installation.
Wind turbine foundation Installation method Vertical disturbance	Monopile	Representative of the foundation installation method that would result in the maximum vertical area of sediment disturbance during installation.
Project-related vessels	Based on full build-out of EW 1 and EW 2, which correspond to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum number of Project-related vessels, which will result in the maximum construction and installation footprint.
Export cable landfall	Based on EW 1 and EW 2. EW 1: HDD in a 200-ft by 200-ft (61-m by 61-m) area. EW 2: HDD in a 246-ft by 246-ft (75-m by 75-m) area.	Representative of the maximum area to be utilized to facilitate the export cable landfall.
Onshore export and interconnection cables	Based on EW 1 and EW 2: EW 1: 0.2 mi (0.4 km). EW 2: 5.7 mi (9.2 km).	Representative of the maximum length of onshore export and interconnection cables to be installed.
Onshore substations	Based on EW 1 and EW 2: EW 1: 10.8-ac (4.4-ha) area. EW 2: 7.4-ac (3.0-ha) area.	Representative of the maximum area to be utilized to facilitate the construction of the onshore substation.
O&M Base	6.5-ac (2.6-ha) area.	Representative of the maximum area to be utilized to facilitate the construction of the O&M Base.

Table 4.1-3 Summary of Maximum Design Scenario Parameters for Geological Conditions (continued)

Parameter	Maximum Design Scenario	Rationale
Staging and construction areas, including port facilities, work compounds, and lay-down areas	Based on EW 1 and EW 2. Maximum number of work compounds and lay-down areas required. Ground disturbing activities are not anticipated. Independent activities to upgrade or modify staging, construction areas, and ports prior to Project use will be the responsibility of the facility owner.	Representative of the maximum area required to facilitate the offshore and onshore construction activities.
Operations		
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum number of Project-related vessels, which will result in the maximum operations and maintenance disturbance footprint.

4.1.2.2.1 Construction

The siting and design of Project components must be informed by geological conditions known to exist in the Project Area. During construction, the installation of offshore and onshore components, including foundations, wind turbines, substations, export and interarray cables, as well as anchoring of working vessels and Project infrastructure, may be disrupted or damaged as a result of the geological conditions in the Study Area. Installation of the Project is not anticipated to result in broad scale impacts to the geological setting in the area.

After reviewing the available geological data, it has been determined that the primary concerns relating to the construction, operations, and decommissioning of the Project include impacts to the Project design resulting from seabed and soil conditions that are not suitable for construction. As such, the Project has included appropriate foundation and cable installation methodologies that account for these conditions. Project infrastructure will be designed and installed using industry-standard methodology, which allows for the Project infrastructure to withstand the geological conditions within the Project Area for the duration of the Project lifetime.

Onshore infrastructure erected for the operations of the Project will adhere to relevant guidelines and building codes. In addition, onshore infrastructure designs will account for geological conditions in the area. During construction, there will be short-term disturbance of the upper layers of soil along the onshore export and interconnection cable routes; following installation, all trenches will be back-filled, and surface grades will be returned (i.e., graded) to pre-construction conditions as practicable. Design and installation of the export cable landfall, onshore export and interconnection cables, onshore substations, and O&M Base will be supported by an onshore geotechnical investigation to be completed in advance of final design. Activities at staging and construction facilities will be consistent with the established and permitted uses of these facilities, and Empire will comply with applicable permitting standards to limit environmental impacts from Project-related activities.

4.1.2.2.2 Operations and Maintenance

Operations of the Project must account for the geological conditions identified in the Project Area. Monitoring of assets that have the potential to be impacted by natural and anthropogenic hazards, including foundations, and interarray and export cables, is described in **Section 3.5.1**, and generally includes regular surveys of foundations as well as the offshore export cables and interarray cables routes, to confirm the cables have not become exposed or that the cable protection measures have not worn away. An Operations and Maintenance (O&M) Plan will be developed and finalized during the FDR/Fabrication Installation Report (FIR) phase and prior to the commencement of construction.

4.1.2.2.3 Decommissioning

Impacts during decommissioning are expected to be similar or less than those experienced during construction. It is important to note that advances in decommissioning methods/technologies are expected to occur throughout the operations phase of the Project. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.1.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

In order to mitigate the potential impact-producing factors described in Section 4.1.2.2, the Project is proposing to implement the following avoidance, minimization, and mitigation measures.

4.1.2.3.1 Construction

During construction, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.1.2.2.1:

- The siting of offshore components to avoid anomalous or challenging geological conditions to the extent practicable;
- Project infrastructure will be designed and constructed with consideration of the geological conditions within the Project Area;
- Additional study and analysis will be completed prior to construction and installation activities to inform the selection of methods to allow for Project infrastructure to be constructed in a way that allows for the least impact, both to and from, the geological conditions in the Project Area;
- The siting of onshore components in previously disturbed areas, existing roadways, and/or right of ways (ROWs) to the extent practicable; and
- Areas disturbed by construction activities will be restored (i.e., graded) to pre-construction conditions, to the extent practicable.

4.1.2.3.2 Operations and Maintenance

During operations, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.1.2.2.2:

- The on-going monitoring of assets that have the potential to be impacted by geological conditions, including foundations, and interarray and export cables, to confirm the cables have not become exposed or that the scour and cable protection measures have not worn away.

4.1.2.3.3 Decommissioning

Avoidance, minimization, and mitigation measures proposed to be implemented during decommissioning are expected to be similar to those implemented during construction and operations, as described in Section 4.1.2.3.1 and Section 4.1.2.3.2. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and avoidance, minimization, and mitigation measures for decommissioning activities will be proposed at that time.

4.1.3 Natural and Anthropogenic Hazards

This section details the potential natural and anthropogenic hazards within the Project Area. Identification of natural hazards is essential prior to the development of the Project so that measures can be identified and implemented during construction, operations, and decommissioning activities. Natural hazards discussed in this section include those stated in 30 CFR § 585.626(a)(6) and include natural seafloor and shallow hazards and anthropogenic hazards.

Other resources and assessments detailed within this COP that are related to natural and anthropogenic hazards include:

- Geological Conditions (Section 4.1.2);
- Marine Archaeological Resources (Section 6.1);
- Commercial and Recreational Fishing (Section 8.8);
- Marine Energy and Infrastructure (Section 8.10);
- Marine Site Investigation Report (Appendix H); and
- Marine Archaeologic Resources Assessment (Appendix X).

Data Relied Upon and Studies Completed

For the purposes of this section, the Natural and Anthropogenic Hazards Study Area includes the Lease Area and the EW 1 and EW 2 submarine export cable siting corridors (see **Figure 4.1-23**).

In accordance with 30 CFR § 585.626, this section relies on several sources of data and information in its assessment of natural and anthropogenic hazards that may be present in the Project Area. These include both publicly available information and data collected during Project Site Assessment activities (i.e. geophysical and geotechnical surveys) as described in **Section 4.1.2.1**.

4.1.3.1 Affected Environment

The affected environment is defined as the coastal and offshore areas in the New York Bight that have the potential to directly or indirectly affect the construction, operations, and decommissioning of the Project. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

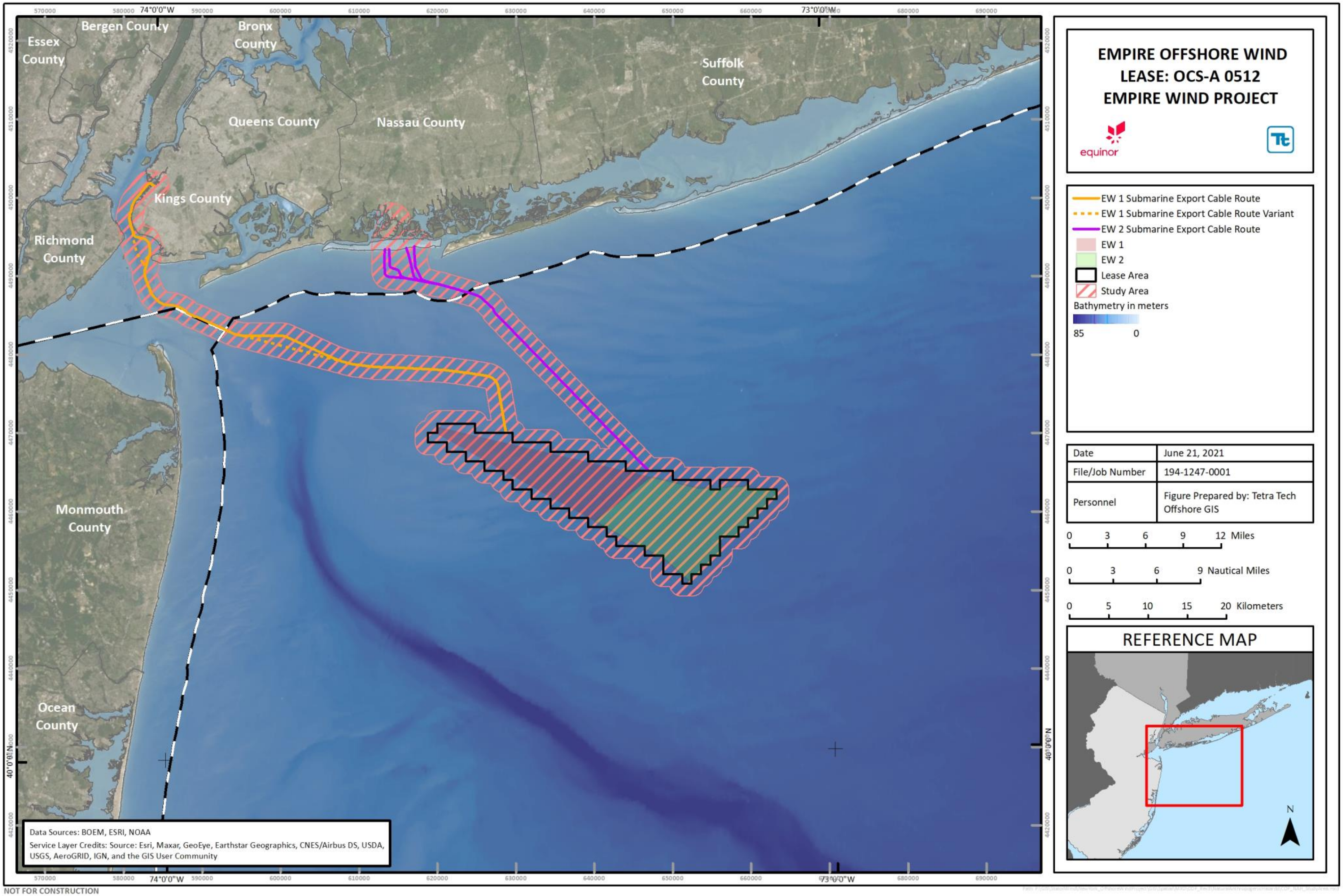


Figure 4.1-23 Natural and Anthropogenic Hazards Study Area

Existing natural and anthropogenic hazardous conditions in the Project Area are identified and discussed in detail in **Appendix H**. Additional surveys commenced in the summer and fall of 2020, and will continue into 2021, to collect data and interpretation information for the new EW 1 submarine export cable route variants. This section will be amended in accordance with an agreed-upon schedule with BOEM. [redacted] Ongoing efforts to evaluate the potential for UXO presence in the Project Area are continuing, and any necessary updates will be provided to BOEM.

4.1.3.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts during the construction, operations, and decommissioning of the Project, as it relates to natural and anthropogenic hazards identified within the Project Area, is the potential for damage or disruption of the Project during EW 1 and EW 2. The maximum design scenario, as described in **Table 4.1-4**, represents the greatest potential for damage or disruption to the Project as a result of natural and anthropogenic hazards, and includes the foundation installation and submarine export cable burial/landfall and interarray cable burial. The parameters provided in **Table 4.1-4** represent the maximum potential impact from full build-out of the Lease Area of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations) with both submarine export cable routes to EW 1 and EW 2.

Table 4.1-4 Summary of Maximum Design Scenario Parameters for Natural and Anthropogenic Hazards

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations). EW 1: 71 wind turbines and 1 offshore substation EW 2: 103 wind turbines and 1 offshore substation	Representative of the maximum number of structures.
Submarine export cables	Based on full build-out of EW 1 and EW 2. EW 1: 40 nm (74 km) EW 2: 26 nm (48 nm)	Representative of the maximum length of new submarine export cables to be installed.
Interarray cables	Based on full build-out of EW 1 and EW 2, with the maximum number of structures (174 wind turbines and 2 offshore substations) to connect. EW 1: 116 nm (214 km) EW 2: 144 nm (267 nm)	Representative of the maximum length of interarray cables to be installed.
Wind turbine foundation Horizontal disturbance	GBS	Representative of the foundation that would result in the maximum horizontal area of sediment disturbance during installation.

Table 4.1-4 Summary of Realistic Maximum Design Scenario Parameters for Natural and Anthropogenic Hazards (continued)

Parameter	Realistic Maximum Design Scenario	Rationale
Wind turbine foundation Installation method Vertical disturbance	Monopile	Representative of the foundation installation method that would result in the maximum vertical area of sediment disturbance during installation.
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum number of Project-related vessels, which will result in the maximum construction and installation footprint.
Operations		
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum number of Project-related vessels, which will result in the maximum operations and maintenance disturbance footprint.

4.1.3.2.1 Construction

During construction, the installation of offshore components, including foundations, wind turbines, offshore substations, and submarine export cables, and interarray cables, as well as anchoring of working vessels and Project infrastructure, may be disrupted or damaged as a result of the natural and anthropogenic hazards in the Study Area. Perhaps, more importantly, the siting and design of Project components must be informed by the presence or absence of the features. Based on the current understanding of the Study Area, the following primary natural and anthropogenic hazards have been identified and/or may be present, including, but not limited to:

- Identified UXO, wrecks, debris, and cable assets may require avoidance buffers and/or crossing agreements;
- Fishing activity, as evidenced by the presence of fishing gear, may expose and/or damage buried submarine cables;
- Presence of soft soils and shallow gas, which may increase the risk of unstable seabed;
- Buried channels may contain submerged marine archaeological resources; and
- Navigation channels and other federal-authorized areas, particularly along the EW 1 submarine export cable route, will require deeper burial of submarine export cables.

The presence of some of these features may also present a risk to Project personnel and/or stakeholders (i.e. fishermen snagging gear) in the Project area during construction, operations, and decommissioning.

Throughout the construction phase of the Project, impacts to natural conditions may occur, as disruptions to surface geology and sediments are unavoidable. Construction methods will take into consideration these disruptions, and methods that impact the surface geology and sediments to the most limited extent feasible will be implemented.

Identified UXO, wrecks, debris, and cable assets may require avoidance buffers and/or crossing agreements. While geophysical survey campaigns were not specifically designed to identify the existence of UXO in the survey area, a Project-specific UXO study was conducted. It detailed the known existence of munitions and explosives of concern (MEC) areas encountered along the EW 1 submarine export cable route and within the Project Area. The UXO study identified the potential existence of a World War II shipwreck along the EW 1 submarine export cable route. The study also considered a BOEM UXO study identifying potential sources of UXO and MEC within the Study Area and surrounding region. Based on the completed risk assessment, which included an assessment of the risk associated with BOEM-identified UXO areas with the Study Area (AC-02, NY WEA-01, and FUDS# C02NY0016), the identified risk level for MEC and UXO is relatively low for most installation activities in the Lease Area. Along the EW 1 export cable route, the identified risk level for the area between the Lease Area and Ambrose channel is considered medium. The risk level from the Ambrose Channel to Bay Ridge is relatively low. Empire continues to evaluate the potential for UXO presence in the Project Area. If future studies identify MEC or UXO within any portion of the Project Area, appropriate mitigate measures will be taken, included recommended avoidance. In addition, industry standard precautions will be taken during construction operations, which include accurate positioning on all submerged Project equipment to decrease the likelihood of contact with any MEC or UXO. MEC and UXO studies and mitigation plans are an ongoing effort for the Project, and will continue to evolve as necessary.

Precautions, including a buffer around identified marine cultural resources, will be taken to avoid disruption of identified wrecks, as discussed in **Section 6.1 Marine Archaeological Resources**. Potentially hazardous debris will be avoided to the extent practical and may be investigated further to ensure that it does not pose a risk to the safety of the Project and Project personnel. No known in-service cables exist within the Lease Area, and cable owner organizations have been contacted to confirm this and identify members with a potential interest in any in-service or planned assets within the Project Area. For submarine assets along the export cable routes, the owners will be engaged to ensure adequate deconfliction and agreement of crossing methodologies. Cable owner organizations as well as the USACE have been contacted to identify members with potential interest in out-of-service or planned assets. This is further discussed in **Section 8.10 Marine Energy and Infrastructure**.

Fishing activity, as evidenced by the presence of fishing gear, may expose and/or damage buried submarine cables. Fishing and trawl activity was observed throughout the Project Area as discussed in **Section 8.8 Commercial and Recreational Fishing**. Fishing buoys were observed in the multibeam and sidescan sonar data, as well as seabed scarring indicating trawl fishing, were observed in the western half of the Lease Area. Empire has maintained communication with the fishing industry in order to decrease the impacts to the industry caused by the Project. As discussed in Section 3.3.2.2, Empire will determine through the Cable Burial Risk Assessment the appropriate target burial depth for submarine export cables, informed by engagement with regulators and stakeholders, extensive experience with submarine assets, and based on an assessment of seabed conditions and activity in the area. The target burial depth accounts for seabed mobility and the risk of interaction with external hazards such as fishing gear and vessel anchors, while also considering other factors such as existing navigational routes.

Presence of soft soils and shallow gas, which may increase the risk of unstable seabed. Presence of soft clay at shallower depths from the seabed has been detected during geotechnical surveys in the Lease Area; additional analysis is necessary to determine presence of soft soils along the submarine export cable routes. A preliminary site zonation assessment, based on the data processed to date, was completed. The soft clay area has been mapped and is accounted for in the Project's geotechnical design basis.

Potential impacts and risks to the installation and stability of foundations as related to shallow gas are considered low risk for both the Lease Area and along the EW 1 submarine export cable route.

Buried channels may contain submerged marine archaeological resources. Buried paleochannel features were identified within the Lease Area and along portions of each of the submarine export cable routes related the Paleo Hudson River drainage, including Pleistocene Channels and Holocene Channels. The average burial depth of the Paleo Hudson River, the oldest and largest paleochannel identified and located in the eastern portion of the Lease Area, is 230 ft (70 m), with associated flood plains identified at burial depths of 49 ft (15 m). The remaining two paleochannel systems identified, the Pleistocene and the Holocene, are both younger and smaller than the main Paleo Hudson channel. These features are more prevalent in the eastern portion of the Lease Area, and have been identified at depths of 118 ft (36 m) and 26 ft (14 m), respectively.

The existence of these paleolandscape features represent a potential natural hazard as the physical and geotechnical properties of the stratigraphic layers may vary significantly between the various geologic units. Development of the Project's ground model captures and maps this variability and mitigates the risk of unexpected changes in the physical and engineering properties of the sediments in the area. Information collected through geophysical and geotechnical survey campaigns allows for the iterative refinement of the ground model, and drives mitigation measures including micrositing and foundation design factors that need to be addressed in order to avoid impacts from the layers identified. Further detail on the geotechnical analysis and the foundation design will be captured in the updated Marine Site Investigation Report and the FDR/FIR respectively.

Navigation channels and other federally managed areas, particularly along the EW 1 submarine export cable route, will require deeper burial of submarine export cables. The EW 1 route avoids but closely parallels Ambrose Channel and Anchorage Channel, the primary navigation channels in and out of Lower and Upper New York Bay respectively. The route also intersects the Bay Ridge navigation channel. Subject to ongoing discussions with USACE and other stakeholders, Empire will bury these sections of the submarine export cable route at a deeper depth in order to avoid any future issues with maintenance of these areas and continues to consult with USACE on this matter as it relates to current and potential improvements of these features.

4.1.3.2.2 Operations and Maintenance

Operations of the Project must account for the natural and anthropogenic hazards identified in the Project Area. Monitoring of assets that have the potential to be impacted by natural and anthropogenic hazards, including foundations, and interarray and export cables, is described in Section 3.5.1, and generally includes regular surveys of foundations as well as the submarine export cables and interarray cables routes, to confirm the cables have not become exposed or that the cable protection measures have not lost their integrity. An O&M Plan will be developed and finalized during the FDR/FIR phase and prior to the commencement of construction of offshore facilities. Based on the current understanding of the Study Area, the following primary natural and anthropogenic hazards have been identified and/or may be present, including, but not limited to:

- Mobile seabeds may result in exposure of buried submarine export cables.

Mobile seabeds may result in exposure of buried submarine export cables. Megaripples exist in the Lease Area, primarily in the western half of the Lease Area and measuring less than 3 ft (1 m) in height. Sandwaves identified along the EW 1 submarine export cable route generally exhibit a maximum height of 6.6 ft (2 m), and wavelengths between 10 to 98 ft (4 to 30 m). Data collected along the EW 2 submarine export cable route did not identify sandwaves like those found along the EW 1 submarine export cable route; however, general knowledge of mobile seabeds in coastal regions indicates the possibility of mobile seabeds along these routes.

Further studies may be needed to identify specific locations of mobile seabed along these submarine export cable routes. This indicates the potential for scour and mobile seabed. Areas of mobile seabed indicate the possibility for sediment to shift, exposing cables, or increasing the amount of sediment covering the cables leading to potential over burial. Empire will implement necessary measures to ensure proper cable burial and protection that accounts for mobile seabed in this area, as well as plan for the possibility of sandwave removal during any future repairs to the cables.

4.1.3.2.3 Decommissioning

Impacts during decommissioning are expected to be similar or less than those experienced during construction. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.1.3.3 Summary of Avoidance, Minimization, and Mitigation Measures

Infrastructure related to the Project will be designed and constructed with consideration of the hazards within the Project Area. Ongoing survey work continues to confirm, update, and refine the ground model, the identified hazards and risks, and understanding of the seabed and subsurface conditions. The ongoing and pending detailed study and analysis of these factors drives the micrositing and design of Project features. This ongoing study also informs and refines any necessary mitigation measures to avoid/mitigate any potential negative impacts. While additional detail will be provided to BOEM in supplemental filings, the following preliminary avoidance, minimization, and mitigation measures are proposed to be implemented in order to mitigate the potential impact-producing factors described for natural and anthropogenic hazards.

4.1.3.3.1 Construction

During construction, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.1.3.2.1:

- Siting of the offshore components to minimize and avoid natural and anthropogenic hazards to the extent practicable;
- Deeper burial of the submarine export cables in areas within certain identified navigation channels, subject to ongoing discussions with the USACE and other applicable stakeholders;
- Deeper burial of the submarine export and interarray cables in areas identified as having seabed penetrating fishing activity;
- Complete detailed, dedicated UXO survey for areas deemed necessary prior to installation;
- Implementation of measures to allow for proper cable burial and protection that accounts for mobile seabed in this area, as well as plan for the possibility of sandwave removal during any future repairs to the cables;
- Implementation of a horizontal buffer of at least 164 ft (50 m) for identified potential submerged cultural resources unless further investigation and/or consultation with the appropriate authorities deems unnecessary; and
- Distribution of information and Local Notice to Mariners (LNM) and active engagement with applicable stakeholders to ensure awareness of the positions of Project-related assets to avoid any collision or interference.

4.1.3.3.2 Operations and Maintenance

During operations, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.1.3.2.2:

- Periodic inspections of offshore Project components, including foundations, scour protection, and submarine export and interarray cables, to verify integrity of the Project components and to confirm adequate burial;
- Implementation of a horizontal buffer of at least 164 ft (50 m) for identified potential submerged cultural resources unless further investigation and/or consultation with the appropriate authorities deems unnecessary;
- Provide as-built information to NOAA to support necessary updates to navigation charts in coordination with NOAA and other stakeholders as needed; and
- Distribution of information and LNMs and active engagement with applicable stakeholders to ensure awareness of the positions of Project related assets to avoid any collision or interference.

4.1.3.3.3 Decommissioning

Avoidance, minimization, and mitigation measures proposed to be implemented during decommissioning are expected to be similar to those implemented during construction and operations, as described in Section 4.1.3.2.1. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and avoidance, minimization, and mitigation measures for decommissioning activities will be proposed at that time.

4.1.4 References

Table 4.1-5 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
FEMA	Flood Hazard Zones	https://www.fema.gov/national-flood-hazard-layer-nfhl	N/A
NOAA	Tropical Cyclone Storm Segments	ftp://ftp.coast.noaa.gov/pub/MSP/TropicalCycloneWindExposure.zip	https://inport.nmfs.noaa.gov/inport/item/54189
NOAA	National Data Buoy Center Buoy	https://www.ndbc.noaa.gov/stations.shtml	N/A
NOAA	Tropical Cyclone Exposure (North Atlantic)	ftp://ftp.coast.noaa.gov/pub/MSP/TropicalCycloneWindExposure.zip	https://inport.nmfs.noaa.gov/inport/item/54196
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coastal/crm.html	N/A

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4.2 Water Quality

This section describes the water quality within and surrounding the Project Area, which includes the Lease Area, submarine export cable routes, onshore export and interconnection cable routes, onshore substations, and O&M Base. Potential impacts to water quality resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Empire are also described that are intended to avoid, minimize, and/or mitigate potential impacts to water quality.

Other assessments detailed within this COP that are related to water quality include:

- Physical and Oceanographic Conditions (Section 4.1);
- Wetlands and Waterbodies (Section 5.2 and Appendix O);
- Benthic Resource and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.5 and Appendices T and U); and
- Sediment Transport Analysis (Appendix J).

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the offshore waters and coastlines within and in the vicinity of the Lease Area and the EW 1 and EW 2 submarine export cable routes, and a 0.25-mi (0.4-km) buffer around the onshore components, including the landfall, onshore export and interconnection cables, onshore substations, and O&M Base (see **Figure 4.2-1** through **Figure 4.2-3**)[2].

In order to understand existing water quality in the Study Area, publicly available resources for marine, groundwater, and surface waters were consulted and assessed. Publicly available data was also used to develop a Sediment Transport Analysis, which was conducted in order to satisfy the requirements of 30 CFR § 585.627(a)(2), and to assess the potential impacts resulting from installation of the submarine export cables (see **Appendix J Sediment Transport Analysis** for additional information). Data required to complete this analysis included meteorological data, flows and velocities, and seabed sediment characterizations, and included data from the following sources:

- Eatontown 1.2 NE, Station US1NJMN0010[3];
- Experimental System for Predicting Shelf and Slope Optics (ESPreSSO) hydrodynamic model and the Regional Ocean Modeling System (ROMS)[4]; and
- Poseidon Project sediment characterization data (ESS Group 2013).

[2] While the O&M Base will serve both EW 1 and EW 2, the base will be located at SBMT, adjacent to the EW 1 onshore substation, and will therefore be included within the EW 1 Onshore Study Area for the purposes of this analysis.
[3] https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:US1NJMN0010/detail
[4] http://tds.marine.rutgers.edu/thredds/dodsC/roms/espresso/2009_da/his.html

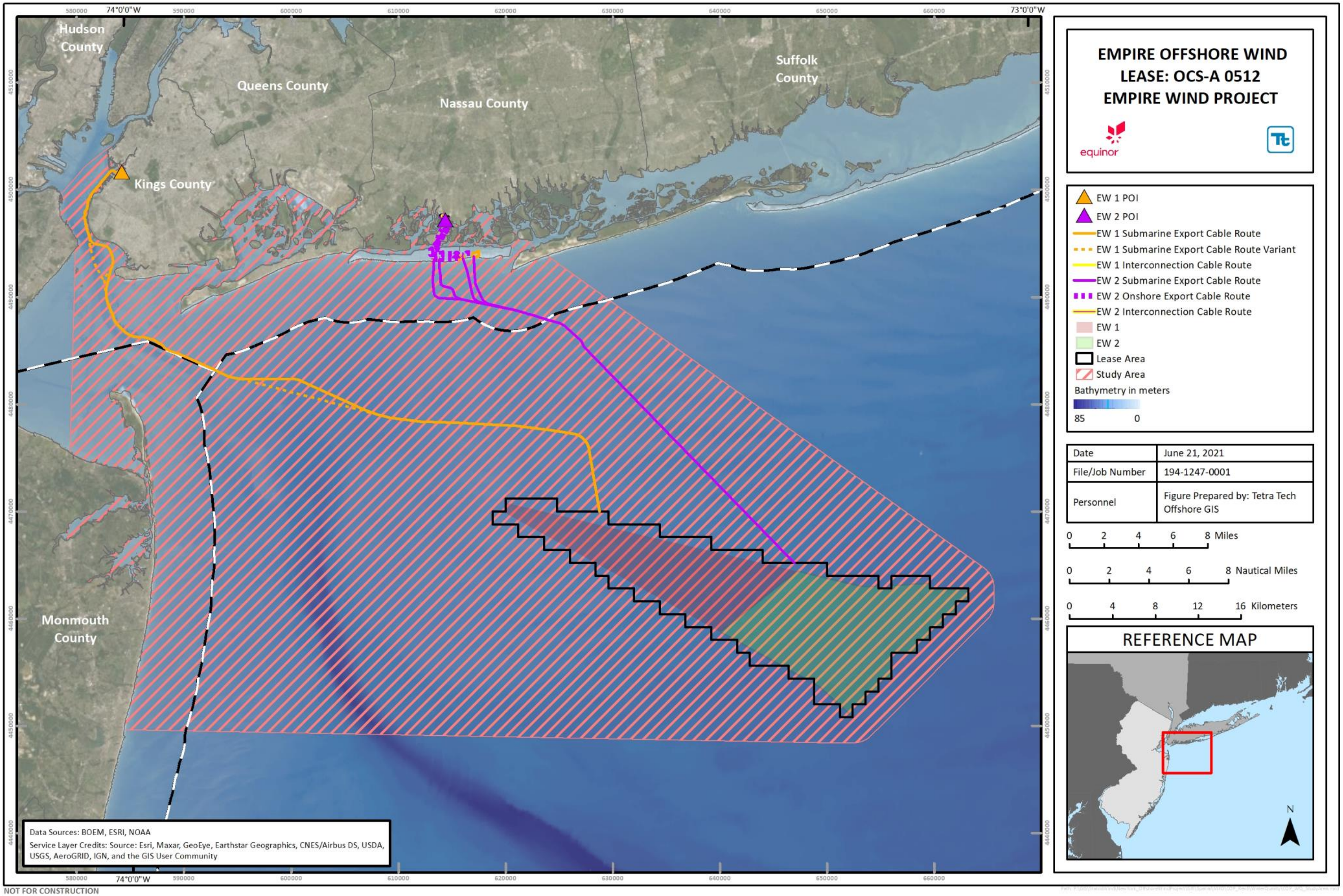

Figure 4.2-1 Water Quality Offshore Study Area

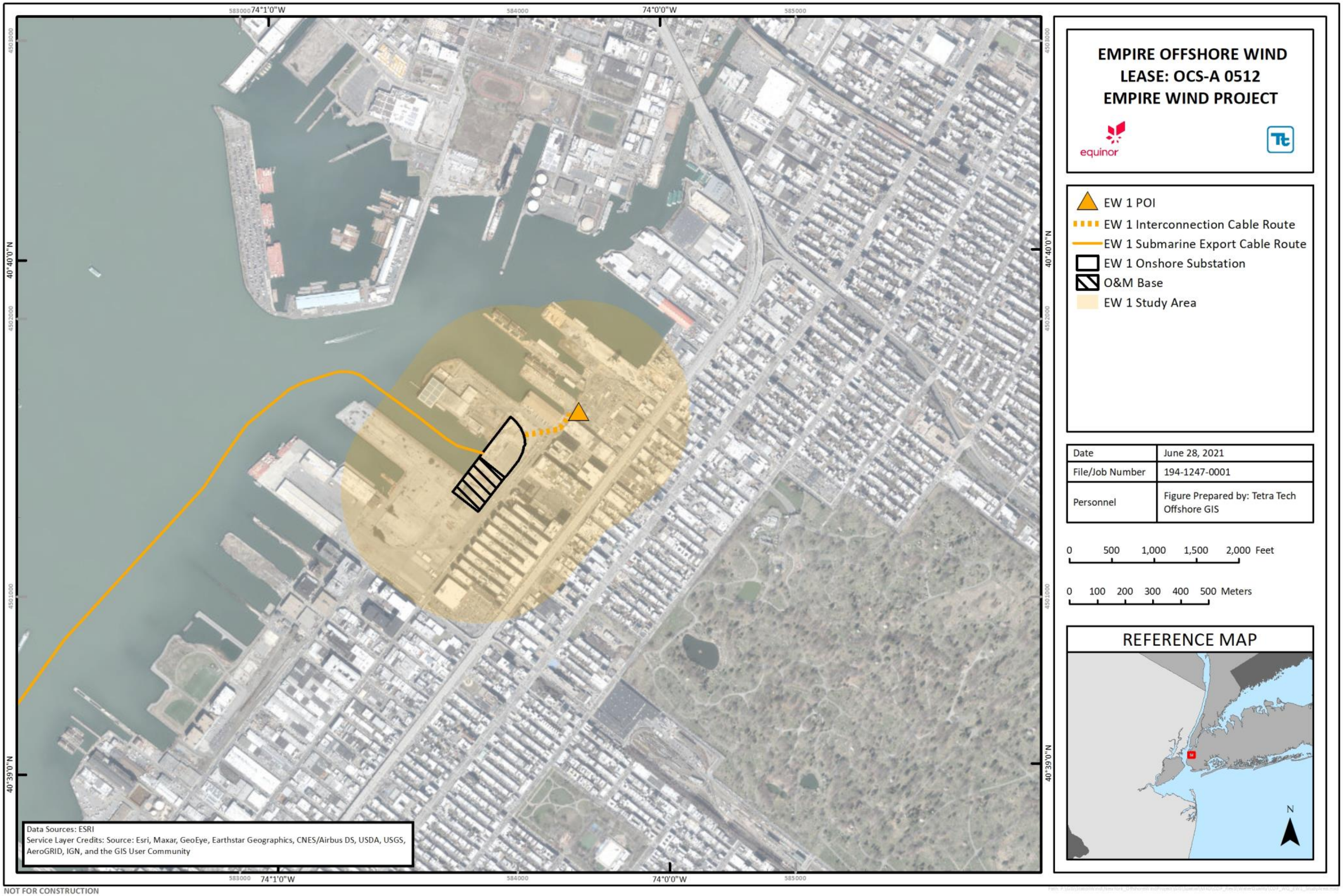

Figure 4.2-2 EW 1 Water Quality Onshore Study Area

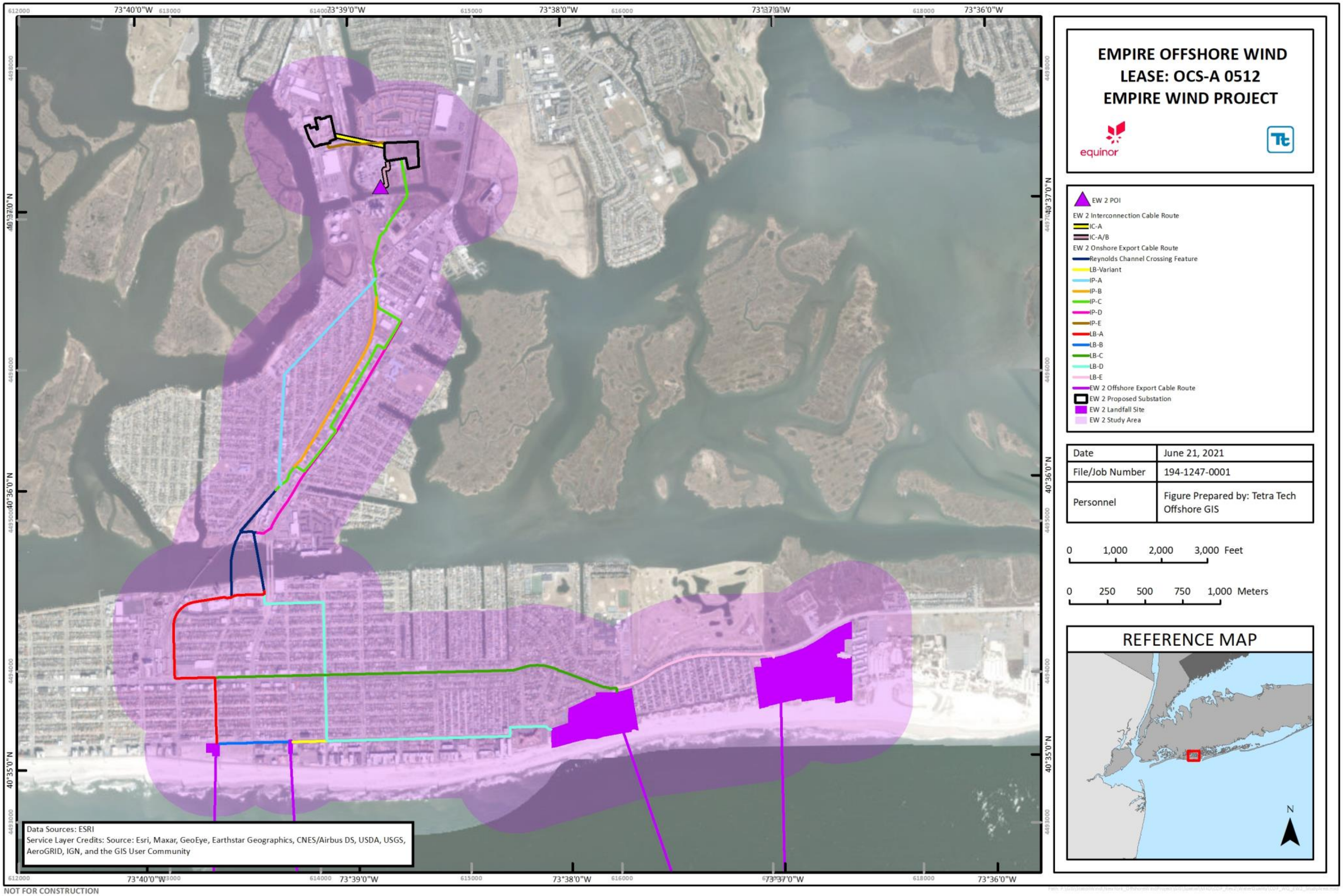

Figure 4.2-3 EW 2 Water Quality Onshore Study Area

4.2.1 Affected Environment

Water quality generally refers to the physical, chemical, and biological attributes of water. For the purposes of this section, water quality is assessed relative to the ability of these parameters of water to support the uses that currently exist and the flora, fauna, and ecosystem functions that occur within the respective waterbodies in the Study Area. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

Factors such as pollutant loading from both natural and anthropogenic sources can contribute to changes in water quality, which are usually detrimental to marine life and ecosystems. Natural pollutants can be delivered into water systems via freshwater drainage, transport of offsite marine waters, and influx from sediments. Anthropogenic pollutant sources often include those from direct discharges, runoff, dumping, seabed activities, and spills. Other parameters of water quality can also be affected by human activities as well as responding to natural events. Water temperatures change seasonally but are also altered when water is used for power plant or industrial cooling or when mixing is forced across stratified layers within the water column. Dissolved oxygen levels fluctuate with water depth, seasonally, and with changes in biological and chemical oxygen demand, which can reflect natural and anthropogenic changes in levels of organic matter in the water.

4.2.1.1 Marine Water Quality

Overall, water quality in New York Bight immediately offshore is generally classified as 'fair' by the EPA due to a varying range of water quality metrics. Some metrics are within recommended water quality limits and represent good water quality, while others represent impaired water quality with metrics that are greater than recommended limits (EPA 2012a). Most water quality pollutants in New York Bight originate from inshore areas, specifically the Hudson River, which drains to New York Bay (EPA 2012a). Water contaminants originating in the Atlantic Ocean, which is the dominant source of water in New York Bight, are limited to discharges from ships, including bilge and ballast water and sanitary waste. The Hudson River provides the primary source of pollutants, dissolved nutrients, and freshwater inflow; other smaller waterbodies that contribute freshwater inflows include the Passaic River, Hackensack River, and Raritan River. Water quality generally improves with distance from shore as oceanic circulation and tidal flushing disperses, dilutes, and biodegrades contaminants from New York Bay. Hence, areas closer to shore experience a greater range and frequency of variation in a number of water quality parameters whereas areas further offshore experience the more stable and less variable conditions of the oceanic water volume. Areas with poor water quality are generally close to large population densities and/or industrial activity (EPA 2012a).

Very little water quality data has been collected in New York Bight, with the most recent collections in the early 2000s at a handful of stations. Ambient suspended sediment concentrations ranged from 1.78 milligrams per liter (mg/L) to 7.85 mg/L (Litten 2003). Particulate organic carbon content ranged from 0.1 mg/L to 0.13 mg/L and dissolved organic carbon ranged from 1.5 mg/L to 19.03 mg/L (Litten 2003). Dissolved oxygen concentrations are fairly constant, typically between 7 mg/L to 9 mg/L, although the bottom layer can drop to as low as 4 mg/L during periods of stratification in late summer (Balthis et al. 2009). Salinity in New York Bight is reflective of marine conditions, with salinities generally between 30 and 35 parts per thousand (ppt) (Balthis et al. 2009; NYSDEC 2005). Vertical gradients in salinity are usually small, and average gradients reach up to 2 ppt in western portions of the area (USACE 2008). Surface temperatures range from approximately 46 °F (8 °C) in the winter and early spring to 70 °F (21°C) in late summer and early fall, with an average temperature of 57 °F (14 °C) (NYSDOS 2013; Balthis et al. 2009). Bottom temperatures are slightly cooler, ranging from 44 °F to 56 °F (7 °C to 13 °C) (Balthis et al. 2009). Stratification occurs during late spring and summer, and then the waters mix in the fall (see **Section 4.1 Physical and Oceanographic Conditions** for additional details; NYSDOS 2013).

New York Bay is located adjacent to one of the highest population density areas and greatest percent impervious surface areas in the U.S. (USACE and PANYNJ 2016). Stormwater runoff from the area contributes large amounts of non-point source pollution, and there are 14 major wastewater treatment facilities in New York City and 11 in New Jersey that discharge to the bay (HEP 2011).

Sediment loads to New York Harbor are high due to overland runoff, poor land management practices, tributary channel erosion, and shoreline modification, primarily from upriver portions of the Hudson River watershed (USACE and PANYNJ 2016). Increased stormflow due to urbanization has furthered modified the natural environment and causes increased scour, and thus sediment loads, in some area (USACE and PANYNJ 2016).

Dissolved oxygen levels throughout the Harbor have experienced an upward trend from 1970 to 2009 (HEP 2012). Summertime dissolved oxygen concentrations were greater than 5 mg/L in the New York Bay in both surface and bottom waters (HEP 2011).

Overall, concentrations of contaminants, bacteria, nutrients, and metals have been decreasing due to the implementation and enforcement of regulations under the CWA over 45 years ago (HEP 2012). Despite improvements in water quality, legacy chemicals in the sediments, including mercury, polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane, and dioxin, still exceed acceptable levels, and these contaminants can be resuspended in the water column during major storm events or from activities such as dredging (Steinberg et al. 2004).

Bacterial trend data show that most areas within New York Harbor remain below the best use primary contact standards, which for most waterbodies, is a monthly geometric mean of 200 colonies/100 milliliters (mL). The fecal coliform geometric mean in areas of the harbor outside the proposed EW 1 submarine export cable route have been above the water quality standard (HEP 2011). Over the last several decades, summer geometric means of bacteria have decreased from more than 2,000 colonies/100 mL to around 20 colonies/100 mL (NYCEP 2009). In 2017, the fecal coliform concentrations in lower New York Bay were some of the lowest in the area, and summer geometric means were below the NYS Standard of 200 colonies/100 mL (NYCEP 2017). However, sampling for the latest Waterbody Inventory and Priority Waterbodies List (WI/PWL) reports still showed elevated bacteria concentrations, specifically following rain events, which allow stormwater and combined sewer overflow (CSO) discharge to enter the harbor (NYCEP 2017).

The areas offshore Long Island are monitored for bacteria due to safety concerning swimming and bathing, although the areas are considered lower risk due to their proximity to the Atlantic Ocean (Suffolk County 2019). Bacteria samples collected at Kismet Beach, approximately 23 mi (37 km) to the east of the EW 2 export cable landfall were below the 104 colony-forming unit/100 mL *Enterococci* bathing standard over the last ten years (Suffolk County 2019).

Nitrogen levels are also low in the lower New York Bay compared to other regions in New York Harbor, although summer means of inorganic nitrogen have remained greater than 0.30 mg/L (NYCEP 2017). Annual average total nitrogen concentrations in New York Harbor have ranged from 1 mg/L to 0.5 mg/L from 1990 to 2017 (Stinnette 2018). Dissolved inorganic phosphorus generally ranged between 0.02 mg/L and 0.05 mg/L from 2003 to 2006 (EPA 2012a).

Levels of metal pollutants in the water column vary considerably but generally decrease with distance from New York Harbor. Because most of these pollutants are associated with freshwater flows from the contributory rivers (Hudson, Raritan, Passaic, etc.), they may also vary with vertical position in the water column where a vertical gradient in salinity develops. Metals tend to be found in higher concentrations in lower salinity surface waters flowing out of the rivers (USACE 2008).

4.2.1.2 Impaired Waterbodies

New York State Water Quality Standards (NYS WQS), promulgated under 6 NYCRR Part 703, set the required water quality criteria that must be met to support the best use indicated. Waterbodies that do not meet the criteria associated with their use classification are considered to be impaired. The New York State Department of Environmental Conservation (NYSDEC) maintains the WI/PWL, a database that contains information on water quality, the ability of waters to support their use classifications, and known or suspected sources of contamination or impairment. Water use classifications for waters in the Study Area include shell fishing, general recreation, and public bathing. General recreation use waters (classification SB) include those where the public may occasionally come into contact with the water through uses such as boating, while public bathing water (classification I) include those where the public may have prolonged contact with the water through uses such as swimming. Waters classified as public bathing includes areas with public beaches. Waters classified as SA are best used for shell fishing for market purposes, in addition to recreation and fishing.

The EW 1 submarine export cable route intersects several impaired waterways, while the EW 2 onshore export cable route intersects one. Based on the most recent NYSDEC WI/PWL reports, these waters are not supportive of the uses specified for Class I and SB waters and are listed as impaired (**Table 4.2-1**, **Figure 4.2-4**, and **Figure 4.2-5**).

Table 4.2-1 Summary of Impaired Marine Waterbody Classes Potentially Crossed by the Submarine Cable Routes

NYSDEC Segment	NYSDEC Classification	Best Usage (per 6 NYCRR 701)	Impairment	Impairment Sources
Upper New York Bay (1701-0022)	I	Public bathing and general recreation use	PCBs, dioxin, floatable debris, pathogens	Toxic/contaminated sediment, CSOs, urban/storm runoff, migratory species, municipal discharges
Lower New York Bay / Gravesend Bay (1701-0179	I	Public bathing and general recreation use	PCBs, pathogens, floatable debris	Toxic/contaminated sediment, CSOs, urban/storm runoff, migratory species, municipal discharges
Lower New York Bay (1701-0004)	SB	General recreation use	PCBs, pathogens, floatable debris	Toxic/contaminated sediment, CSOs, urban/storm runoff, municipal discharges
Reynolds Channel East (1701-0215)	SA	Shell fishing, general recreation use	Pathogens	Urban/storm runoff

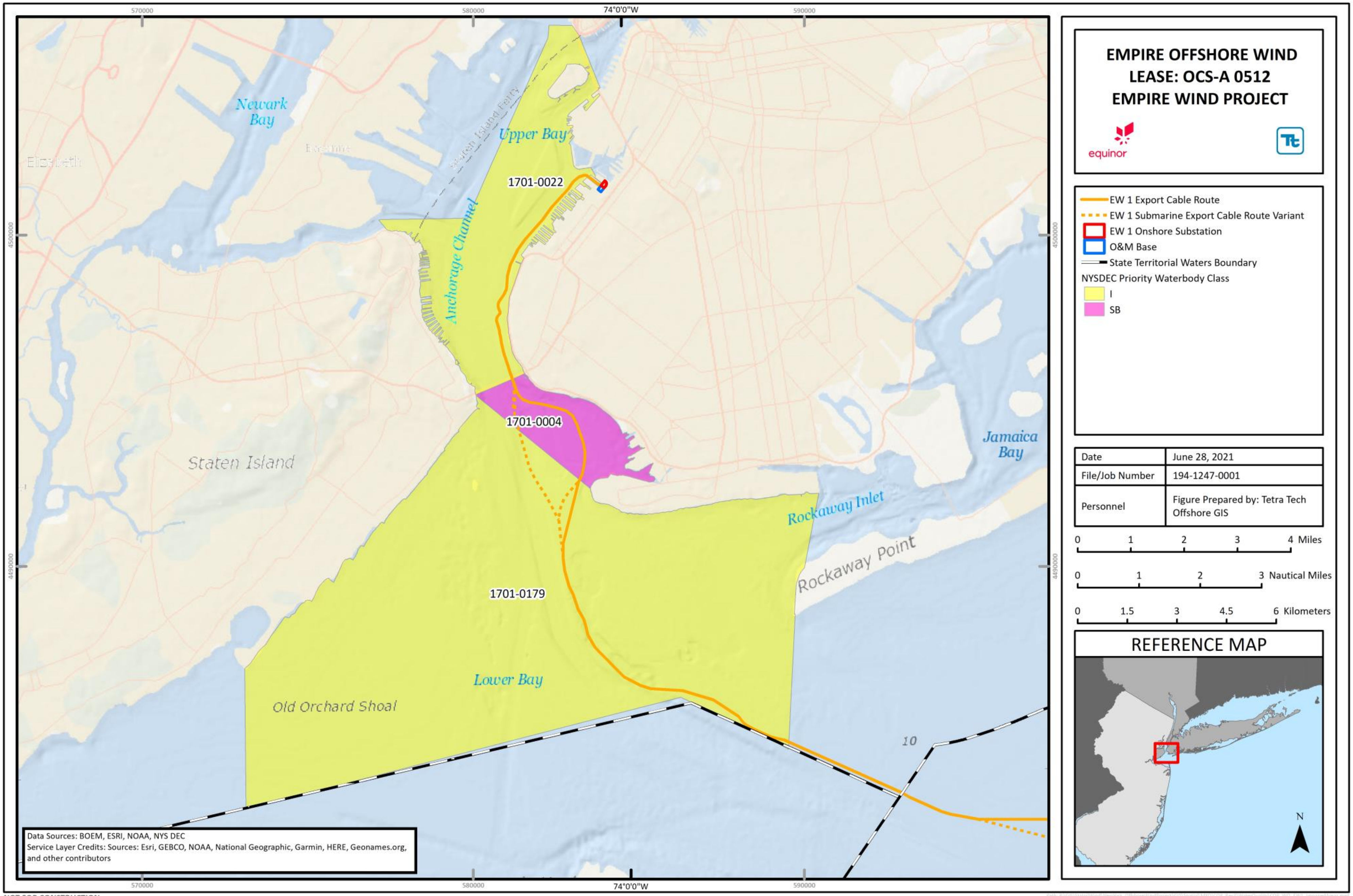

Figure 4.2-4 Impaired Waterbodies along the EW 1 Submarine Export Cable Route

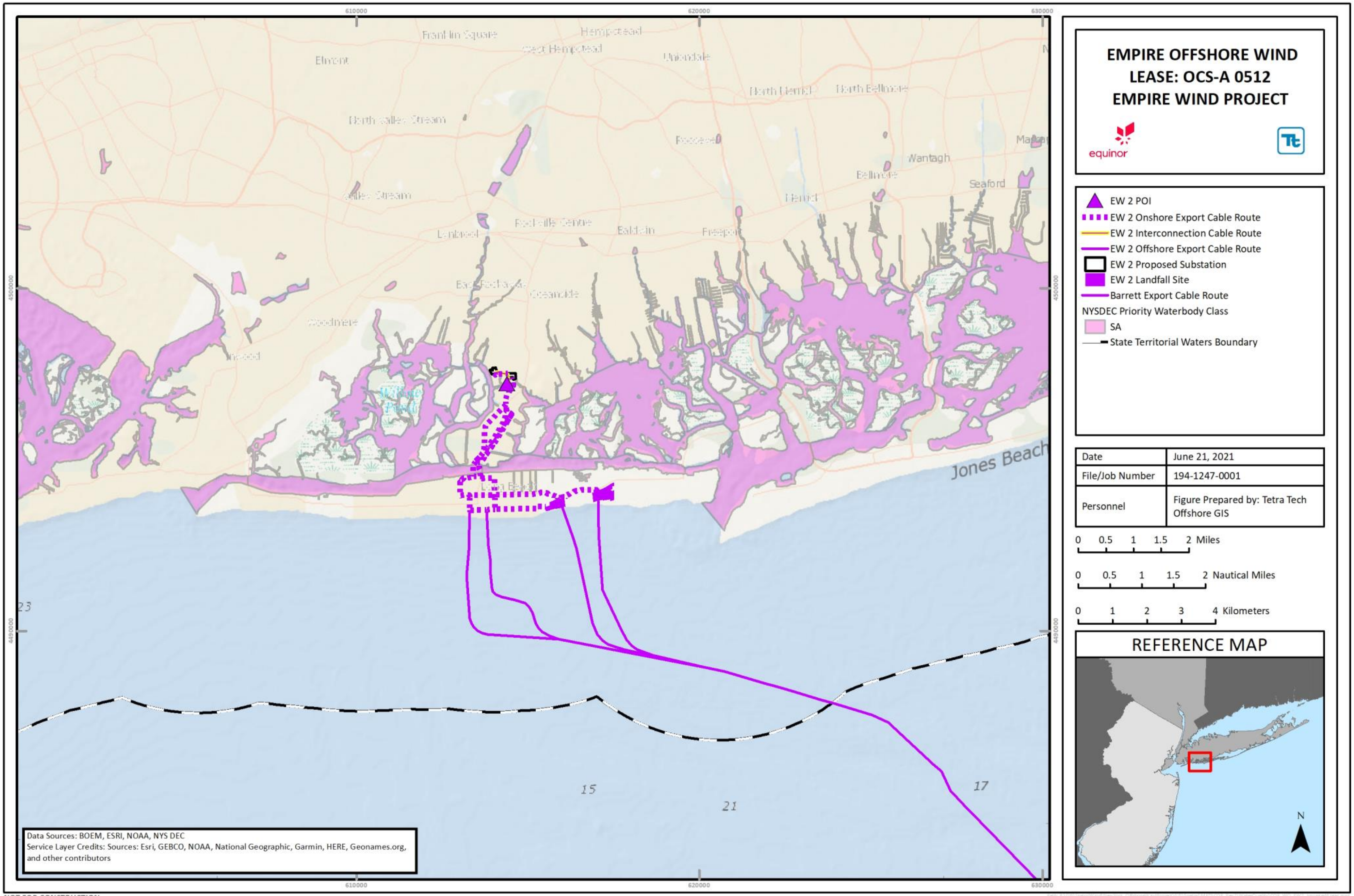

Figure 4.2-5 Impaired Waterbodies along the EW 2 Onshore Export Cable Route

4.2.1.3 Marine Sediment Quality

Sediment quality is degraded in several areas along the submarine export cable routes. Levels of contaminants, such as heavy metals, pesticides, polycyclic aromatic hydrocarbons (PAHs), and dioxins/furans are elevated in Upper New York Bay and the East River. However, sediments in Lower New York Bay, Raritan Bay and the New York Bight are generally much less contaminated (Douglas et al. 2005). Sediment contamination is present in some portions of the New York Bight, which hosts the largest deposit of sewage sludge in the nation dumped in the apex of the New York Bight (125 million cubic meters [163 million cubic yards] over 64 years). The contaminated sediments were dumped at the offshore disposal locations, now known as the Historic Area Remediation Site (HARS); the submarine export cable routes do not intersect HARS within New York Bight (Butman et al. 2002; Mecray et al. 2000).

The proposed EW 1 export cable landfall is located immediately south of the Gowanus Canal, a National Priority List superfund site. Industrial wastewater dischargers, CSOs, and stormwater have discharged to the canal for over 100 years, which then discharges into the commercial and industrial waterfront area in Gowanus Bay (EPA 2012b). However, because circulation and tidal flushing to Gowanus Bay is limited, so has been the dilution and dispersion of contaminants (EPA 2012b).

The Gowanus Canal is contaminated with high levels of a variety of organic carbons and metals, including PAHs, PCBs, mercury, lead, and copper (EPA 2019). Most of the organic contaminants are substantially higher in the Gowanus Canal than in Gowanus Bay and New York Bay. Concentrations of PCBs in the Gowanus Bay range from noncarcinogenic hazard to carcinogenic risk levels (EPA 2012b). In Gowanus Bay surface sediments, PAHs are approximately 5.8 mg/kg, barium 67 mg/kg, cadmium 2.31 mg/kg, copper 81 mg/kg, lead 93 mg/kg, mercury 1.12 mg/kg, nickel 32 mg/kg, and silver 2.15 mg/kg (EPA 2012b).

In 2006, the NYSDEC summarized over twenty years of previously collected sediment data for thirteen contaminants (NYSDEC 2006). These data were collected statewide, including in the New York Harbor and offshore in the New York Bight. In the harbor and adjacent and immediately south of Rockaway Beach, NYSDEC reported mercury and silver levels in surficial sediment collected to be ten times the sediment quality guidelines (NYSDEC 2006).

The proposed EW2 submarine export cable route is located within the New York Bight to the east of the EW 1 submarine export cable route and Rockaway Beach. Maximum exceedances of sediment quality guidelines for contaminants in sediment offshore of Rockaway Beach were generally greater than for sediments offshore of Long Beach (NYSDEC 2006). Offshore of Long Beach and in the New York Bight area close to the Lease Area, contaminants were typically detected in low concentrations and are predicted to not have adverse impacts to biota (NYSDEC 2006).

4.2.1.4 Groundwater

Both the EW 1 and EW 2 export cable landfalls, onshore export and interconnection cable routes, onshore substations, and O&M Base overlay the Long Island Aquifer, one of the most prolific aquifers in the country. Groundwater was historically pumped from this aquifer for drinking water and industrial uses, but impervious coverage throughout the county reduced recharge, and water demand caused freshwater water tables to drop (USGS 1995). After saltwater intrusion occurred, pumping for public supply was ceased in 1947 in Kings and Queens County on western Long Island, and the area has recovered; water tables are now at pre-pumping levels (USGS 1995). The only source of potable freshwater for Nassau and Suffolk Counties on eastern and central Long Island is precipitation that recharges the groundwater system. Long Island's groundwater aquifer system consists of a very large wedge of unconsolidated Cretaceous sands, gravels, silts and clay overlain by similar glacial sediments.

The principal aquifers of Long Island are the Upper Glacial Aquifer, the Magothy Aquifer, and the Lloyd Aquifer, presented vertically from top to bottom (USGS 1995, NYSDEC 2019). The Upper Glacial Aquifer is composed of unconsolidated sediments deposited during the Pleistocene Ice Ages. The Magothy Formation is generally composed of unconsolidated sands with some layers of silts and clays; the lower portion of the Magothy Formation consists of coarse sand and gravel. The Magothy Formation thickens seaward and is about 1,000 ft (305 m) thick in southwestern Suffolk County. This formation occurs approximately 600 ft (183 m) below sea level beneath the south shore of Long Island. The Raritan Formation consists of an upper clay member and a lower sand member (Lloyd Aquifer).

The USGS does not monitor groundwater elevations near the cable landings in New York, although they have a robust monitoring network to the north and east. The depths along eastern and southern shorelines of Long Island ranged from 1.71 ft (0.52 m) below MSL to 5.83 ft (1.78 m) below MSL, with the wells closest to EW 1 export cable landfall measuring depths of 4.69 ft (1.43 m) below MSL and 5.83 ft (1.78 m) below MSL (USGS 1997) and the well closest to the EW 2 export cable landfall measuring 2.69 ft (0.82 m) below MSL. Based on this older data, groundwater elevations near the landfalls and onshore substations are likely less than 5 ft (1.52 m) below MSL (USGS 1997).

While 25 percent of New York State relies on groundwater for their drinking water source, the areas around EW 1 receive their drinking water from the Catskills, located approximately 125 mi (201 km) north. The area near EW 2 is completely dependent on this groundwater source for all of their potable water needs (NYSDEC 2019).

Surface Waters and Wetlands

Both tidally influenced and freshwater surface waters provide a variety of water quality benefits, including trapping sediments and uptake and transformation of nutrients from upland areas. The surface waters along the onshore export and interconnection cable routes have not been monitored, likely due to their small size. Surface waters located near the Project consist of tidal marshes near the EW 2 onshore substation sites and along the onshore export and interconnection cable route. The description of these wetlands' sizes, locations, and potential impacts are provided in **Section 5.2 Wetlands and Waterbodies**.

4.2.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see **Section 3 Project Description**). The parameters provided in **Table 4.2-2** represent the maximum potential impact from full build-out of the Lease Area of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations) with two export cable routes to EW 1 and EW 2.

Table 4.2-2 Summary of Maximum Design Scenario Parameters for Water Quality

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations). EW 1: 71 wind turbines and 1 offshore substation. EW 2: 103 wind turbines and 1 offshore substation.	Representative of the maximum number of structures.
Wind turbine foundation Installation method	Seabed preparation, GBS	Representative of the foundation option that has the installation method that would result in the maximum amount of seabed sediment disturbance, which has the potential to result in turbidity and release contaminants.
Submarine export cables	Based on full build-out of EW 1 and EW 2. EW 1: 40 nm (74 km). EW 2: 26 nm (48 nm).	Representative of the maximum length of new submarine export cables to be installed, which as the potential to result in the greatest amount of seabed sediment disturbance.
Interarray cables	Based on full build-out of EW 1 and EW 2, with the maximum number of structures (174 wind turbines and 2 offshore substations) to connect. EW 1: 116 nm (214 km). EW 2: 144 nm (267 nm).	Representative of the maximum length of interarray cables to be installed, which as the potential to result in the greatest amount of seabed sediment disturbance.
Submarine export and interarray cable Installation method	Mass flow excavation	Representative of the installation method that would result in the maximum amount of seabed sediment disturbing activity, which has the potential to result in turbidity and release contaminants.

Table 4.2-2 Summary of Maximum Design Scenario Parameters for Water Quality (continued)

Parameter	Maximum Design Scenario	Rationale
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum predicted Project-related vessels, which has the potential to impact water quality.
Export cable landfall	Based on EW 1 and EW 2. EW 1: HDD in a 200-ft by 200-ft (61-m by 61-m) area. EW 2: HDD in a 246-ft by 246-ft (75-m by 75-m) area.	Representative of the maximum area to be utilized to facilitate the export cable landfall, which has the potential to impact water quality.
Onshore export and interconnection cables	Based on EW 1 and EW 2. EW 1: 0.2 mi (0.4 km). EW 2: 5.7 mi (9.2 km).	Representative of the maximum length of onshore export and interconnection cables to be installed.
Onshore substations	Based on EW 1 and EW 2. EW 1: 10.8-ac (4.4-ha) area. EW 2: 7.4-ac (3.0-ha) area.	Representative of the maximum area to be utilized to facilitate the construction of the onshore substation.
O&M Base	6.5-ac (2.6-ha) area.	Representative of the maximum area to be utilized to facilitate the construction of the O&M Base.
Operations		
Foundation Scour protection	Based on GBS, which represent the maximum overall footprint (174 x 43,985 yd^2 [36,777 m^2] with scour protection). Total 7,653,390 yd^2 [6,399,198 m^2] including scour protection.	Representative of the maximum area of scour protection installed.
Interarray cables	Based on full build-out of EW 1 and EW 2, with the maximum number of structures (174 wind turbines and two offshore substations) to connect. EW 1: 116 nm (214 km). EW 2: 144 nm (267 nm).	Representative of the maximum length of interarray cables, and associated scour protection installed.
Submarine export cables	Based on full build-out of EW 1 and EW 2. EW 1: 40 nm (74 km). EW 2: 26 nm (48 nm).	Representative of the maximum number and length of submarine export cables, associated scour protection installed.

Table 4.2-2 Summary of Maximum Design Scenario Parameters for Water Quality (continued)

Parameter	Maximum Design Scenario	Rationale
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum predicted Project-related vessels, which have the potential to increase the risk of impacts to water quality.
Onshore O&M activities	Based on EW 1 and EW 2. Longest operational duration, with the maximum amount of Project-related activities expected per year.	Representative of the maximum amount of activities from the Project during the O&M phase, which would have the potential to impact water quality.

4.2.2.1 Construction

During construction, the potential impact-producing factors to water quality may include:

- Construction of offshore components, including foundations, submarine export cables, interarray cables, and scour protection
- Staging activities and assembly of Project components at applicable facilities or areas; and
- Construction of onshore components, including the onshore cable system, associated onshore substations, and O&M Base.

The following potential impacts may occur as a consequence of the factors identified above:

- Short-term disturbance of seabed sediment;
- Short-term increase in erosion and run-off;
- Short-term impacts due to dewatering trenches and excavations;
- Short-term potential for inadvertent return of drilling fluids during HDD;
- Short-term potential for accidental releases from onshore construction vehicles or equipment; and
- Short-term impacts due to accidental spills and/or releases offshore.

Impacts to various water quality parameters such as temperature, dissolved oxygen, or chlorophyll as a result of Project-related activities are not anticipated and will therefore not be discussed further.

Short-term disturbance of seabed sediment: Disturbance of seabed sediments during offshore construction and installation activities could have an effect on marine water quality due to increases of total suspended solids into the water column resulting from sediment resuspension and dispersal; however, impacts on water quality are expected to be short-term and localized (Latham et al. 2017). To evaluate the impacts of submarine export and interarray cable installation, a conservative analytical sediment transport model was developed using publicly available data to quantify potential maximum plume dispersion and sediment concentrations and potential maximum sediment deposition thicknesses (see **Appendix J** for a full description of the methodology and results). The model simulated jet plow, mass flow excavation, and dredging installation methodologies, which would result in the greatest disturbance of marine sediments and therefore provide the maximum expected disturbance of seabed sediment in the Study Area.

Sediments in the Study Area are characterized as predominantly sands and fine sands in the New York Bight area, which includes the Lease Area and most of the submarine export cable routes, to predominantly clays and silts in New York Bay, which includes a section of the EW 1 submarine export cable route (**Appendix J**). In areas that consist predominantly of gravels and sands, the Sediment Transport Analysis indicates a limited extent of increased sediment concentrations, as the larger grain size sediments immediately deposit in the trench (Tetra Tech 2015, 2012; Vinhateiro et al. 2013). In locations that are dominated by fine sand, silts, or clays, these sediments can be released into the water column, temporarily increase total suspended solids near the trench, and cause sediment deposition outside of the trench.

The Sediment Transport Analysis predicted that the plume would typically travel between 328 ft (100 m) and 1,640 ft (500 m) during flood and ebb conditions along the majority of the submarine export cable routes and in the Lease Area. In some areas with stronger currents, the plume could travel more than 3,280 ft (1,000 m). The plume was expected to stay near the substrate layer and not reach the surface. Maximum plume concentrations at 3,280 ft (1,000 m) were below 30 mg/L at all stations, with the exception of the two stations with strong currents.

Coarse particles (medium sand and larger) were not suspended in the water column from jet plow activities. Fine sand settled to the bed in less than 1 minute and within 3 ft (1 m) to 16 ft (5 m) of the trench centerline, depending on current velocities. The fine and very fine sand particles accounted for over 40 percent of the sediment particles resuspended in the water column due to jet plowing in most of the Study Area. Silts and clays would remain suspended for approximately four hours and would be transported further from the trench. The maximum deposition thicknesses were located at the trench centerline, with an average deposition thickness of 9.52 inches (in, 24 centimeters [cm]). Deposition thickness decreased rapidly with distance from the jet plow; at a distance of 82 ft (25 m), the average deposit thickness was less than 0.37 in (0.95 cm) for flood tides, and less than 0.08 in (0.20 cm) for ebb tides. Within 492 ft (150 m) of the trench, deposition thicknesses were negligible, at less than 0.04 in (0.1 cm), at all but two locations along the submarine export cable routes.

For mass flow excavation, the plume was predicted to travel to 82 ft (25 m) in the Narrows during peak flood tide and 164 ft (50 m) during peak ebb tide. Near Gravesend Bay, the plume was predicted to travel around 16 ft (5 m) during both peak flood and ebb tides. The suspended sediment concentration dropped by 50 percent within 60 seconds of suspension in the water column because the sediment was comprised of fine sand and very fine sand, which settles quickly. In both locations, the deposition thickness fell below 0.004 in (0.01 cm) within 246 ft (75 m) during both flood and ebb tides. Mass flow excavation used elsewhere in the project, such as along the EW 2 submarine export cable route, will likely result in similar suspended sediment and deposition quantities as jet plow activities.

Along the EW 1 submarine export cable route, jet plowing would likely disturb areas of contaminated sediments within New York Bay. Sediment core data has been collected and is being tested to determine the concentration of organic and metal contaminants and the depth they are found along the EW 1 submarine export cable route. While surface sediment has organic and metal contamination levels below the effects range median impacts thresholds, deeper sediments have higher concentrations that are above these levels (Lodge et al. 2015). Installation of the EW 2 submarine export cable route is not expected to disturb areas of contaminated sediments.

Results from the Sediment Transport Analysis were also consistent with other sediment transport models completed for wind farm installation projects in the mid-Atlantic region (Swanson and Isaji 2006; Tetra Tech 2012, 2015; Vinhateiro et al. 2018). Data collections and modeling studies of plowing, trenching, and dredging projects showed that displacement of sediments is low, and they typically dissipated to background levels very close to the site (USACE 2015; BOEM 2013; Burton 1993; Elliott et al. 2017; ESS Group 2008; FHWA 2012).

A majority of disturbed sediments, specifically in areas with sandy soils similar to those found in New York Bight, settled immediately to the bed and were not dispersed in the water column (Latham et al. 2017; USACE 2015; Elliott et al. 2017). A Block Island Wind Farm cable study completed during the 2016 cable installation found that sediment impacts to water quality were negligible from jet plowing, and that there was no observable sediment plume (Elliott et al. 2017). Material was deposited 23 ft (7 m) outside the jet plow trench and was up to 10 in (25 cm) thick (Elliott et al. 2017). However, the deposited overspill sediments may have extended beyond 23 ft (7 m), but the deposition was negligible and less than what could be measured (Elliott et al. 2017). A bathymetric survey conducted four months after the initial cable installation found that the deposited materials were redistributed by currents and the sediment deposits were no longer distinguishable (Elliot et al. 2017).

Construction activities associated with installation of foundations in the Lease Area may increase water column suspended sediment concentrations in proximity to a foundation. A 2012 study reported concentrations of fine sand and sand between 5 and 10 mg/L above background levels less than 328 ft (100 m) from the installation site, but concentrations returned to ambient conditions quickly (FHWA 2012).

Furthermore, the seabed and near-bottom water column in the Study Area are highly dynamic environments, with suspension and redeposition of sediment occurring continuously due to storms and tidal currents. Water quality impacts from these processes and other anthropogenic processes, such as trawling and commercial vessel anchoring, are similar to or much larger than any potential Project effects.

Short-term increase in erosion and/or stormwater runoff: Excavation, soil stockpile, and grading associated with installation of the onshore export and interconnection cables and development of the onshore substations and supporting infrastructure may have the potential to temporarily impact the water quality and quantity of stormwater runoff from the construction work areas. Activities at staging and construction facilities will be consistent with the established and permitted uses of these facilities, and Empire will comply with applicable permitting standards to limit environmental impacts from Project-related activities. Impacts to water quality from erosion and run-off during construction are expected to be short-term and localized, as onshore construction areas are generally flat and the soil types are not especially susceptible to erosion. Empire proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- The implementation of soil erosion and sediment control plans, which will be provided for agency review and approval, as applicable, for each onshore component to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book), including development of a Stormwater Pollution Prevention Plan (SWPPP), as applicable;
- The incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State into the site-specific best management practices for activities located within the South Shore Estuary Reserve (SSER), as recommended by the SSER Comprehensive Management Plan; and
- Obtain an industrial stormwater National Pollutant Discharge Elimination System (NPDES) permit (if required) and develop a SWPPP if more than 1 ac (0.4 ha) of land is disturbed at any land fall or onshore substation per the CWA (33 U.S.C. § 1342). The plan will identify the measures that will be employed at the site to control the release of erosion and pollutants to the water and outline an implementation and maintenance schedule.

Short-term impacts due to dewatering trenches and excavations. Disturbance of soils during construction of the onshore export and interconnection cables and the onshore substations may have the potential to temporarily impact the water quality of groundwater resources. Final engineering design will determine if groundwater will need to be managed during construction activities that require digging of pits or trenches for the Project's onshore facilities.

As designs for the onshore export and interconnection cable corridors and the associated onshore substations develop, Empire will determine through site specific tests pits whether groundwater is expected to be encountered during construction activities. If dewatering is expected to occur, Empire will develop a site-specific dewatering plan to protect groundwater and nearby surface water resources in accordance with a Project-specific SWPPP, approved by the applicable agencies, as necessary.

Short-term potential for inadvertent return of drilling fluids during HDD. HDD technologies may be implemented to avoid sensitive areas such as shorelines, wetlands, wetland transition areas, and riparian areas. HDD installation method requires HDD drilling fluid, which typically consists of a water and bentonite mixture. The bentonite mixture is made up of mainly inert, non-toxic clays, and rock particles consisting predominantly of clay with quartz, feldspars, and accessory material such as calcite and gypsum; the mixture is not anticipated to significantly affect water quality if released.

An inadvertent return/release can occur when the drilling fluids migrate unpredictably to the land or seabed surface through fractures, fissures, or other conduits in the underlying rock or unconsolidated sediments. An inadvertent return/release could potentially increase turbidity in marine, groundwater, and/or surface water resources. Should an inadvertent return/release occur, it would likely only result in short-term and localized impacts to water quality in the shallow marine environment associated with the landfall and/or the portion of the onshore export and interconnection cables that traverses near wetlands or streams. Empire proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- Implementation of an Inadvertent Return Plan, approved by the applicable agencies, as necessary.

Short-term potential for accidental releases from onshore construction vehicles or equipment. Construction vehicles and equipment may be accessing regulated areas during construction activities and will be refueled and potentially serviced within the Project Site. Empire proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- The management of accidental spills or releases of oils or other hazardous wastes through a Spill Prevention, Control, and Countermeasures (SPCC) plan, which will be provided for agency review and approval, as applicable;
- Project-related construction sites will use secondary containment for oils and greases in accordance with state and federal regulations, as well as contain spill response kits; and
- Restricting access through wetlands and waterbodies at EW 2 to identified construction sites, access roads, and work zones, to the extent practicable. This is not anticipated to be required at EW 1 due to the absence of wetlands within the onshore area.

Short-term impacts due to accidental spills and/or releases offshore: During construction, water quality has the potential to be impacted through the introduction of contaminants, including oil and fuel spills and releases, for example, from grout used to seal the monopile to the transition piece. Project-related construction vessels also have the potential to release oil and fuels.

Project-related vessels will be subject to USCG regulations about wastewater and discharges, however, and will operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, all Project vessels will comply with USCG standards in U.S.-territorial waters to legally discharge uncontaminated ballast and bilge water, and standards regarding ballast water management. While outside of the 3-nm (5.6-km) state-border/No-Discharge Zone (NDZ), vessels will deploy a USCG-certified Marine Sanitation Device (MSD) with certifications displayed. While inside of the 3-nm (5.6-km) state-border/NDZ, vessels will take normal vessel procedures to close off MSD-effluence discharge piping and redirect it to onboard "Zero-Discharge Tanks" for the appropriate disposal either at dock or outside of an NDZ. Additionally, all vessels less than 79 ft (24.1 m) will comply with the Small Vessel General Permit issued by EPA on September 10, 2014 for compliance with NPDES permitting.

4.2.2.2 Operations and Maintenance

During operations, the potential impact-producing factors to water quality may include:

- Presence of new permanent structures offshore, including foundations, submarine export and interarray cables, and associated scour protection;
- Operations and maintenance activities associated with the onshore export and interconnection cables, onshore substations, and O&M Base.

Operations and maintenance activities associated with the offshore components of the Project. The following potential impacts may occur as a consequence of the factors identified above:

- Long-term effects due to offshore foundations and associated scour protection;
- Short-term change in water quality due to oil spills; and
- Long-term effects due to stormwater run-off.

Long-term effects due to offshore foundations and associated scour protection. During operations, scour processes around foundations and submarine export and interarray cables are a concern due to the potential impacts on water quality through the formation of suspended sediment plumes. Scouring processes will likely be more prevalent in portions of the Study Area in shallower water, such as New York Harbor, where tidal current flow can have a greater effect. The relatively low velocities in the Lease Area, combined with scour mitigation, will limit scour potential around foundations (BOEM 2018). Furthermore, scour is not expected to occur around the cable, due to the target cable burial depths.

Scour around foundations is dependent on water currents, wave action, and water depths, and scour depth can range from 0.3 times the pile diameter to 2.0 times the pile diameter or greater. Water currents are typically the largest indicator of the amount of expected scour (Temple 2004). In general, studies have shown the maximum scour depth around most piles is 1.3 times the diameter of the pile (DNV GL 2016; Whitehouse et al. 2011). The foundations will be located in deeper water depths with lower current speeds (typically 0.7 ft [0.2 m] per second), and piles located in these areas have minimal scour (BOEM 2018; Epsilon 2018; Nielsen et al. 2014; Whitehouse et al. 2011).

Several studies have shown that most scour tends to occur within the first month of installation (Harris 2011; Temple 2004). However, scouring is a continuous process that can change over a period of years (Harris 2011; Whitehouse et al. 2011). In addition, large storms with strong currents can temporarily increase the scour rate (Harris 2011; Temple 2004; Whitehouse et al. 2011). At some sites, backfilling occurs in the scour hole around the pile when there are changes in current conditions (Peterson 2014).

Empire will use scour protection around the foundations and in locations where target cable burial depth was not achieved, and where assessments deem necessary, to further minimize effects of local sediment transport. Scour protection, which usually consists of a layer of small sized rock and gravel topped with a layer of larger rocks placed immediately after installation, can reduce scour (Peterson 2014, Whitehouse et al. 2011). Edge scour is related to the size of the rock and the depth and tapering of the protection, with smaller rock and shallower protections with more tapering resulting in less edge scour (Peterson 2014). Edge scour has been shown to be approximately 0.12 times the diameter of the pile (Whitehouse et al. 2011), and depending on the scour protection and currents, it could be half of that value (Temple 2004; Peterson 2014). In some areas, specifically in deep areas and those with small waves, scour is minimal and scour protection can be foregone (Whitehouse et al. 2011).

Short-term effects due to accidental spills and/or releases: During operation, both the onshore and offshore substations will contain oils, fuels, and/or lubricants (see **Section 3** for additional information). However, as the equipment will be mounted on foundations with associated secondary oil containment or located within buildings, an inadvertent release of oil at these facilities is not expected to impact the quality of the surrounding groundwater or surface water resources. Empire has developed an Oil Spill Response Plan (OSRP; **Appendix F**), which details all measures proposed to avoid inadvertent releases and spills and a protocol to be implemented should a spill event occur. Additional information can be found in **Section 8.12**. Empire proposes to implement the following measures to avoid, minimize, and mitigate impacts to water quality:

- Project-related vessels will operate in accordance with laws regulating the at-sea discharges of vessel-generated waste;
- Project-related construction sites will use secondary containment for oils and greases in accordance with state and federal regulations, as well as contain spill response kits; and
- The management of accidental spills or releases of oils or other hazardous wastes through an SPCC plan for onshore activities and an OSRP for offshore activities, which will be provided for agency review and approval, as applicable.

Long-term effects due to stormwater runoff: The onshore substation site and O&M Base development may increase total impervious areas. Impervious areas prevent rain and snowmelt from infiltrating into the soil, thereby increasing overland flow that enters streams. The generated stormwater runoff can carry sediment and pollutants that buildup on site to nearby surface waters, posing a potential risk to water quality and aquatic life.

The EW 1 export cable landfall and onshore substation and O&M Base are fully developed and there is no expected increase in impervious area from Project operations. Development would be required at the EW 2 export cable landfall and onshore substation. While the construction disturbance area is likely several acres at EW 2, expected long-term increases in impervious area are small, potentially less than an acre. Stormwater pollution prevention controls will be installed on site in accordance with federal and state requirement to capture and treat stormwater runoff on site before entering nearby surface waters.

If required, an industrial stormwater NPDES permit will be obtained that includes a SWPPP (33 U.S.C. § 1342). The plan will identify the measures that will be employed at the site to manage, control, and treat stormwater. If appropriate, state industrial permits will be obtained as well; this includes the NYSDEC Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (GP-0-17-004). The SWPPP and associated stormwater control practices will be developed to meet the NYSDEC industrial stormwater permit requirements.

4.2.2.3 Decommissioning

Impacts during decommissioning are expected to be similar in nature but generally less substantial than those experienced during construction, as described in Section 4.2.2.1. It is important to note that advances in decommissioning methods/technologies are expected to occur throughout the operations phase of the Project.

A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

In order to mitigate the potential impact-producing factors described in Section 4.2.2, Empire is proposing to implement the following avoidance, minimization, and mitigation measures.

4.2.3.1 Construction

During construction, Empire will commit to the following avoidance, minimization, and mitigation measures mitigate the water quality impacts described in Section 4.2.2.1:

- The implementation of soil erosion and sediment control plans, which will be provided for agency review and approval, as applicable, for each onshore component to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book), including development of a SWPPP, as applicable;
- The incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State into the site-specific best management practices for activities located within the SSER, as recommended by the SSER Comprehensive Management Plan;
- Obtain an industrial stormwater NPDES permit (if required) and develop a SWPPP if more than 1 ac (0.4 ha) of land is disturbed at any land fall or onshore substation per the CWA (33 U.S.C. § 1342). The plan will identify the measures that will be employed at the site to control the release of erosion and pollutants to the water and will outline an implementation and maintenance schedule.
- Implementation of an agency-approved inadvertent return plan, approved by the applicable agencies, as necessary;
- The management of accidental spills or releases of oils or other hazardous wastes through a SPCC plan, which will be provided for agency review and approval, as applicable; and
- Restricting access through wetlands and waterbodies at EW 2 to identified construction sites, access roads, and work zones, to the extent practicable. This is not anticipated to be required at EW 1 and the O&M Base due to the absence of wetlands within the onshore area.

4.2.3.2 Operations and Maintenance

During operations, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.2.2.2:

- Project-related vessels will operate in accordance with laws regulating the at-sea discharges of vessel-generated waste;
- The management of accidental spills or releases of oils or other hazardous wastes through a SPCC plan for onshore activities and an OSRP for offshore activities, which will be provided for agency review and approval, as applicable; and
- Stormwater control features will be routinely inspected and cleaned to remove debris or excess vegetation that may impede the designed functionality. The inspection schedule will be detailed in the SWPPP and SPCC or appropriate Operations Plan.

4.2.3.3 Decommissioning

Avoidance, minimization, and mitigation measures proposed to be implemented during decommissioning are expected to be similar to those implemented during construction and operations, as described in Section 4.2.3.1 and Section 4.2.3.2. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and avoidance, minimization, and mitigation measures for decommissioning activities will be proposed at that time.

4.2.4 References

Table 4.2-3 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coastal/crm.html	N/A
NYSDEC	NYSDEC Priority Waterbody Class	http://gis.ny.gov/gisdata/fileserver/?DSID=1118&file=nysdec_wtrcls.zip	http://gis.ny.gov/gisdata/metadata/nysdec.wtrcls.xml

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4.3 Air Quality

This section describes the regulatory framework for air quality, as applicable to the Project, and the affected air environment. Potential impacts to air quality resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Empire are also described, which are intended to avoid, minimize, and/or mitigate potential impacts to air quality.

Other resources and assessments detailed within this COP that are related to air quality include:

- Air Emissions Calculations and Methodology (Appendix K).

Under the federal Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) is responsible for developing and enforcing the regulations protecting air quality in the United States. Project emissions associated with construction, operations, and decommissioning will be subject to EPA regulations governing air quality both onshore and offshore.

The federal CAA established the National Ambient Air Quality Standards (NAAQS) for the following common pollutants, known as criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particulate matter, and sulfur dioxide (SO_2). The standards are set by EPA to protect public health and the environment from harmful air pollutants. To achieve this, EPA sets both primary and secondary standards. The primary standards protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly (EPA 2016a). The secondary standards protect the environment and public welfare from adverse effects associated with pollution, including decreased visibility and damage to animals, crops, vegetation, and buildings (EPA 2016a).

Although many of the criteria pollutants are directly emitted into the atmosphere by industrial and combustion processes, some criteria pollutants form in the atmosphere by chemical reactions. Ozone, for example, is formed in the atmosphere by reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_X), which includes nitric oxide (NO), NO_2, and other NO_X. In this context, VOCs and NO_X, referred to as ozone precursors, are regulated by EPA to achieve ambient ozone reductions.

Similarly, particulate matter is a mixture of solid particles and liquid droplets of varying size found in the atmosphere. EPA has established NAAQS for two different particles sizes—particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). While some particulate matter is emitted directly, $PM_{2.5}$ can form in the atmosphere by chemical reactions between SO_2, NO_X, VOCs, and ammonia. As with ozone, $PM_{2.5}$ precursors are regulated by EPA to achieve ambient $PM_{2.5}$ reductions.

The NAAQS for each criteria pollutant is presented in **Table 4.3-1**. Every five years, EPA conducts a comprehensive review of the NAAQS and revises the standards based on the most recent scientific information available, as necessary. EPA monitors compliance with the NAAQS through a state-wide network of air pollution monitoring stations measuring the concentration of each criteria pollutant. If ambient concentrations do not exceed the NAAQS, the area is designated an attainment area and no further action is required. If ambient concentrations exceed the NAAQS for one or more pollutants, the area is designated a nonattainment area for those pollutants, and the state is required to develop an implementation plan to achieve compliance with the NAAQS. Once a nonattainment area demonstrates compliance with the NAAQS standard, EPA will designate the area a maintenance area (EPA 2017a).

Table 4.3-1 National Ambient Air Quality Standards

Pollutant	Average Time	Standard
$PM_{2.5}$	24 hours	98th percentile concentration averaged over 3 years ≤ 35 µg/m^3
	1 year	Annual mean, averaged over 3 years ≤ 12.0 µg/m^3 (primary)
	1 year	Annual mean averaged over 3 years ≤ 15.0 µg/m^3 (secondary)
PM_{10}	24 hours	150 µg/m^3, not to be exceeded more than once per year on average over 3 years
Ozone (2008)	8 hours	4th highest daily maximum value, averaged over 3 years ≤ 0.075 ppm
Ozone (2015)	8 hours	4th highest daily maximum value, averaged over 3 years ≤ 0.070 ppm
NO_2	1 hour	98th percentile daily maximum, averaged over 3 years ≤ 0.100 ppm
	1 year	Not to exceed 0.053 ppm
SO_2	1 hour	99th percentile daily maximum, averaged over 3 years ≤ 0.075 ppm
	3 hours	0.5 ppm, not to be exceeded more than once per year
CO	1 hour	35 ppm, not to be exceeded more than once per year
	8 hours	9 ppm, not to be exceeded more than once per year
Lead	Rolling 3-month average	Not to exceed 0.15 µg/m^3

Source: 40 CFR § 50
Notes:
µg/m^3 = micrograms per (standard) cubic meter
ppm = parts per million (by volume)

In addition to regulating criteria pollutants through the NAAQS, EPA is also responsible for developing and enforcing regulations governing other air pollutants, including hazardous air pollutants (HAPs) and greenhouse gases (GHGs).

HAPs are pollutants known or suspected to cause adverse health and environmental effects (EPA 2017b). Adverse health effects associated with exposure to HAPs include increased likelihood of developing cancer and other serious impacts to respiratory, reproductive, and immune system health and early childhood development (NJDEP 2018).

GHGs are gases that trap heat in the atmosphere and contribute to global warming by retaining heat in the atmosphere (EPA 2019a). Common GHGs include carbon dioxide (CO_2), methane, and nitrous oxide, which can be released into the atmosphere through the production, transportation, and burning of fossil fuels, and through emissions from livestock and other agricultural and industrial practices (EPA 2019a). In the United States, CO_2 accounted for approximately 82 percent of all GHG emissions in 2017 (EPA 2019b).

Although EPA has not established ambient air quality standards for HAPs or GHGs, emissions of HAPs and GHGs are regulated through national and state emissions standards and permit requirements.

Outer Continental Shelf Air Regulations

The federal CAA authorizes EPA to regulate air quality on the OCS. EPA has promulgated OCS air regulations at 40 CFR Part 55, which establish air pollution control and permitting requirements for emission sources and activities occurring on the OCS.

According to Section 328 of the CAA (at 42 U.S.C. § 7627(a)(4)(c)), an OCS source includes the following: (i) any equipment, activity, or facility that emits, or has the potential to emit, any air pollutant; (ii) is regulated or authorized under the OCS Lands Act (43 U.S.C. § 1331); and (iii) is located on the OCS or in or on waters above the OCS. This includes vessels that are permanently or temporarily attached to the seabed (40 CFR § 55.2).

In support of the Project's OCS air permit application, Empire developed an inventory of anticipated emissions from Project-related construction and operations and maintenance vessels operating at or within 25 nm (46.3 km) of the Project Area. This inventory does not quantify emissions associated with Project decommissioning, given the uncertainty of future technology and regulations. These future decommissioning emissions will be the subject of a future OCS air permit application.

In addition to the federal OCS air regulations, the OCS sources operating within 25 nm (46.3 km) of the seaward boundary of a state are subject to the requirements applicable to the Corresponding Onshore Area (COA), as determined by EPA. For the Project, the COA is likely to be New York State, in which case the OCS sources associated with the Project activities are expected to be subject to the air permitting requirements of the NYSDEC. The state of New Jersey also has the option to petition EPA for designation as the COA, and if such a petition were successful, the Project OCS sources would instead be subject to the air permit requirements of the New Jersey Department of Environmental Protection (NJDEP).

As stipulated in 30 CFR § 585.659 and BOEM guidelines, Empire will follow the OCS air regulations and, in accordance with 40 CFR § 55.6, has completed a Project-specific emissions inventory in support of an OCS air permit application, as presented in **Appendix K Air Emissions Calculations and Methodology**[5]. This emissions inventory includes potential emissions both regulated and not regulated by the OCS air regulations, as explained later in this section (see General Conformity Applicability and NEPA Review).

In addition to the information provided pursuant to 30 CFR § 585.659, Empire intends to submit a Notice of Intent (NOI) to EPA Region 2 office and the air pollution control agencies of the Nearest Onshore Area (NOA) and neighboring areas (i.e., NYSDEC and NJDEP) in accordance with the OCS air regulations. Following submission of the NOI, Empire will submit an air permit application to EPA[6]. For the OCS air permit application, Empire will develop an inventory of anticipated emissions by year for the construction and operations and maintenance phases of the Project, based on the best available information at that time, with a degree of conservatism to account for the unknown. As previously explained, the Project decommissioning emissions will be subject to a future OCS air permit application. Empire will compare the anticipated emissions to EPA's New Source Review (NSR) permitting thresholds to determine the Project-specific permitting requirements. NSR is a federal pre-construction permitting program responsible for ensuring new emissions sources do not contribute to a violation of the NAAQS (EPA 2006). Pollutants regulated by the NSR permitting program include the criteria pollutants, VOCs, and other HAPs. If the Project's anticipated emissions do not exceed the NSR permitting thresholds for one or more pollutant, the Project will be considered a minor source and will be subject to minor source permitting. If the Project's anticipated emissions exceed the NSR permitting

[5] The Air Emissions Calculations and Methodology is currently being revised to incorporate the refined PDE, consisting of up to 174 wind turbines and 2 offshore substations and the O&M Base. This section will be updated to incorporate the results of the revised Emissions Calculations and Methodology in accordance with an agreed-upon schedule with BOEM.

[6] NJDEP adopted legislation on May 4, 2020 to amend its air quality regulations under N.J.A.C 7:27-32; NJDEP incorporates by reference the federal OCS air regulations at 40 CFR § 55. NJDEP will also seek delegation from EPA to be a permitting authority for OCS air sources subject to 40 CFR § 55. If awarded delegation, the OCS air permit application might be submitted to NJDEP instead of EPA, if EPA were to designate New Jersey as the COA. (However, EPA would continue to be involved in reviewing and commenting on OCS air permits issued by NJDEP).

threshold for one or more pollutant, the Project will be considered a major source and will be subject to major source permitting for those pollutants.

In New York, the major source thresholds for attainment areas are 100 tons per year (tpy) for all NSR-regulated pollutants (6 NYCRR 231-13.5), while thresholds for severe ozone nonattainment areas (which includes the counties of the New York Metropolitan Area) are limited to 25 tpy for VOCs and 25 tpy for NO_X (6 NYCRR 231-13.1). In New Jersey, the major facility thresholds are 100 tpy for CO, particulate matter, and SO_2; 25 tpy for both VOCs and NO_X; and 10 tpy for lead and any HAP (N.J.A.C. 7:27-8). As NSR permitting is pollutant-specific, the Project can be considered a major source for some pollutants and a minor source for others.

General Conformity Applicability and NEPA Review

Under Section 176(c)(4) of the Clean Air Act, certain actions taken by federal agencies are subject to the EPA's General Conformity Rule. BOEM has advised Empire of its determination that General Conformity does not apply to the Project or to Project emissions, even if such emissions would occur in a nonattainment or maintenance area.[7] However, for informational purposes, the applicable inventory details in the COP are presented as though General Conformity still does apply.

The General Conformity rule requires federal agencies to demonstrate proposed actions comply with the NAAQS (EPA 2017a). Section 176(c)(1) of the CAA defines conformity as the upholding of "an implementation plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards." Therefore, in nonattainment or maintenance areas, federal agencies must demonstrate proposed actions conform to the applicable EPA-approved state implementation plan to achieve and/or maintain the NAAQS (EPA 2017a). In attainment areas without state implementation plans, federal agencies must demonstrate proposed actions will not cause new violations of the NAAQS and/or increase the frequency or severity of previous violations (EPA 2017a). As a result, Project emissions should not cause or contribute to new violations of the NAAQS; increase the frequency or severity of a previous violation of the NAAQS; or prevent or delay attainment of the NAAQS or interim emission reductions.

In accordance with 40 CFR § 51 Subpart W and 40 CFR § 93 Subpart B, BOEM must issue a General Conformity Determination, stating if construction and operation of the Project will conform with the applicable state and/or federal implementation plan. The General Conformity thresholds are presented in **Table 4.3-2** and only apply to nonattainment areas or maintenance areas.

Table 4.3-2 General Conformity Thresholds

Pollutant	Designation	Tons per year
Nonattainment Area (NAA) Thresholds		
Ozone (VOCs or NO_X precursors)	Extreme NAA	10
	Severe NAA	25
	Serious NAA	50
	Other ozone NAA outside an ozone transport region	100
	Other ozone NAAs inside an ozone transport region	50 (VOCs)
		100 (NO_X)

[7] Brandi Sangunett, BOEM, telephone communication to Laura Morales, Empire, March 31, 2021.

Table 4.3-2 General Conformity Thresholds (continued)

Pollutant	Designation	Tons per year
CO	All NAAs	100
SO_2	All NAAs	100
NO_2	All NAAs	100
PM_{10}	Moderate NAA	100
	Serious NAA	70
$PM_{2.5}$ (direct emissions, SO_2, NO_X, VOCs, and ammonia)	Moderate NAA	100
	Serous NAA	70
Lead	All NAAs	25
Ozone (VOCs or NO_X precursors)	All Maintenance Areas	100 (NO_X)
	Maintenance areas outside an ozone transport region	100 (VOCs)
	Maintenance areas inside an ozone transport region	50 (VOCs)
CO	All Maintenance Areas	100
SO_2	All Maintenance Areas	100
NO_2	All Maintenance Areas	100
Maintenance Area Thresholds		
PM_{10}	All Maintenance Areas	100
$PM_{2.5}$ (direct emissions, SO_2, NO_X, VOCs, and ammonia)	All Maintenance Areas	100
Lead	All Maintenance Areas	25

Source: 40 CFR § 93.153(b)
Note:
tpy = tons per year

Empire has developed an emissions inventory for construction and operations emissions for comparison to the General Conformity thresholds. The emission inventory for the General Conformity Determination does not include emissions subject to the OCS air regulations, which will be included in the OCS permit application (i.e., emissions that occur at or within 25 nm [46.3 km] of the Project Area). The emissions inventory includes construction and operations emissions that occur in the following nonattainment and maintenance areas:

- The following jurisdictions in the New York-Northern New Jersey-Long Island Area, NY-NJ-CT Ozone Nonattainment Area (2008 and 2015 NAAQS):
  - Bronx County, New York
  - Kings County, New York (EW 1 onshore substation)
  - Nassau County, New York (EW 2 onshore substation)
  - New York County, New York
  - Queens County, New York
  - Richmond County, New York
  - Rockland County, New York
  - Westchester County, New York

  - Bergen County, New Jersey
  - Hudson County, New Jersey
  - Monmouth County, New Jersey

- The following jurisdictions in the New York-Northern New Jersey-Long Island Area, NY-NJ-CT Carbon Monoxide Maintenance Area (1971 NAAQS):
  - Bronx County, New York
  - Kings County, New York (EW 1 onshore substation)
  - Nassau County, New York (EW 2 onshore substation)
  - New York County, New York
  - Queens County, New York
  - Richmond County, New York
  - Westchester County, New York
  - Bergen County, New Jersey
  - Hudson County, New Jersey

- The following Moderate PM_{10} Nonattainment Area (1987 Annual NAAQS)
  - New York County, New York

- The following jurisdictions in the New York-Northern New Jersey-Long Island Area, NY-NJ-CT $PM_{2.5}$ Maintenance Area (1997 Annual NAAQS):
  - Bronx County, New York
  - Kings County, New York (EW 1 onshore substation)
  - Nassau County, New York (EW 2 onshore substation)
  - New York County, New York
  - Orange County, New York
  - Queens County, New York
  - Richmond County, New York
  - Rockland County, New York
  - Westchester County, New York
  - Bergen County, New Jersey
  - Hudson County, New Jersey
  - Monmouth County, New Jersey

- The following jurisdictions in the New York-Northern New Jersey-Long Island Area, NY-NJ-CT $PM_{2.5}$ Maintenance Area (2006 24-Hour NAAQS):
  - Bronx County, New York
  - Kings County, New York (EW 1 onshore substation)
  - Nassau County, New York (EW 2 onshore substation)
  - New York County, New York
  - Orange County, New York
  - Queens County, New York
  - Richmond County, New York
  - Rockland County, New York
  - Westchester County, New York
  - Bergen County, New Jersey
  - Hudson County, New Jersey
  - Monmouth County, New Jersey

Emissions in these nonattainment and maintenance areas would include vessel emissions associated with the transportation of materials and construction and operations activities. In addition, the emissions inventory includes construction emissions that would occur in several jurisdictions that are designated as attainment for all current NAAQS, but which have been included for the purpose of NEPA review:

- The following jurisdictions in the Norfolk-Virginia Beach-Newport News (Hampton Roads) Air Quality Control Region (AQCR):
  - Hampton City, Virginia
  - Norfolk City, Virginia
  - Virginia Beach City, Virginia

- The following jurisdictions in the Corpus Christi-Victoria Intrastate AQCR:
  - Aransas County, Texas
  - Nueces County, Texas
  - San Patricio County, Texas

Data Relied Upon and Studies Completed

For the purposes of this section, the OCS Air Quality Study Area includes a 25-nm (46.3-km) buffer around the Lease Area within federal waters (e.g. stops at the 3-nm [5.6-km] state waters boundary). The Conformity Determination Air Quality Study Area includes the counties in which the Project construction and operations and maintenance activities are proposed to occur (see **Figure 4.3-1**).

As required by the regulations and guidance described herein, the following analyses are provided in this COP:

- An air emissions analysis addressing 40 CFR § 55, OCS Air Regulations; and
- An air quality analysis supporting BOEM's NEPA and CAA review with respect to 40 CFR § 51(W), entitled "Requirements for Preparation, Adoption, and Submittal of Implementation Plans." and 40 CFR § 93(B), entitled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans."

4.3.1 Affected Environment

This section describes the affected environment, inclusive of all onshore and offshore areas potentially impacted by Project construction, operations, and decommissioning activities; this includes areas associated with permanent Project facilities and O&M ports, as well as areas that will temporarily host construction activities. These areas include the OCS area located at or within 25 nm (46.3 km) of the Lease Area, the New York-Northern New Jersey-Long Island, NY-NJ-CT AQCR, the Norfolk-Virginia Beach-Newport News (Hampton Roads) AQCR, the Corpus Christi-Victoria AQCR, and other onshore and offshore areas in New York and New Jersey where Project activities will occur. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

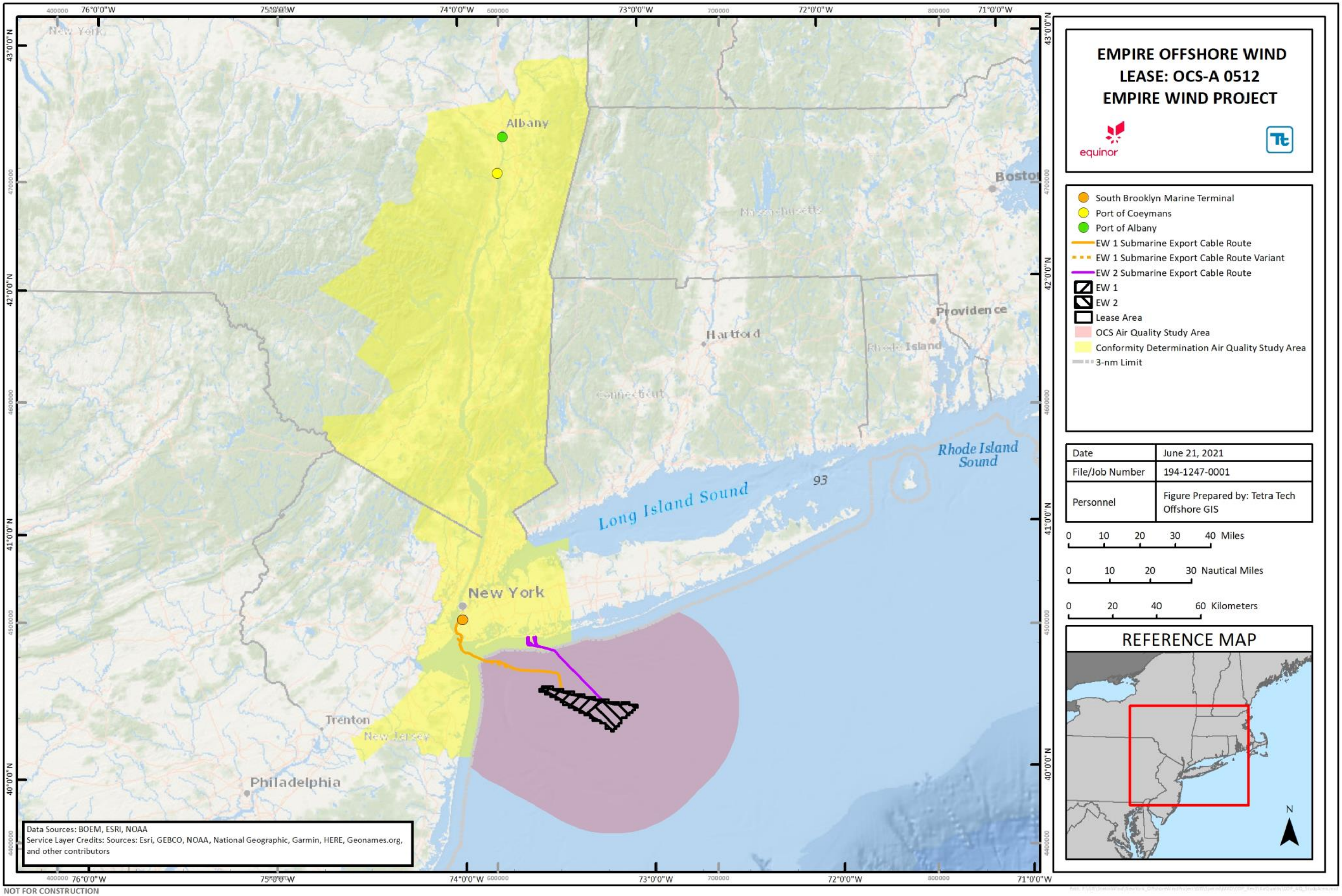

Figure 4.3-1 Air Quality Study Area

4.3.1.1 New York

In New York State, the NYSDEC Division of Air Resources is responsible for ensuring clean air and managing the state and federal air pollution control programs. Within this division, the Bureau of Air Quality Surveillance operates 58 air pollution monitoring stations collecting meteorological data and ambient concentrations of criteria pollutants, VOCs, and other air toxics across the state (NYSDEC 2019). The data collected at these monitoring stations inform air pollution control programs and policies. Of the 58 monitoring stations, 24 stations collect air quality data in the New York City metropolitan area, including Rockland County, Westchester County, Nassau County, Suffolk County, and the five counties within New York City (NYSDEC 2019).

The following counties in New York State where Project emissions could potentially occur during construction or operations are currently designated as serious ozone nonattainment with respect to the 2008 standard and moderate ozone nonattainment with respect to the 2015 ozone standard: Bronx, Kings, Nassau, New York (Manhattan), Queens, Richmond (Staten Island), Rockland, and Westchester. New York County (Manhattan) is also currently designated a PM_{10} nonattainment area with respect to the 1987 PM_{10} standard (EPA 2019c). The monitors demonstrate compliance with the NAAQS for other criteria pollutants. Additionally, a number of New York counties that are currently in attainment for CO and $PM_{2.5}$ were previously designated as nonattainment and are therefore classified as maintenance areas for the purpose of General Conformity.

The following counties in New York State where Project emissions could potentially occur during construction or operations are maintenance areas for the 1971 CO standard: Bronx, Kings, Nassau, New York (Manhattan), Queens, Richmond (Staten Island), and Westchester.

The following counties where Project emissions could potentially occur during construction or operations are maintenance areas for the 1997 annual $PM_{2.5}$ standard: Bronx, Kings, Nassau, New York (Manhattan), Queens, Orange, Richmond (Staten Island), Rockland, and Westchester.

Finally, the following counties where Project emissions could potentially occur during construction or operations are maintenance areas for the 2006 24-hour $PM_{2.5}$ standard: Bronx, Kings, Nassau, New York (Manhattan), Orange, Queens, Richmond (Staten Island), Rockland, and Westchester.

In addition to monitoring criteria pollutants to determine compliance with the NAAQS, NYSDEC operates an air toxics monitoring program to monitor the ambient concentration of VOCs across the state. The program currently collects samples at 12 monitoring stations within the state's network of monitoring stations (NYSDEC 2017). While some compounds exhibit more variable trends, data from 2006 to 2017 indicates that annual average concentrations have generally decreased since 2006 (NYSDEC 2017).

In July 2019, the NYSERDA finalized the New York State Greenhouse Gas Inventory: 1990-2016, which inventories GHG emissions by sector. The report indicates that while GHG emissions increased between 1990 and 2005, GHG emissions in the state have been decreasing since 2005 (NYSERDA 2019). The state has reduced emissions from 236 million metric tons of GHG in 1990 to 206 million metric tons of GHG in 2016, achieving an 8 percent decrease in GHG emissions over this period. The state reduced GHG emissions, while national emissions increased approximately 2 percent over the same period from 1990 to 2016 (NYSERDA 2019).

4.3.1.2 New Jersey

In New Jersey, the NJDEP Division of Air Quality is responsible for ensuring clean air and managing the state and federal air pollution control programs. Within this division, the Bureau of Air Monitoring operates 32 air pollution monitoring stations collecting meteorological data and ambient concentrations of criteria pollutants, VOCs, and other air toxics across the state (NJDEP 2018). Of the 32 monitoring stations, 14 stations collect air quality data in or near areas potentially affected by the Project, including Bergen, Hudson, and Monmouth counties, as well as neighboring Union and Middlesex counties. The data collected at these monitoring stations inform air pollution control programs and policies.

The following counties in New Jersey where Project emissions could potentially occur during construction or operation are currently designated as serious ozone nonattainment with respect to the 2008 standard and moderate ozone nonattainment with respect to the 2015 standard: Bergen, Hudson, and Monmouth. Additionally, several New Jersey counties that are currently in attainment for CO and $PM_{2.5}$ were previously designated as nonattainment and are therefore classified as maintenance areas for the purpose of General Conformity.

The following counties in New Jersey where Project emissions could potentially occur during construction or operations are maintenance areas for the 1971 CO standard: Bergen and Hudson.

The following counties where Project emissions could potentially occur during construction or operations are maintenance areas for both the 1997 annual $PM_{2.5}$ standard and the 2006 24-hour $PM_{2.5}$ standard: Bergen, Hudson, and Monmouth. Data collected at the monitoring stations indicate that criteria pollutant levels in the state have decreased, with the exception of an anomalous increase in SO_2 concentrations observed around 2013 associated with a facility in Pennsylvania (NJDEP 2018).

In addition to monitoring criteria pollutants in order to determine compliance with the NAAQS, NJDEP monitored the ambient concentration of VOCs at four monitoring stations within the state (NJDEP 2018). In December 2017, NJDEP finalized the 2015 Statewide GHG Emissions Inventory, which inventories GHG emissions in the state. Although the GHG emissions have periodically increased (e.g., in 2007, 2010, and 2014), the report indicates that GHG emissions have trended downward since 2005 (NJDEP 2017). To ensure GHG emissions continue declining, New Jersey promulgated the Global Warming Response Act, which established GHG reduction goals to limit emissions to 1990 levels by 2020 and to achieve an 80 percent reduction in emissions from 2006 levels by 2050 (New Jersey Statutes Annotated 26:2C-37 *et seq*.). The statewide GHG emissions have been under the 2020 target since 2008. In order to achieve the 2050 target, the state will have to reduce emissions by an additional 75.2 million metric tons from the 101 million metric tons of carbon dioxide equivalent (CO_{2e}) emissions estimated for 2015.

4.3.1.3 Virginia

In Virginia, the Virginia Department of Environmental Quality (VDEQ) Air Pollution Control Board is responsible for ensuring clean air and managing the state and federal air pollution control programs. Within this division, the Office of Air Quality Monitoring compiles meteorological data and ambient concentrations of criteria pollutants, VOCs, and other air toxics from 38 ambient monitoring sites in the state of Virginia, operated by VDEQ, the City of Alexandria, the U.S. Department of Agriculture Forest Service, and the National Park Service (VDEQ 2019). The data collected at these monitoring stations inform air pollution control programs and policies. Of the 38 monitoring stations, five stations collect air quality data in the Tidewater District in southeastern Virginia, including stations in Hampton, Norfolk, and Virginia Beach (VDEQ 2019).

The following jurisdictions in Virginia where Project emissions could potentially occur during construction are designated as attainment for all current NAAQS, but they have been included in the emissions inventory for the purpose of NEPA review: Hampton City, Norfolk City, and Virginia Beach City.

The Norfolk-Virginia Beach-Newport News (Hampton Roads) AQCR, in which the above jurisdictions are located, is designated as attainment for all current NAAQS. Ambient monitoring data from the most recent three years available (2016 through 2018) indicate that no exceedances of the 2015 8-hour ozone standard have occurred in the Virginia Beach area in the past three years, and that concentrations for all pollutants have either gradually decreased or remained roughly the same (VDEQ 2019).

VDEQ currently does not publish an official inventory of greenhouse gas emissions in Virginia, so information about current statewide emissions and trends over time are not readily available. However, VDEQ promulgated a new CO_2 budget trading regulation in 2019 to reduce CO_2 emissions from fossil fuel fired electric generating facilities, and is in the process of developing regulations to limit methane emissions from natural gas infrastructure and from landfills (VDEQ 2020).

4.3.1.4 Texas

In Texas, the Texas Commission on Environmental Quality (TCEQ) is responsible for ensuring clean air and managing the state and federal air pollution control programs. TCEQ collects ambient concentration data for criteria pollutants, VOCs, and other air toxics from a total of 249 monitoring stations in the state of Texas, 9 of which are located in the Corpus Christi area (TCEQ 2020a). The following jurisdictions in Texas where Project emissions could potentially occur during construction are designated as attainment for all current NAAQS, but they have been included in the emissions inventory for the purpose of NEPA review: Aransas County, Nueces County, and San Patricio County. Summaries of ambient monitoring data for the three most recent years (2017-2019) show that concentrations for most criteria pollutants have either decreased or remained roughly steady (TCEQ 2020b).

TCEQ currently does not publish an official inventory of greenhouse gas emissions in Texas. However, the U.S. Energy Information Administration has published trends for fossil-fuel CO_2 emissions in Texas. In 2017, the most recent year available, Texas emitted 706.5 million metric tons of fossil-fuel CO_2, which is a 1.6 percent reduction from the all-time high of 718.1 million metric tons in 2002, but represents an upward trend from a recent low of 610.4 million metric tons in 2009 (EIA 2020).

4.3.2 Impact Analysis for Construction, Operations, and Decommissioning

The potential impacts resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see **Section 3 Project Description**). For air quality, the maximum design scenario is the maximum number of combustion engines required to transport personnel, equipment, and materials both onshore and offshore, and associated emissions, as described in **Table 4.3-3**. The parameters provided in **Table 4.3-3** represent the maximum potential impact from full build-out of the Lease Area out of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations) with both export cable routes to EW 1 and EW 2.

Table 4.3-3 Summary of Maximum Design Scenario Parameters for Air Quality

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations): EW 1: 71 wind turbines and 1 offshore substation. EW 2: 103 wind turbines and 1 offshore substation.	Representative of the maximum number of structures for EW 1 and EW 2.
Wind turbine foundation	GBS	Representative of the foundation option that has the installation method that would result in the maximum amount of Project-related emissions.
Submarine export cables	Based on full build-out of EW 1 and EW 2. EW 1: 40 nm (74 km). EW 2: 26 nm (48 nm).	Representative of the maximum length of new submarine export cables to be installed, which would result in the maximum amount of Project-related emissions.
Interarray cables	Based on full build-out of EW 1 and EW 2, with the maximum number of structures (174 wind turbines and 2 offshore substations) to connect. EW 1: 116 nm (214 km). EW 2: 144 nm (267 nm).	Representative of the maximum length of interarray cables to be installed, which would result in the maximum amount of Project-related emissions.
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of a construction and installation scenario that presents the maximum number of vessels, which would result in the maximum amount of Project-related emissions.
Duration Offshore construction	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum period of cumulative duration for installation.	Representative of the maximum period required to install the offshore components, which would result in the maximum amount of Project-related emissions.
Project-related vehicles and equipment	Based on the development of EW 1 and EW 2 (construction and installation of 2 export cables landfalls, onshore export and interconnection cables, and onshore substations) and the maximum associated Project-related vehicles.	Representative of the maximum amount of vehicles and equipment, which would result in the maximum amount of Project-related emissions.

Table 4.3-3 Summary of Maximum Design Scenario Parameters for Air Quality (continued)

Parameter	Maximum Design Scenario	Rationale
Staging and construction areas, including port facilities, work compounds and lay-down areas	Based on EW 1 and EW 2. Maximum number of work compounds and lay-down areas required. Ground disturbing activities are not anticipated. Independent activities to upgrade or modify staging, construction areas, and ports prior to Project use will be the responsibility of the facility owner.	Representative of the maximum area required to facilitate the offshore and onshore construction activities, which would result in the maximum amount of Project-related emissions.
Onshore construction Duration	Based on the development of EW 1 and EW 2 (construction and installation of two export cables landfalls, onshore export and interconnection cables, and onshore substations) and maximum period of cumulative duration for installation.	Representative of the maximum period required to install the onshore components, which has the potential to temporarily impact resources in the Project Area.
Operations		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations). EW 1: 71 wind turbines and 1 offshore substation. EW 2: 103 wind turbines and 1 offshore substation.	Representative of the presence of new fixed structures in an area that previously consisted of none.
Project-related vessels	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and maximum associated vessels.	Representative of the maximum predicted Project-related vessels, which would result in the maximum amount of Project-related emissions.
Offshore O&M activities	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, the longest operational duration, and the maximum amount of Project-related activities expected per year.	Representative of the maximum amount of activities from the Project during the O&M phase, which would result in the maximum amount of Project-related emissions.
Onshore O&M activities	Based on the development of EW 1 and EW 2 (construction and installation of 2 export cables landfalls, onshore export and interconnection cables, and onshore substations) and the maximum amount of Project-related activities expected per year.	Representative of the maximum amount of activities from the Project during the O&M phase, which would result in the maximum amount of Project-related emissions.

Table 4.3-3 Summary of Maximum Design Scenario Parameters for Air Quality (continued)

Parameter	Maximum Design Scenario	Rationale
Onshore substations	Based on EW 1 and EW 2: EW 1: 4.8-ac (3.6-ha) area. EW 2: 7.4-ac (3.0-ha) area.	Representative of the presence of a new structure in an area where there was previously none.
O&M Base	4.5-ac (1.8-ha) area.	Representative of the presence of a new structure in an area where there was previously none.

4.3.2.1 Construction

During construction, the potential impact-producing factors to air quality may include:

- Transportation of Project-related components to the associated ports, staging locations, and Project sites;
- Staging activities and assembly of Project components at applicable facilities or areas;
- Construction of the offshore components, including the wind turbines, offshore substations, submarine export cables, and interarray cables; and
- Construction of the onshore components, including the onshore export and interconnection cables, onshore substations, and O&M Base.

With the following potential consequential impact-producing factors:

- Short-term increase in Project-related emissions.

Short-term increase in Project-related emissions. During construction, Project-related air emissions could have short-term impacts to air quality. Primary Project emissions sources include marine vessels, which will potentially transit waters of New York, New Jersey, Virginia, and Texas, with the majority of Project-related construction emissions expected to occur offshore, within the Lease Area and along the submarine export cable routes. Most of these vessels and the onboard construction equipment will utilize diesel engines burning low sulfur fuel while some larger construction vessels may use bunker fuel. Construction staging and laydown for offshore and onshore construction may occur at port facilities in New York State, as well as the locations for each onshore substation and export cable interconnection, in Kings County and Nassau County, New York. Onshore construction activities will primarily utilize diesel-powered equipment that include HDD operations, trenching/duct bank construction, and cable pulling and termination. In addition, a localized increase in fugitive dust may result during onshore construction activities. Any fugitive dust generated during construction of the onshore components of the Project will be managed in accordance with the Project's onshore Fugitive Dust Control Plan.

A complete emissions inventory for the construction phase, including underlying assumptions for engine type and rating, engine use (hours), number of trips, and emission factors, is provided in **Appendix K.** The avoidance, minimization, and mitigation measures that have been incorporated in the inventory assumptions area are also provided in **Appendix K**, and include, but are not limited to, use of low-sulfur fuels, use of vessels that meet Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) requirements, acquisition of Emission Reduction Credits (ERC), and minimization of engine idling time.

Estimated emissions are presented as total annual emissions for the purpose of comparison to OCS air permitting and General Conformity thresholds. Outer Continental Shelf air permit emissions include those from OCS sources, vessels meeting the definition of OCS Source (40 CFR § 55.2), and vessels traveling to and from the Project when within 25 nm (46.3 km) of the Lease Area's perimeter (described in **Table 4.3-4** through **Table 4.3-8**, as "Inside OCS Radius"). General Conformity air emissions include emissions outside the 25-nm (46.3-km) perimeter and within the defined Nonattainment Areas (NAAs) and maintenance areas outward to 3 nm (5.6 km) of a state's seaward boundary. Conformity emissions are apportioned to the NAA or maintenance area where the emissions will occur based on the assumptions for vessel trips between ports and the Lease Area, as well as the locations of the export cable routes (described in the **Table 4.3-4** through **Table 4.3-8**, through the associated county). Emissions are presented by the pollutants identified in technical guidance. Total emissions include all combustion sources anticipated for Project-related usage offshore and onshore.

Table 4.3-4 through **Table 4.3-8** present the combined potential emissions for EW 1 and EW 2, by calendar year for each geographic area considered. The emissions in each area include total emissions from construction (both onshore and offshore) and operations and maintenance, including vessel transits. Under the construction schedule, EW 1 and EW 2 both begin construction of onshore facilities in 2023, followed by the commencement of construction for the EW 1 offshore facilities in 2024, and for the EW 2 offshore facilities in 2025, with EW 1 having a total construction duration of four years, and EW 2 having a total construction duration of five years. Construction emissions would begin in calendar year 2023 (start of EW 1 and EW 2) and continue through calendar year 2026 (completion of EW 2). Emissions from operations and maintenance would begin as EW 1 is completed and would be concurrent with construction emissions from EW 2. It is assumed that the following tasks would occur in each year of activity:

- **Year 1:** Onshore substation construction (EW 1 and EW 2), and O&M Base construction (shared facility for both EW 1 and EW 2);
- **Year 2:** Onshore substation construction (EW 1 and EW 2), wind turbine foundation installation (EW 1 only), submarine export cable installation (EW 1 only), temporary mooring of foundations, onshore export and interconnection cables (EW 1 only), and onshore landfall construction (EW 1 only);
- **Year 3**: Onshore substation construction (EW 1 and EW 2), wind turbine foundation installation (EW 1 and EW 2), submarine export cable installation (EW 1 and EW 2), interarray cable installation (EW 1 only), offshore substation topside and foundation installation (EW 1 and EW 2), temporary mooring of foundations, wind turbine installation and offshore commissioning (EW 1 only), onshore export and interconnection cables (EW 1 and EW 2), and export cable landfall construction (EW 1 and EW 2);
- **Year 4:** Wind turbine foundation installation (EW 2 only), interarray cable installation (EW 2 only), offshore substation topside and foundation installation (EW 2 only), temporary mooring of foundations, wind turbine installation and offshore commissioning (EW 2 only), onshore export and interconnection cables (EW 2 only), export cable landfall construction (EW 2 only), and normal operations and maintenance (EW 1 only);
- **Year 5:** Wind turbine installation and offshore commissioning (EW 2 only), and normal operations and maintenance (EW 1 only); and
- **Year 6:** Normal operations and maintenance (EW 1 and EW 2).

Table 4.3-4 Calendar Year 2023 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	0	0	0	0	0	0	0	0
Ozone NAA (NY-NJ-CT)	0.44	3.40	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	0	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	3.40	--	--	0.14	6.82E-03	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	3.40	--	--	0.14	6.82E-03	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	1.18	--	--	--	--	--
Non-OCS federal waters	0	0	0	0	0	0	0	0
Virginia state waters (Hampton Roads AQCR)	0	0	0	0	0	0	0	0
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS a/	**0.44**	**3.40**	**1.18**	**0.14**	**0.14**	**6.82E-03**	**0.10**	**1,231**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

Table 4.3-5 Calendar Year 2024 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	189.11	4,709.84	915.11	118.83	115.26	110.59	17.58	256,692
Ozone NAA (NY-NJ-CT)	**22.56**	**538.51**	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	**0.45**	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	**548.45**	--	--	**13.45**	**12.73**	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	**548.45**	--	--	**13.45**	**12.73**	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	**88.22**	--	--	--	--	--
Non-OCS federal waters	4.42	116.81	9.73	1.64	1.59	3.51	0.39	5,800
Virginia state waters (Hampton Roads AQCR)	0.53	14.02	1.17	0.20	0.19	0.42	0.05	696
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS a/	**220.92**	**5,463.42**	**1,065.70**	**139.22**	**135.04**	**127.30**	**20.73**	**301,228**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

Table 4.3-6 Calendar Year 2025 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	526.84	13,074.36	2,484.39	328.43	318.58	308.71	48.99	711,308
Ozone NAA (NY-NJ-CT)	**50.44**	**1,224.07**	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	**1.11**	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	**1,248.63**	--	--	**31.29**	**28.59**	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	**1,248.63**	--	--	**31.29**	**28.59**	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	**205.32**	--	--	--	--	--
Non-OCS federal waters	12.03	317.66	26.47	4.46	4.33	9.55	1.06	15,773
Virginia state waters (Hampton Roads AQCR)	1.24	32.71	2.73	0.46	0.45	0.98	0.11	1,624
Texas state waters (Corpus Christi-Victoria AQCR)	0.03	0.70	0.06	9.79E-03	9.50E-03	0.02	2.33E-03	35
TOTAL, ALL AREAS a/	**601.25**	**14,858.84**	**2,847.13**	**377.28**	**365.96**	**347.97**	**56.16**	**813,592**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

Table 4.3-7 Calendar Year 2026 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	315.23	7,751.23	1,603.03	206.36	200.17	170.72	29.58	432,562
Ozone NAA (NY-NJ-CT)	**15.02**	**349.65**	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	**0.51**	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	**361.04**	--	--	**10.70**	**7.05**	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	**361.04**	--	--	**10.70**	**7.05**	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	**69.30**	--	--	--	--	--
Non-OCS federal waters	3.29	86.89	7.24	1.22	1.18	2.61	0.29	4,315
Virginia state waters (Hampton Roads AQCR)	0.35	9.35	0.78	0.13	0.13	0.28	0.03	464
Texas state waters (Corpus Christi-Victoria AQCR)	5.28E-03	0.14	1.16E-02	1.96E-03	1.90E-03	4.19E-03	4.67E-04	7
TOTAL, ALL AREAS a/	**339.02**	**8,298.16**	**1,743.68**	**224.36**	**217.63**	**180.73**	**31.92**	**466,455**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

Table 4.3-8 Calendar Year 2027 Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	147.16	3,544.20	920.72	110.10	106.80	63.95	14.09	212,480
Ozone NAA (NY-NJ-CT)	**6.10**	**120.58**	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	**0**	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	**126.71**	--	--	**4.86**	**1.64**	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	**126.71**	--	--	**4.86**	**1.64**	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	**30.80**	--	--	--	--	--
Non-OCS federal waters	0	0	0	0	0	0	0	0
Virginia state waters (Hampton Roads AQCR)	0	0	0	0	0	0	0	0
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS a/	**156.15**	**3,722.32**	**989.53**	**118.31**	**114.76**	**65.63**	**14.91**	**225,719**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

As shown, the combined EW 1 and EW 2 potential emissions for the construction schedule have the potential to exceed the General Conformity thresholds for the following nonattainment or maintenance areas:

- Calendar years 2024 through 2027:
  - 2008 Serious Ozone NAA (New York-Northern New Jersey-Long Island Area, NY-NJ-CT) for NO_x as an ozone precursor;
  - 2015 Moderate Ozone NAA (New York-Northern New Jersey-Long Island Area, NY-NJ-CT) for NO_x as an ozone precursor;
  - $PM_{2.5}$ 1997 Annual Maintenance Area (New York-N. New Jersey-Long Island Area, NY-NJ-CT) for NO_x as a $PM_{2.5}$ precursor; and
  - $PM_{2.5}$ 2006 24-Hour Maintenance Area (New York-N. New Jersey-Long Island Area, NY-NJ-CT) for NO_x as a $PM_{2.5}$ precursor.

- Calendar year 2025:
  - 2008 Serious Ozone NAA (New York-Northern New Jersey-Long Island Area, NY-NJ-CT) for VOC as an ozone precursor.

4.3.2.2 Operation and Maintenance

During operations and maintenance, the potential impact-producing factors to air quality may include:

- Transportation of Project-related components and crew to the associated ports, staging locations, and Project site;
- Operations and maintenance of the offshore components, including the wind turbines, offshore substations, submarine export cables, and interarray cables; and
- Operations and maintenance of the onshore components, including the onshore export and interconnection cables, onshore substations, and O&M Base.

With the following potential consequential impact-producing factors:

- Long-term increase in Project-related emissions.

Long-term increase in Project-related emissions. During the operations and maintenance phase, potential Project-related emissions will result from the Project-related vessels used to service the wind turbines and offshore substation platforms, the operation of emergency generators at each offshore substation platform and onshore substation, and GHG emissions of sulfur hexafluoride (SF_6) from gas-insulated switchgear installed at the offshore substation platforms, onshore substations, and wind turbines. Onshore activities are not considered for the purposes of the OCS air permitting threshold assessment.

As detailed in **Appendix K**, operations and maintenance activities are assumed to include routine operational support performed by one service operations vessel (SOV) along with four smaller crew transfer vessels (shared by both EW 1 and EW 2) transiting to and from the Project to service the wind turbines over the operational life of the Project. Maintenance activities are assumed to include a variety of survey and repair vessels that will operate on an infrequent, intermittent basis over the operational life of the Project. Operations support vessels are assumed to operate out of the South Brooklyn Marine Terminal (SBMT), while survey and repair vessels may either operate out of SBMT, or may arrive from an overseas report (e.g., if a heavy lift vessel is required). **Table 4.3-9** presents the combined potential operations and maintenance emissions for EW 1 and EW 2.

Table 4.3-9 Operations and Maintenance Potential Emissions for Calendar Year 2028 Onward (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
Inside OCS radius	29.54	759.07	246.97	23.12	22.43	10.37	2.82	51,871
Ozone NAA (NY-NJ-CT)	**0.98**	**17.20**	--	--	--	--	--	--
PM_{10} NAA (New York County)	--	--	--	**0**	--	--	--	--
$PM_{2.5}$ Maintenance Area (1997 Annual, NY-NJ-CT)	--	**17.20**	--	--	**0.54**	**0.02**	--	--
$PM_{2.5}$ Maintenance Area (2006 24-hour, NY-NJ-CT)	--	**17.20**	--	--	**0.54**	**0.02**	--	--
CO Maintenance Area (NY-NJ-CT)	--	--	**7.70**	--	--	--	--	--
TOTAL, ALL AREAS a/	**30.52**	**776.26**	**255.98**	**23.68**	**22.97**	**10.39**	**2.88**	**54,824**

Note:
a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO_2) that are precursors for more than one General Conformity pollutant.

Under the anticipated construction schedule, construction of EW 1 and EW 2 would be completed by the end of calendar year 2027, and emissions for calendar year 2028 onward would only include routine operations and maintenance emissions from both EW 1 and EW 2.

Most of the ongoing operations and maintenance emissions would occur inside the OCS radius and would be covered by the OCS air permit. No General Conformity thresholds would be triggered for routine operations and maintenance emissions.

The estimated Project operations and maintenance emissions values in **Table 4.3-9** are based on the following Project operating assumptions:

- 500 operating hours per year per engine, for the emergency generator engine at each offshore substation and onshore substation;
- 328.5 operating days per year for one SOV, with 26 annual round trips to port;
- 240.9 operating days per year for each of four crew transfer vessels, each with 120 annual round trips to port;
- 60 operating days per year for one survey vessel, with one annual round trip to port;
- 90 operating days per year, on average, for a heavy lift vessel (30 days for EW 1 and 60 days for EW 2), with 3 annual round trips to the Lease Area;
- 90 operating days per year, on average, for each of two barge tugs to support the heavy lift vessel (30 days for EW 1 and 60 days for EW 2), with 3 annual round trips to port;
- 42 operating days per year, on average, for one interarray cable lay vessel (14 days for EW 1 and 28 days for EW 2), with 3 annual round trips to port;
- 10 operating days for one submarine export cable lay vessel, estimated to occur approximately once every 10 years for both EW 1 and EW 2, with one included round trip to port; and
- Approximately 6 operating days for each of 16 temporary 150 kW generator engines, estimated to be required approximately once every 10 years for both EW 1 and EW 2, in the event that damage to an interarray cable leaves multiple wind turbines without access to backup grid power.

Estimated air emissions from operations and maintenance activities are not expected to have a significant impact on regional air quality over the operational life of the Project and are generally expected to be smaller compared to the impacts anticipated during construction activities. The use of wind to generate electricity reduces the need for electricity generation from traditional fossil fuel powered plants that produce GHG emissions and will result in the displacement of marginal generation from fossil fuel-fired power plants.

4.3.2.3 Decommissioning

Impacts during decommissioning are expected to be similar or less than those experienced during construction, as described in Section 4.3.2.1. It is important to note that advances in decommissioning methods/technologies, as well as advancements in emissions reduction technologies, are expected to occur throughout the operations phase of the Project. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. Furthermore, these future decommissioning emissions will be the subject of a future OCS air permit application. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.3.3 Summary of Avoidance, Minimization, and Mitigation Measures

In order to mitigate the potential impact-producing factors described in Section 4.3.2, Empire is proposing to implement the following avoidance, minimization, and mitigation measures.

4.3.3.1 Construction

During construction, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.3.2.1:

- Where required, Empire will purchase sufficient emission reduction credits to offset the NO_X and VOC emissions for Project-related activities. Empire will provide documentation of the purchase of offsets in accordance with the requirements set forth in the Record of Decision (ROD) and/or the issued OCS air permit;
- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements when operating within the North American Emission Control Area (200 nm [370.4 km]) established by the International Maritime Organization (IMO);
- Project-related diesel-powered equipment will use ultra-low sulfur diesel fuel, per the requirements of 40 CFR § 80.510(b)[8];
- Project-related vessels will use low sulfur diesel fuel where possible and be at or below the maximum fuel sulfur content requirement of 1,000 ppm established per the requirements of 40 CFR § 80.510(k).
- Project-related vessels will comply with applicable EPA, or equivalent, emission standards;
- Empire will provide BOEM with data on horsepower rating of all propulsion and auxiliary engines, duration of time operating in state waters, load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, which will confirm that sufficient emissions offsets have been acquired;
- Empire will provide vessel engines and emissions control equipment information to BOEM and the EPA in accordance with the requirements set forth in the ROD and/or the issued OCS air permit; and
- Project-related vehicles, diesel engines, and/or nonroad diesel engines at the staging site will comply with applicable state regulations regarding idling. In New York State, 6 NYCRR 217-3 prohibits all on-road diesel-fueled and non-diesel-fueled heavy-duty vehicles from idling for more than five minutes. N.J.A.C. 7:27-14 and 7:27-15 restricts the unnecessary idling of diesel and gasoline engines, respectively, to three minutes.

4.3.3.2 Operations and Maintenance

During operations, Empire will commit to the following avoidance, minimization, and mitigation measures will be implemented to mitigate the impacts described in Section 4.3.2.2:

- Empire will purchase sufficient emission reduction credits to offset the NO_X and VOC emissions for Project-related activities. Empire will provide documentation of the purchase of offsets in accordance with the requirements set forth in the ROD and/or the issued OCS air permit;
- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements when operating within the North American Emission Control Area (200 nm [370.4 km]) established by the IMO;
- Project-related vessels will use low sulfur diesel fuel where possible and be at or below the maximum fuel sulfur content requirement of 1,000 ppm established per the requirements of 40 CFR § 80.510(k);
- Project-related vessels will comply with applicable EPA, or equivalent, emission standards;
- Empire will provide BOEM with data on horsepower rating of all propulsion and auxiliary engines, duration of time operating in state waters, load factor, and fuel consumption for Project-related vessels

[8] Beginning June 1, 2010, all non-road diesel fuel is subject to a 15-ppm sulfur content limit, which is defined in practice as ultra-low sulfur diesel fuel.

to determine actual emissions from Project-related vessels, which will confirm that sufficient emissions offsets have been acquired; and

- Empire will provide vessel engines and emissions control equipment information to BOEM and the EPA in accordance with the requirements set forth in the ROD and/or the issued OCS air permit.

4.3.3.3 Decommissioning

Avoidance, minimization, and mitigation measures proposed to be implemented during decommissioning are expected to be similar to those implemented during construction and operations, as described in Section 4.3.3.1 and Section 4.3.3.2. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and avoidance, minimization, and mitigation measures for decommissioning activities will be proposed at that time.

4.3.4 References

Table 4.3-10 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coastal/crm.html	N/A

EIA (U.S. Energy Information Administration). 2020. "State Carbon Dioxide Emissions Data." Available for download at https://www.eia.gov/environment/emissions/state/excel/states/texas.xlsx. Accessed September 16, 2020.

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EPA. 2017b. "What are Hazardous Air Pollutants?" Last updated February 9, 2017. Available online at https://www.epa.gov/haps/what-are-hazardous-air-pollutants. Accessed August 14, 2019.

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NYSDEC. 2019. "2019 Annual Monitoring Network Plan." NYSDEC Division of Air Resources Bureau of Air Quality Surveillance. Published April 17, 2019. Available for download at https://www.dec.ny.gov/chemical/33276.html. Accessed August 14, 2019.

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TCEQ. 2020b. "Air Quality Successes - Criteria Pollutants." Available online at https://www.tceq.texas.gov/airquality/airsuccess/airsuccesscriteria. Accessed September 16, 2020.

VDEQ (Virginia Department of Environmental Quality). 2019. "Virginia Ambient Air Monitoring 2018 Data Report." Available online at https://www.deq.virginia.gov/Portals/0/DEQ/Air/AirMonitoring/2018_Virginia_Ambient_Air_Monitoring_Report.pdf. Accessed August 14, 2020.

VDEQ. 2020. "Virginia DEQ – Greenhouse Gases." Available online at https://www.deq.virginia.gov/Programs/Air/GreenhouseGasPlan.aspx. Accessed August 14, 2020.

4.4 Acoustics

4.4.1 In-Air Acoustic Environment

This section describes the regulatory framework for in-air sound, as applicable to the Project, and the affected in-air sound environment. Potential impacts to the in-air sound environment resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Empire are also described, which are intended to avoid, minimize, and/or mitigate potential impacts resulting from in-air noise. It is Empire's objective to successfully demonstrate compliance with all applicable noise regulations and requirements; however, exceptions and/or variances may be sought, if needed, for construction-related activities.

Other resources and assessments detailed within this COP that are related to sound include:

- Underwater Noise (Section 4.4.2 and Appendix M); and
- In-Air Acoustic Assessment (Appendix L).

There are no federal noise regulations directly applicable to assessing sound impacts resulting from the Project at offsite receptors; however, construction and operational worker's exposure to Project-related sound impacts is regulated through the Occupational Health and Safety Act of 1970 (OSHA). Additionally, as the onshore components of the Project will be located in New York, state regulations and guidelines will be applicable to the in-air sound associated with the Project. The EW 1 onshore substation and export cable landfall will be located in the borough of Brooklyn in New York City, Kings County, New York; and the EW 2 onshore substation and export cable landfall is in the City of Long Beach, Hempstead Township, and the Hamlet of Oceanside in unincorporated Nassau County, New York. There are local noise requirements for all proposed onshore substation locations and export cable landfalls. These restrictions will be followed unless work outside of these timeframes is authorized by the appropriate regulatory authority.

New York

The NYSDEC guidelines are defined in the publication "Assessing and Mitigating Noise Impacts" (2001). This document states that as L_P (e.g. sound pressure level) increases from 0 to 3 decibels, A-scale (dBA) should have no appreciable effect on receivers; increases of 3 to 6 dBA may have the potential for adverse impact only in cases where the most sensitive of receptors are present; and increases of more than 6 dBA may require a closer analysis of impact potential depending on existing sound levels and character of surrounding land use. The NYSDEC guidance states that the 6 dBA increase is to be used as a general guideline. Although not explicitly stated in the policy, the 6 dBA increase has been applied to the minimum measured equivalent sound level (L_{eq}) or alternatively the time averaged L_{90} (e.g. noise level exceeded 10 percent of the time) sound level for the licensing of other projects in New York State. There are other guidelines that should also be considered. For example, in settings with low ambient sound levels, NYSDEC guidance has deemed an absolute limit of 40 dBA as adequately protective.

The NYSDEC policy further states that the EPA "Protective Noise Levels" guidance found that an annual day-night sound level (L_{dn}) of 55 dBA was sufficient to protect the public health and welfare, and in most cases, did not create an annoyance. A 55 dBA L_{dn} would be equivalent to a daytime sound level of 55 dBA L_{eq}, and a nighttime sound level of 45 dBA L_{eq}, or a continuous level of approximately 49 dBA L_{eq}. In terms of absolute threshold values, the introduction of any new sound source should not raise ambient levels above 65 dBA L_{eq} in non-industrial settings to protect against speech disturbance or above approximately 79 dBA L_{eq} for industrial environments for associated noise-related health and safety reasons. In most cases, NYSDEC recommends that projects exceeding either of these threshold levels or resulting in an increase of 10 dBA consider avoidance and mitigation measures.

New York City

Title 24, Chapter 2 of the New York City Administrative Code regulates sound by the existing land use of receiving property, not its zoning designation. There are two separate regulations that apply to the Project operation: (1) absolute octave band limits at residential and commercial property, and (2) incremental limits for all off-site locations. These provisions do not apply to construction noise; however, construction is limited to Monday through Friday from 7:00 am to 6:00 pm. A noise mitigation plan must be completed for any construction activity before construction begins.

The octave band limits in Administrative Code Section 24-232 are summarized in **Table 4.4-1** and apply to residential/commercial property as measured inside a room with the windows open. The octave band limits are prescribed in linear or unweighted decibels. They are equivalent to broadband limits of 45 dBA for residential use and 49 dBA for commercial use.

Table 4.4-1 New York City Noise Code Section 24-232 Octave Band Limits (dB)

Octave Band (Hz) a/	Limits for Residential Property Receiver	Limits for Commercial Property Receiver
31.5	70	74
63	61	64
125	53	56
250	46	50
500	40	45
1,000	36	41
2,000	34	39
4,000	33	38
8,000	32	37

Note:
a/ Octave band limits shown as unweighted, and are equivalent to 45 dBA and 49 dBA respectively, when converted to A-weighting and summed.

The incremental limits in Administrative Code Section 24-218 prohibit an increase in the "ambient sound level" of 7 dBA or more during the nighttime hours of 10:00 p.m. to 7:00 a.m. at any receiving property. Ambient sound is defined in Section 24-203 of the Administrative Code as the total sound level "at a location that exists" excluding "extraneous sounds," which are defined as "intense, intermittent" sounds. Although the Noise Code assigns no sound metric to the term "ambient sound," the standard convention in acoustical assessment is to represent this condition as the average (L_{eq}) sound level.

In addition to the City of New York Noise Code Regulations, the City also has zoning regulations, established by the New York City Department of City Planning. Sections 42-213 and 214 of the City's Zoning Resolution set regulatory limits on octave band sound levels from operation of a facility "at any point on or beyond any lot line." The decibel limits for whole octave bands from 31 hertz (Hz) to 16,000 Hz differ depending on manufacturing districts. The manufacturing district relevant to the Project will be M3-1, as shown in **Table 4.4-2** given in linear or unweighted decibels.

Table 4.4-2 New York City Zoning Resolution Sections 42-213 & 214 Octave Band Limits (dB)

Octave Band Frequency (Hz)	Limits for M3-1 District
31.5	80
63	80
125	75
250	70
500	64
1,000	58
2,000	53
4,000	49
8,000	46

Hempstead Township

Two of the proposed EW 2 export cable landfalls and the onshore substation sites are proposed to be in the Hamlet of Oceanside in Nassau County, New York. Based upon correspondence with Nassau County Planning Department, the Hamlet of Oceanside is under the jurisdiction of the Town of Hempstead, New York and follows the town's zoning regulations. The Town of Hempstead regulates noise through its ordinance (Chapter 144, Ordinance Number 25 amended in its entirety 11-1-1983 by L.L. Number 99-1983, effective 11-7-1983). Generally, construction is limited to the hours of 7:00 am and 6:00 pm on weekdays.

The Town prescribes limits by octave band frequency for transient (**Table 4.4-3**) and steady-state sound sources (**Table 4.4-4**), given in linear or unweighted decibels. During daytime hours (7:00 am to 7:00 pm) the limits in **Table 4.4-3** would apply to a transient noise having a duration of more than 12 seconds. During nighttime hours, the limits in **Table 4.4-3** would apply to a transient noise having a duration of more than 6 seconds.

Table 4.4-3 Hempstead Township Transient Noise Limits (dB)

Octave Band Frequency (Hz)	Octave Band Sound Pressure Level (dB)
63	92
125	87
250	79
500	72
1,000	66
2,000	60
4,000	54
8,000	52

Table 4.4-4 Hempstead Township Steady Noise Limits (dB)

Octave Band Frequency (Hz)	Octave Band Sound Pressure Level (dB)
63	72
125	67
250	59
500	52
1,000	46
2,000	40
4,000	34
8,000	32

City of Long Beach

Two potential EW 2 export cable landfalls are in the City of Long Beach in Nassau County, New York. The City of Long Beach regulates noise through the City of Long Beach Noise Control Ordinance. Chapter 16, Section 16-6 lists the following as a violation of the Ordinance and are applicable to the Project:

- No person shall operate or permit to be operated any tools or equipment used in construction, drilling, excavations or demolition work, between the hours of 8:00 p.m. and 8:00 a.m. the following day or any time on Sunday or legal holidays prior to noon, except the provisions of this section shall not apply to emergency work.

- No person shall cause or permit the operation of any device, vehicle, construction equipment or lawn maintenance equipment, including but not limited to any diesel engine, internal combustion engine or turbine engine, without a properly functioning muffler, in good working order and in constant operation regardless of sound level produced.

- Any excessive or unusually loud sound that either annoys, disturbs, injures or endangers the comfort, repose, health, peace or safety of a reasonable person of normal sensibilities.

In addition to those specific prohibitions set forth in Ordinance Section 16-6, the following general prohibitions regarding continuous sound levels shall apply in determining unreasonable noise:

- No person shall make, cause, allow, or permit the operation of any source of sound on a particular category of property or any public space or rights-of-way in such a manner as to create a sound level that exceeds the particular continuous A-weighted decibel limits set forth in **Table 4.4-5** when measured at or within the real property line of the receiving property except as provided in subsections (B) and (C).

- When measuring sound within a dwelling unit of a multi-dwelling-unit building, all exterior doors and windows shall be closed and measurements shall be taken in the center of the room.

- When measuring on Ocean Beach Park sound shall be measured at the center of the boardwalk at a point directly perpendicular to the source.

Table 4.4-5 Permissible Continuous Sound Levels by Receiving Property Category, in dBA

Sound Source Property Category	Another Dwelling Within a Multi Dwelling Unit Building		Residential		Commercial or Public Service or Community Service Facility	Industrial or Public Service Industrial Facility	Ocean Beach Park or Parks
	(7am-10pm)	(10pm-7am)	(7am-10pm)	(10pm-7am)	(All times)	(All times)	(6am-11pm)
Any location within a multi-dwelling unit building	50	45	65	50	70	75	65
Residential (or public spaces or rights-of-way)			65	50	70	75	65
Commercial or public service or community service facility			65	50	70	75	65
Industrial or public service industrial facility			65	50	70	75	65

Section 16-8 of the Ordinance describes general prohibitions regarding impulsive sound levels.

- No person shall make, cause, allow or permit the operation of any impulsive source of sound within any and all property in the city that has a peak sound pressure level in excess of eighty (80) dBA. If an impulsive sound is the result of the normal operation of an industrial or commercial facility and occurs more frequently than four (4) times in any hour the levels set forth in **Table 4.4-5** shall apply.

Regardless of the decibel limits, the provisions of this Ordinance shall not apply to noise from construction activity provided all motorized equipment used in such activity is equipped, where applicable, with functioning mufflers, except as provided in Ordinance Section 16-6.

Village of Island Park

The following noise restrictions are found within Chapter 349 of The Village of Island Park Codes.

- No person, with the intent to cause public inconvenience, annoyance or alarm, or recklessly creating a risk thereof, shall cause, suffer, allow or permit to be made unreasonable noise.

- The erection, including excavation, demolition, alteration or repair, of any building other than between 7:00 a.m. and 9:00 p.m., except in case of a public safety emergency.

- The sounding of any horn or signaling device of an automobile, motorcycle or other vehicle for any unnecessary or unreasonable period of time.

- No person or persons, firm, association, corporation or contractor shall do, perform, cause, suffer or permit the operation of any mower or power lawn mower, machine or power tools or any other power equipment to commence operation earlier than 8:00 a.m. or later than 9:00 p.m. on Monday through Saturday or earlier than 9:00 a.m. and later than 9:00 p.m. on Sunday. All other noise generated from musical instruments or events will be allowed until 11:00 p.m.

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area for the offshore components includes the offshore waters and coastlines within and in the vicinity of the Lease Area and the EW 1 and EW 2 submarine export cable routes (Offshore Study Area; see **Figure 4.4-1**). The Study Area for the onshore components includes a 0.25-mi (0.4-km) buffer around the EW 1 and EW 2 onshore export and interconnection cable routes, the associated onshore substation parcels, and the O&M Base (see **Figure 4.4-2** and **Figure 4.4-3**)[9].

This section was prepared in accordance with state and local noise regulations as outlined in Regulatory Context. In addition, an In-Air Acoustic Assessment was completed in support of the Project (see **Appendix L In-Air Acoustic Assessment**). The objectives of the In-Air Acoustic Assessment include identifying noise-sensitive land uses in the area that may be affected by the Project as well as describing the standards to which the Project will be assessed. To characterize existing ambient conditions at the onshore substation and export cable landfall sites, baseline sound measurements were conducted with an operator present for a minimum of thirty minutes during daytime and nighttime periods in accordance to American National Standards Institute (ANSI) 12.9: 2013/ Part 3 "Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-Term Measurements with an Observer Present" (ANSI 2013).

Acoustic modeling was then completed to assess the impacts associated with Project-related construction and operations activities. The acoustical modeling for the Project was conducted with the Cadna-A® sound model from DataKustik GmbH (version 2020 MR1; DataKustik GmbH 2020). The outdoor sound propagation model is based on the International Organization for Standardization (ISO) 9613, Part 1: "Calculation of the absorption of sound by the atmosphere," (1993) and Part 2: "General method of calculation," (1996). It is used by acoustical engineers to accurately describe sound emission and propagation from complex facilities (i.e. more than one sound source) and in most cases yields conservative results of operational sound levels in the surrounding community. Model predictions are accurate to within 1 decibel (dB) of calculations based on the ISO 9613 standard.

4.4.1.1 Affected Environment

The affected environment is defined as the coastal and onshore areas that have the potential to be directly and/or indirectly affected by the construction, operations, and decommissioning of the Project. This includes the export cable landfalls, onshore export and interconnection cable routes, onshore substations, and the O&M Base. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

[9] While the O&M Base will serve both EW 1 and EW 2, the facility will be located at SBMT, adjacent to the EW 1 onshore substation, and will therefore be included within the EW 1 Onshore Study Area for the purposes of this analysis.

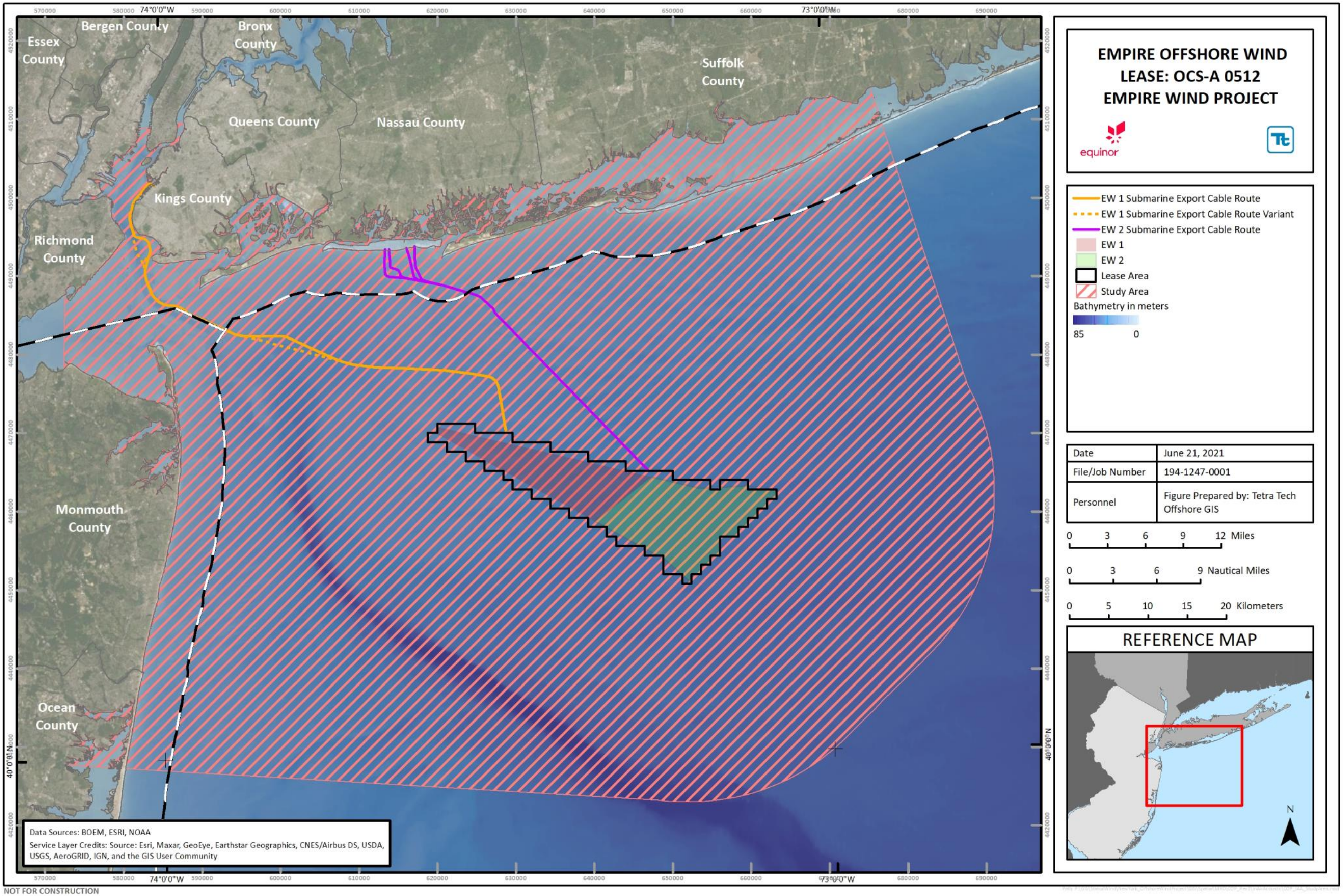

Figure 4.4-1 In-Air Noise Offshore Study Area

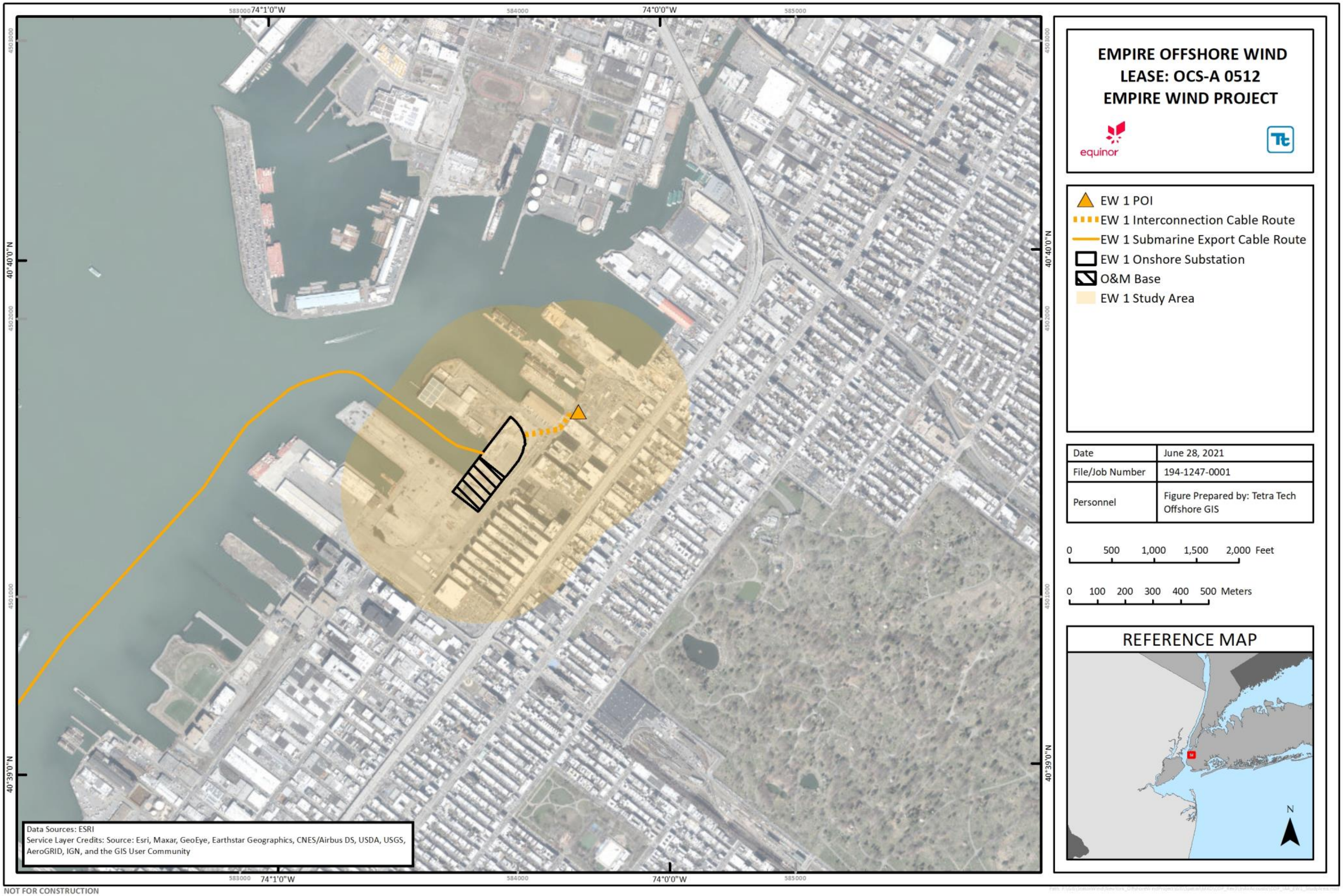

Figure 4.4-2 EW 1 In-Air Noise Onshore Study Area

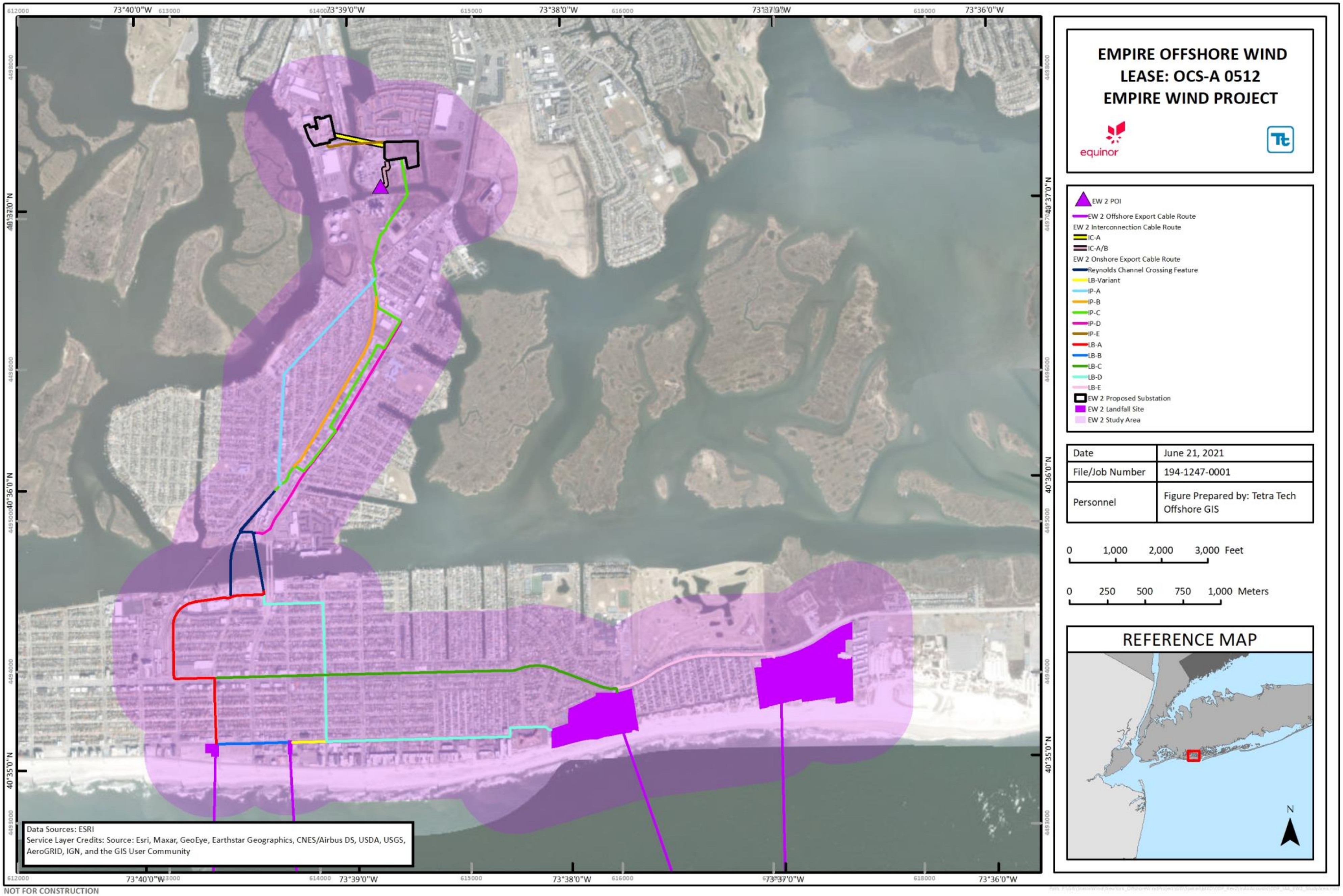

Figure 4.4-3 EW 2 In-Air Noise Onshore Study Area

Ambient sound levels are characterized by different sound levels. To take into account sound fluctuations, environmental sound is commonly described in terms of L_{eq}. The L_{eq} value is the energy-averaged sound level over a given measurement period. To describe the background ambient sound level, the L_{90} percentile metric is typically utilized, representing the quietest 10 percent of any time period. Conversely, the L_{10} is the sound level exceeded 10 percent of the time and is a measurement of intrusive noises, such as vehicular traffic or aircraft overflights, while the L_{50} metric is the sound level exceeded 50 percent of the time. The ambient acoustic environment within the EW 1 and EW 2 Onshore Study Areas is largely influenced by vehicular traffic. Localized traffic is steady during the daytime hours, with fewer cars traversing local roads at night. Noise from trains and planes are also present during both daytime and nighttime. Natural sounds from birds, trees and other wildlife are also minor sound sources in the area, as are ocean waves in coastal areas. The ambient sound measurement locations within the EW 1 and EW 2 Onshore Study Areas are shown in **Figure 4.4-4** and **Figure 4.4-5** and include residential areas in proximity to the Project.

Table 4.4-6 summarizes the measured sound levels for each of the time periods as well as location addresses. For context, a quiet suburban area would typically have nighttime levels in the range of 35 to 45 L_{90} dBA (ANSI 2013). Measurements completed by Empire showed existing nighttime L_{90} levels are in the range of 33 to 65 dBA. The measured ambient sound levels exhibited typical diurnal patterns, with higher ambient sound levels during the daytime ranging from 45 to 66 L_{90} dBA.

Table 4.4-6 Baseline Noise Measurement Results

Site	Monitoring Location	Location	Time Period	Sound Level Metrics (dBA)			
				L_{10}	L_{50}	L_{90}	L_{eq}
EW 1 Onshore Substation and Export Cable Landfall	NM-1	630 2nd Avenue	Day	72	67	66	69
			Night	58	55	53	63
EW 1 Onshore Substation and Export Cable Landfall	NM-2	100 39th Street	Day	67	56	46	65
			Night	69	66	65	67
EW 2 Onshore Substation	NM-3	136 Harris Drive	Day	57	49	48	55
			Night	52	46	44	49
EW 2 Onshore Substation	NM-4	1 Georgia Avenue	Day	59	55	51	56
			Night	54	49	47	51
EW 2 Onshore Substation	NM-5	154 Waterford Road	Day	51	47	45	48
			Night	50	48	47	50
EW 2 Export Cable Landfall	NM-6	125 East Broadway	Day	59	53	51	59
			Night	50	47	46	49

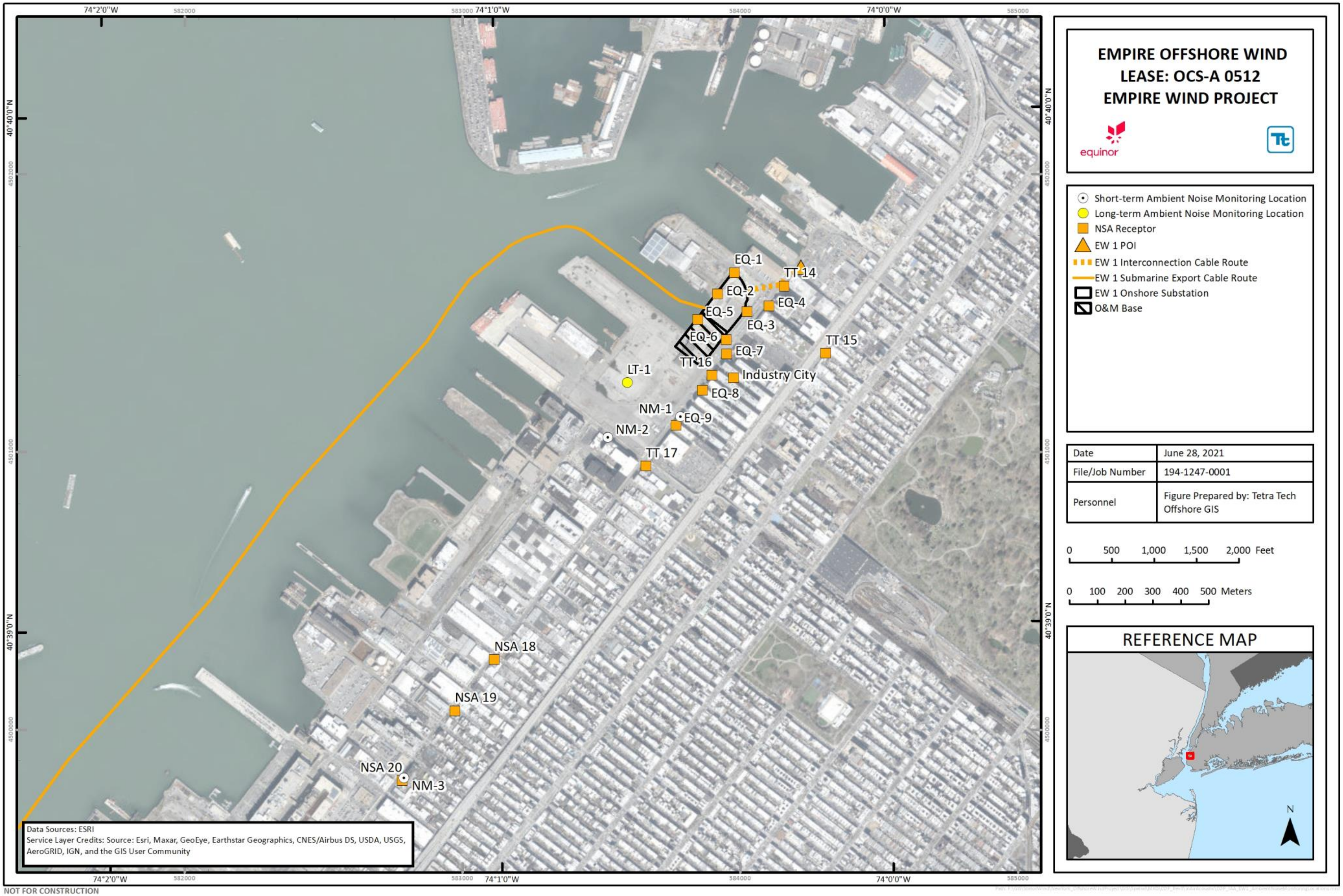

Figure 4.4-4 EW 1 Noise Monitoring Locations

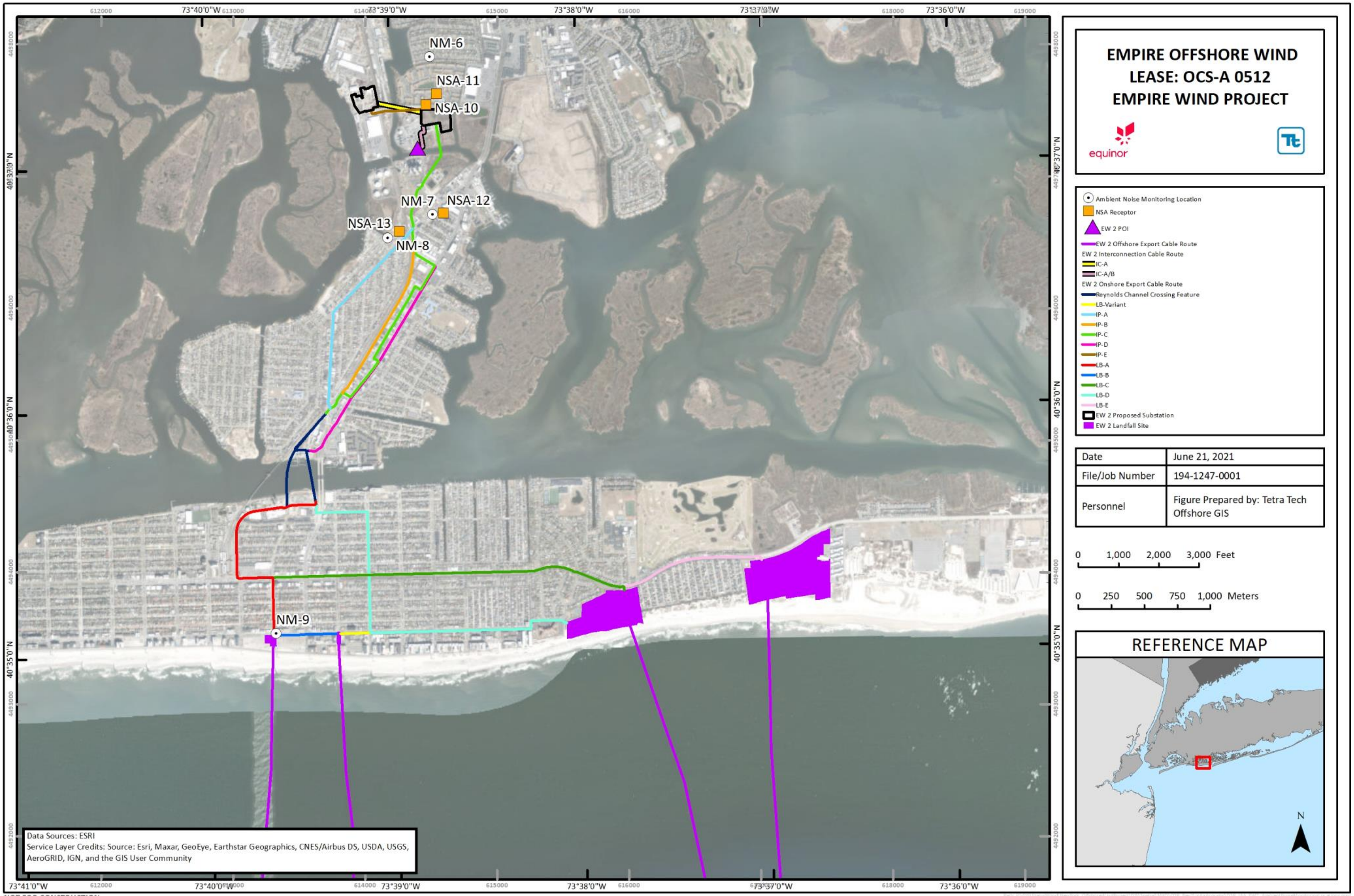

Figure 4.4-5 EW 2 Noise Monitoring Locations

4.4.1.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the PDE (see **Section 3 Project Description**). For in-air sound, the onshore maximum design scenario from a regional perspective is the construction of EW 1 and EW 2 in the Lease Area, which will include installation of onshore export and interconnection cables, onshore substations, and the O&M Base. The maximum design scenario for assessments associated with full build-out of the Lease Area of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations) with both export cable routes to EW 1 and EW 2, and the associated onshore components, including the export cable landfall, onshore export and interconnection cables, onshore substations, and O&M Base (see **Table 4.4-7**).

Table 4.4-7 Summary of Maximum Design Scenario Parameters for In-Air Sound

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and two offshore substations). EW 1: 71 wind turbines and 1 offshore substation. EW 2: 103 wind turbines and 1 offshore substation.	Representative of the maximum number of structures.
Wind turbine foundation	Monopile	Representative of the foundation option that has an installation method that would result in the maximum introduction of underwater noise.
Duration Offshore construction	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and the maximum period of cumulative duration for installation.	Representative of the maximum period required to install the offshore components, which has the potential to disturb local marine users through construction-related noises.
Export cable landfall	Based on EW 1 and EW 2. EW 1: HDD in a 200-ft by 200-ft (61-m by 61-m) area. EW 2: HDD in a 246-ft by 246-ft (75-m by 75-m) area.	Representative of the loudest landfall installation method at the landfall and nearshore environment, which has the potential to disturb the local public.
Duration Onshore construction	Based on the development of EW 1 and EW 2 (construction and installation of 2 export cables landfalls, onshore export and interconnection cables, and onshore substations) and the maximum period of cumulative duration for installation.	Representative of the maximum period required to install the onshore components, which has the potential to disturb the local public through construction-related noises.

Table 4.4-7 Summary of Maximum Design Scenario Parameters for In-Air Sound (continued)

Parameter	Maximum Design Scenario	Rationale
Operations and Maintenance		
Onshore substations	Based on EW 1 and EW 2: EW 1: 4.8 ac (1.9 ha) area. EW 2: 7.4 ac (3.0 ha) area.	Representative of the presence of a new structure in an area where there was previously none, which would introduce the maximum Project-related operations sound levels.
Onshore O&M activities	Based on the development of EW 1 and EW 2 (construction and installation of 2 export cables landfalls, onshore export and interconnection cables, and onshore substations) and the longest operational duration, with the maximum amount of Project-related activities expected per year.	Representative of the maximum amount of activities from the Project during the O&M phase, which would have the potential to impact local traffic patterns and available parking in the Project Area.

4.4.1.2.1 Construction

During construction, the potential impact-producing factors to the in-air sound environment may include:

- Construction of the offshore components, including the foundations and submarine export cables; and
- The export cable landfall, including HDD and use of cofferdams;
- Staging activities and assembly of Project components at applicable facilities or areas; and
- Construction of the onshore components, including the onshore export and interconnection cables, the onshore substations, and the O&M Base.

With the following potential consequential impact-producing factors:

- Short-term elevated in-air noise levels associated with vibratory pile driving activities for cofferdams;
- Short-term elevated in-air noise levels associated with impact pile driving activities for foundations;
- Elevated in-air noise levels associated with support vessels;
- Short-term elevated in-air noise levels associated with HDD activities; and
- Short-term elevated in-air noise levels associated with construction of the onshore export and interconnection cables, onshore substations, and O&M Base.

Elevated in-air noise levels associated with vibratory pile driving at nearshore cofferdam for HDD exit: The installation of sheet pile for the nearshore cofferdam will require the use of vibratory pile driving installation, and is estimated to produce sound levels of 78 dBA in air at a distance of approximately 400 ft (122 m) with a corresponding L_W of 127 dBA (USDOT 2012). The resulting received sound levels are presented in **Table 4.4-8**.

As shown in **Table 4.4-8**, vibratory pile driving at the EW 1 cofferdam will result in a modeled sound pressure level of 77 dBA at the shore. The vibratory pile driving at the worst-case EW 2 cofferdam will result in a modeled sound pressure level of 62 dBA at the shore. While open-cut trench is the preferred export cable landfall installation method for the EW 1 submarine export cable, the use of HDD, and therefore the installation of a cofferdam, is proposed as part of the PDE. As such, this activity was modeled and assessed.

Table 4.4-8 Sound Levels (dBA) during Vibratory Pile Driving at Nearshore Cofferdam

Site	Distance (feet)	Sound Level at Shore During Vibratory Piling (dBA)
EW 1	367	77
EW 2 Landfall A and EW 2 Landfall B	1,825	60
EW 2 Landfall C and EW 2 Landfall D	1,500	62

This construction activity will last for a relatively short duration of time and is not expected to constitute a violation of local nuisance by-laws or ordinances nor result in a potential imminent hazard to public health or the environment.

Elevated in-air noise levels associated with impact pile driving of wind turbine and offshore substation foundations: During construction, pile driving of the foundations will generate noise (see **Section 4.4.2 Underwater Acoustic Environment** and **Appendix M Underwater Acoustic Assessment** for details on the level of impact anticipated underwater). Acoustic modeling was conducted for noise produced from impact pile driving two wind turbine monopile foundations at the most shallow and deep monopile's representative location relative to the shoreline, as this is anticipated to represent the average impact scenario for this activity. Based on the modeling, pile driving activities are estimated to produce sound levels of 87 dBA in air at a distance of 400 ft (122 m) with a corresponding L_W at the source of 137 dBA (USDOT 2012).

The highest predicted received sound level at any onshore location during pile driving is less than 30 dBA, which is well below all applicable noise regulations. Given the extended distances between the Project and coastal shorelines (approximately 14 and 17 mi [22 and 27 km]), no negative impacts are expected. Offshore, marine users may be potentially disturbed due to the sound levels generated from pile driving. Because Empire proposes to implement safety zones of up to 1,640 ft (500 m) around relevant structures, activities, and vessels in a dynamic approach, as previously defined for the Block Island Wind Farm (81 FR 31862), sound levels generated are not anticipated to harm marine users in the area.

Elevated in-air noise levels associated with support vessels: During construction, Project-related vessels will be utilized to transport personnel and materials and to install offshore Project components. The IMO has established noise limits that are detailed in the regulatory guidance document "Noise Levels on Board Ships," which contains the Code on Noise Levels on Board Ships (IMO 1981, 1975, resolution A.468(XII)). In terms of sound generation limits of vessels, resolution A.468 limits received noise levels to 70 dBA at designated listening stations at the navigation bridge and windows during normal sail and operational conditions. In addition, the IMO further limits noise to 75 dBA at external areas and rescue stations with recommended limits 5 dBA lower. The vessels used for nearshore work and vessels transiting between Project ports and the Lease Area will comply with these IMO noise standards, as applicable.

Nearshore, installation of the submarine export cables activities moves along the cable laterally. Therefore, no shoreline noise sensitive areas (NSAs) will be exposed to significant noise levels for an extended period of time. Due to the relatively short duration, it is not anticipated that construction activities associated with the installation of the submarine export cables will cause any significant impact in the communities along the shoreline.

Elevated in-air noise levels associated with HDD at the export cable landfall: Landfall of the export cables at EW 2 will be completed using HDD techniques. HDD techniques will also be used at EW 2 for the onshore export cable crossing at Reynolds Channel and for EW 2 Interconnection Cable Route A (IC-A). While open-cut trench is the preferred onshore landfall installation method for the EW 1 submarine export cable, the use of HDD is still proposed as part of the PDE. As such, this activity was modeled and assessed.

HDD construction equipment consists of HDD drill rigs and auxiliary support equipment including electric mud pumps, portable generators, mud mixing and cleaning equipment, forklifts, loaders, cranes, trucks, and portable light plants. **Table 4.4-9** presents the HDD components included in the analysis and **Table 4.4-10** provides candidate noise control mitigation strategies. Once the HDD and pull-back are complete, noise from the export cable landfall area will be limited to typical construction activities associated with equipment such as tracked graders, backhoes and pickup trucks. HDD construction activities will occur during daytime period unless a situation arises that would require operation to continue into the night or deemed acceptable from the appropriate regulatory authority. In the case of night operations, only the HDD drill rig and power unit will be used unless deemed acceptable from the appropriate regulatory authority.

Table 4.4-9 HDD Equipment Sound Pressure Source Levels, dBA at 3-ft

HDD Equipment Component	Sound Level without Acoustical Treatment	Sound Level with Acoustical Treatment
HDD Drill Rig and Power Unit	102	88
Drilling Mud Mixer/Recycling Unit	90	85
Mud Pumping Unit	102	85
Generator Set, 100 kilowatts	100	80
Generator Set, 200 kilowatts	102	80
Vertical Sump Pump	75	75

Table 4.4-10 HDD Candidate Noise Control Strategies

HDD Equipment Component	Candidate Noise Control Strategies
Trucks	Restrictions of hours of operations and routes (away from receivers).
Light Plants (electric generators)	Acoustical enclosures or barriers for generators.
Mud Pumping Units	Acoustical enclosures for mud pumps and engines equipped with exhaust silencers.
Loaders/Forklifts	Engines equipped with exhaust silencers. Modification of backup alarms to low volume types. Locating loading bins away from receivers.
Power Unit and HDD Drill Rig	A complete acoustical enclosure for the power unit equipped with a critical grade exhaust silencer. Partial enclosure or barrier for the HDD rig.
Light Plants (Electric Generators)	Acoustical enclosures or barriers for electric generators and exhaust silencers.
Cranes and Boom Trucks	Exhausts equipped with silencers. Engine compartment acoustically treated. Usage restrictions.

Table 4.4-11 summarizes the predicted sound levels at the closest NSAs, indicated as HDD-NSA#, assuming the HDD sources operate continually for daytime and nighttime construction scenarios. These predictive results demonstrate that with application of the proposed noise mitigation strategies, resulting sound levels will not constitute a violation of local nuisance by-laws for the New York City or the Town of Hempstead's stationary source noise limits, nor result in a potential imminent hazard to public health or the environment.

Once the HDD and pull-back are complete, noise from the export cable landfall area will be limited to typical construction activities associated with equipment such as tracked graders, backhoes and pickup trucks. HDD construction activities will occur during daytime period unless a situation arises that would require operation to continue into the night or deemed acceptable from the appropriate regulatory authority. In the case of night operations, only the HDD drill rig and power unit will be used unless deemed acceptable from the appropriate regulatory authority. If necessary, subject to regulatory requirements and stakeholder engagement, Empire will install moveable temporary noise barriers as close to the sound sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 dBA.

Table 4.4-11 Sound Levels (dBA) during HDD Construction

Site	Location	Distance (feet)	Sound Level at NSAs due to Drill Rig Only (Nighttime Operations)	Sound Level at NSAs due to all HDD Sources (Daytime Operations)
EW 1	NSA-14	1,906	49	52
	NSA-15	2,532	47	50
	NSA-16	1,291	53	56
	NSA-17	2,106	49	52
	EQ-1	1,354	53	56
	EQ-2	1,028	55	58
	EQ-3	1,392	52	55
	EQ-4	1,718	51	54
	EQ-5	752	58	61
	EQ-6	1,191	54	57
	EQ-7	1,291	53	56
	EQ-8	1,329	53	56
	EQ-9	1,605	51	54
	Industry City	1,517	53	55
EW 2 Landfall A	HDD-NSA 1	620	54	57
	HDD-NSA 2	190	65	68
	HDD-NSA 3	850	51	54

Table 4.4-11 Sound Levels (dBA) during HDD Construction (continued)

Site	Location	Distance (feet)	Sound Level at NSAs due to Drill Rig Only (Nighttime Operations)	Sound Level at NSAs due to all HDD Sources (Daytime Operations)
EW 2 Landfall B	HDD-NSA 4	16	83	86
	HDD-NSA 5	207	65	68
	HDD-NSA 6	246	63	66
	HDD-NSA 7	49	76	79
	HDD-NSA 8	256	64	67
	HDD-NSA 9	92	70	73
	HDD-NSA 10	92	71	74
EW 2 Landfall C	HDD-NSA 11	748	54	57
	HDD-NSA 12	689	55	58
	HDD-NSA 13	377	60	63
EW 2 Landfall D	HDD-NSA 14	246	64	67
	HDD-NSA 15	554	57	60
EW 2 Reynolds Channel Crossing – Location 1	HDD-NSA 16	200	65	68
EW 2 Reynolds Channel Crossing – Location 2	HDD-NSA 17	568	56	59
	HDD-NSA 18	417	54	57
EW 2 – Location 3	HDD-NSA 19	584	57	60
	HDD-NSA 20	548	51	54
	HDD-NSA 21	902	50	53
EW 2 Reynolds Channel Crossing – Location 4	NSA-1	1,463	46	49
	NSA-2	896	48	51
	NSA-3	883	49	52
	NSA-4	843	48	51
	NSA-5	1,476	43	46
	NSA-6	1,739	42	45
	NSA-7	2,093	40	43
	NSA-8	3,281	37	40
	NSA-9	3,363	35	38

Table 4.4-11 Sound Levels (dBA) during HDD Construction (continued)

Site	Location	Distance (feet)	Sound Level at NSAs due to Drill Rig Only (Nighttime Operations)	Sound Level at NSAs due to all HDD Sources (Daytime Operations)
EW 2 Onshore Substation A	NSA-1	3,002	36	39
	NSA-2	1,063	51	54
	NSA-3	929	51	54
	NSA-4	804	53	56
	NSA-5	174	65	68
	NSA-6	459	58	61
	NSA-7	594	56	59
	NSA-8	2,963	36	39
	NSA-9	2,444	38	41
EW 2 Onshore Substation B	NSA-1	3,002	36	39
	NSA-2	1,063	51	54
	NSA-3	929	51	54
	NSA-4	804	53	56
	NSA-5	174	65	68
	NSA-6	459	58	61
	NSA-7	594	56	59
	NSA-8	2,963	36	39
	NSA-9	2,444	38	41

Elevated in-air noise levels associated with construction of the onshore substation and onshore export and interconnection cables: The construction of the O&M Base, onshore substations, and the onshore export and interconnection cables will result in a temporary increase in sound levels near these activities resulting from the use of construction equipment. The noise levels resulting from construction activities will vary greatly depending on factors such as the type of equipment and the operations being performed and could be periodically audible from off-site locations at certain times.

The EPA has published data on the L_{eq} sound levels for typical construction phases (EPA 1971). Following the EPA method, sound levels were projected from the acoustic center of the building footprint to the closest NSAs shown in **Figure 4.4-4** and **Figure 4.4-5**. This calculation conservatively assumes all equipment operating concurrently onsite for the specified construction phase and no sound attenuation for ground absorption or onsite shielding by the existing buildings or structures. The results of these calculations are presented in **Table 4.4-12** and show estimated construction sound levels will vary depending on construction phase and distance, with the highest levels expected in proximity to the closest neighborhoods during the site excavation phase.

Table 4.4-12 General Construction Noise Levels (dBA)

Construction Phase	50 feet from Source (L_{eq})	250 feet from Source (L_{eq})	500 feet from Source (L_{eq})	1,000 feet from Source (L_{eq})
Clearing	84	70	65	58
Excavation	91	77	72	65
Foundations	78	64	59	52
Erection	85	71	66	59
Finishing	89	75	70	63

In addition to the construction equipment listed in **Table 4.4-12**, pile driving may be needed to install the foundation for the O&M Base and the onshore substations. The pile driving technique, vibratory or impact, has not been selected at this stage of Project design development. In the event that vibratory pile driving is selected, noise levels are expected to be consistent with those reported during the excavation phase of construction (see **Table 4.4-12**). If impact pile driving is required, higher noise levels may be produced for temporary short-term periods.

Due to the character of the impulsive sound they produce, impact pile drivers are not typically analyzed in combination with non-impulsive construction sound sources such as heavy-duty vehicles. Noise is generated from pile driving equipment from both the ram striking the pile as well as the operating steam, air, or diesel exhaust as it is exhausted from the cylinder (this is not present with hydraulic impact hammers). Assuming an approximate impact rate of 1,400 blows per minute, a modeled sound pressure level of 111 dBA at 20 ft (6 m) is estimated. Assuming a load or usage factor of 20 percent, it is expected that sound from pile driving would attenuate to 70 dBA at a distance of approximately 1,000 ft (305 m) and would attenuate to below 60 dBA within 1 linear mile of this construction activity, depending on meteorological and topographical effects.

As these levels are similar to existing daytime sound levels experienced at these same locations, construction-related sounds are not expected to create a noise nuisance condition within the Onshore Study Areas. Nonetheless, as construction activities could occur within 100 ft (30 m) of the closest neighborhoods. Activities at staging and construction facilities will be consistent with the established and permitted uses of these facilities, and Empire will comply with applicable permitting standards to limit environmental impacts from Project-related activities. In addition, Empire proposes to implement the following measures to avoid, minimize, and mitigate impacts:

- Construction equipment will be well maintained and vehicles using internal combustion engines equipped with mufflers will be routinely checked to ensure they are in good working order;
- Quieter-type adjustable backup alarms would be used for vehicles as feasible;
- Noisy construction equipment will be located as far as possible from NSAs; and
- A noise complaint hotline will be made available to help actively address all noise related issues.

4.4.1.2.2 Operations and Maintenance

During operations, the potential impact-producing factors to the in-air sound environment may include:

- Operation of offshore wind turbines and offshore substations;
- Operation of onshore substations; and
- Operations and maintenance activities.

with the following potential consequential impact-producing factors:

- Long-term elevated in-air sound levels associated with the wind turbines and offshore substation operations;
- Long-term elevated in-air sound levels associated with onshore substation operations; and
- Short-term elevated in-air sound levels associated with operations and maintenance activities.

Elevated in-air sound levels associated with the operations of the wind turbines and offshore substations: During operations, an increase in in-air sound levels resulting from the wind turbines and offshore substations is expected; however, will be below audibility thresholds at all coastal areas due to the distance from shore, as well as the masking effect (e.g. sound of waves and wind will mask the sound generated by the wind turbine rotation). Offshore, marine users may be impacted due to the higher sound levels resulting from wind turbine and offshore substation operation, depending on their distance relative to the wind turbines, but this effect will be well below relevant OSHA health and safety requirements, even in immediate proximity of the wind turbine and offshore substation locations.

Elevated in-air sound levels associated with the operations of the onshore substations: During operations, the onshore substation equipment is anticipated to generate operational sound. Sound modeling of onshore substation components was completed in support of this COP and can be found in **Appendix L**. As the onshore substation engineering design is only at a conceptual level, it is possible that the final warranty sound specifications could vary slightly. As shown in **Table 4.4-13**, **Table 4.4-14**, **Table 4.4-15**, and **Table 4.4-16**, compliance is demonstrated with the applicable noise policy for all sites.

Table 4.4-13 All Onshore Substations: Predicted Nighttime L_{90} Sound Levels (dBA) at the Closest Noise Sensitive Areas

Site	Location	Distance (ft)	Nighttime Ambient Sound Level, L_{90}	Ambient Location from Table S-8	Modeling Results	Modeling Results Plus Existing Ambient	Increase Above Existing Ambient
EW 1	NSA-14	278	53	NM-1	44	53	0
	NSA-15	1,035	53	NM-1	40	53	0
	NSA-16	435	53	NM-1	34	53	0
	NSA-17	1,775	65	NM-2	25	65	0
	EQ-1 a/	0	53	NM-1	41	53	0
	EQ-2 a/	0	53	NM-1	64	64	11
	EQ-3 a/	0	53	NM-1	52	56	3
	EQ-4	137	53	NM-1	46	54	1
	EQ-5 a/	0	53	NM-1	51	55	2
	EQ-6 a/	0	53	NM-1	40	53	0
	EQ-7	162	53	NM-1	40	53	0
	EQ-8	628	53	NM-1	31	53	0
	EQ-9	1,160	53	NM-1	27	53	0

Table 4.4-13 All Onshore Substations: Predicted Nighttime L_{90} Sound Levels (dBA) at the Closest Noise Sensitive Areas (continued)

Site	Location	Distance (ft)	Nighttime Ambient Sound Level, L_{90}	Ambient Location from Table S-8	Modeling Results	Modeling Results Plus Existing Ambient	Increase Above Existing Ambient
EW 1 (continued)	Industry City	448	53	NM-1	39	53	0
EW 2 Onshore Substation A	NSA-1	372	44	NM-3	36	45	1
	NSA-2	184	44	NM-3	36	45	1
	NSA-3	177	44	NM-3	36	45	1
	NSA-4	172	44	NM-3	37	45	1
	NSA-5	355	44	NM-3	32	44	0
	NSA-6	450	44	NM-3	33	44	0
	NSA-7	549	44	NM-3	30	44	0
	NSA-8	1,914	47	NM-5	30	47	0
	NSA-9	1,887	47	NM-4	29	47	0
EW 2 Onshore Substation B	NSA-1	860	44	NM-3	31	44	0
	NSA-2	281	44	NM-3	38	45	1
	NSA-3	240	44	NM-3	39	45	1
	NSA-4	197	44	NM-3	40	45	1
	NSA-5	37	44	NM-3	40	45	1
	NSA-6	118	44	NM-3	44	45	1
	NSA-7	78	44	NM-3	46	46	2
	NSA-8	809	47	NM-5	32	47	0
	NSA-9	584	47	NM-4	35	47	0

Note:
a/ Onshore substation boundary location

Most of the applicable noise regulations consist of octave band frequency sound limits and not broadband sound limits. Compliance with those octave band sound limits is addressed in **Table 4.4-14**, **Table 4.4-15**, and **Table 4.4-16**. However, the New York City Code, which applies to the EW 1 onshore substation, includes an incremental increase limit of 7 dBA at a receiving property relative to ambient nighttime sound levels. **Table 4.4-13** demonstrates that the EW 1 onshore substation will successfully demonstrate compliance with the 7-dBA incremental increase limit. **Table 4.4-14** shows that the EW 1 onshore substation will be in compliance with New York City octave band noise limits for the M3 district and at residential receivers. Locations EQ-1, EQ-2, EQ-3, EQ-5, and EQ-6 are receptors at the onshore substation boundary and are shown to be in compliance with the M3 district limits. **Table 4.4-15** and **Table 4.4-16** show that the EW 2 onshore substation will successfully demonstrate compliance with the Town of Hempstead's steady state source octave band level limits.

Table 4.4-14 EW 1 Onshore Substation: Tonal L_{90} Sound Levels (dB) at the Closest Noise Sensitive Areas

Maximum Permitted Sound Pressure Level (in decibels)			EW 1 Octave Band Sound Pressure Level (dB)										
Octave Band (cycles per second)	District M3	Limits for Residential Property Receiver	NSA-14	NSA-15	NSA-16	NSA-17	EQ-1 a/	EQ-2 a/	EQ-3 a/	EQ-4	EQ-5 a/	EQ-6 a/	EQ-7
20 to 75	80	70	49	45	41	35	51	67	56	51	54	47	46
75 to 150	75	61	50	46	41	35	50	69	58	52	56	46	46
150 to 300	70	53	45	41	35	27	43	64	52	47	51	40	41
300 to 600	64	46	44	40	34	24	40	64	52	46	50	39	40
600 to 1,200	58	40	37	33	27	15	31	58	46	39	44	33	34
1,200 to 2,400	53	36	30	25	20	5	24	53	40	34	38	27	28
2,400 to 4,800	49	34	21	12	10	0	15	47	34	26	31	19	19
Above 4,800	46	33	0	0	0	0	2	38	23	8	14	5	1
		Average (dBA)	44	40	34	25	41	64	52	46	51	40	40

Note: a/ Onshore substation boundary location

Table 4.4-14 EW 1 Onshore Substation: Tonal L_{90} Sound Levels (dB) at the Closest Noise Sensitive Areas (Continued)

Maximum Permitted Sound Pressure Level (in decibels)			EW 1 Octave Band Sound Pressure Level (dB)		
Octave Band (cycles per second)	District M3	Limits for Residential Property Receiver	EQ-8	EQ-9	Industry City
20 to 75	80	70	40	37	44
75 to 150	75	61	39	36	45
150 to 300	70	53	32	28	40
300 to 600	64	46	31	26	39
600 to 1,200	58	40	24	18	33
1,200 to 2,400	53	36	17	9	26
2,400 to 4,800	49	34	5	0	16
Above 4,800	46	33	0	0	0
		Average (dBA)	31	27	39

Table 4.4-15 EW 2 Onshore Substation A: Tonal L_{90} Sound Levels (dB) at the Closest Noise Sensitive Areas

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB) Limit	Octave Band Sound Pressure Level (dB)								
		NSA-1	NSA-2	NSA-3	NSA-4	NSA-5	NSA-6	NSA7	NSA8	NSA-9
63	72	40	41	41	41	38	37	36	35	34
125	67	45	46	46	46	42	42	41	41	40
250	59	42	44	44	44	39	39	37	36	36
500	52	35	36	37	38	33	33	31	30	29
1,000	46	35	35	35	36	31	32	30	30	29
2,000	40	30	29	30	30	25	26	24	24	23
4,000	34	23	22	23	23	16	18	15	14	12
8,000	32	7	9	11	11	0	0	0	0	0
	Average (dBA)	36	36	36	37	32	33	30	30	29

Table 4.4-16 EW 2 Onshore Substation B: Tonal L_{90} Sound Levels (dB) at the Closest Noise Sensitive Areas

Octave Band Center Frequency (Hz)	Octave Band Sound Pressure Level (dB) Limit	Octave Band Sound Pressure Level (dB)								
		NSA-1	NSA-2	NSA-3	NSA-4	NSA-5	NSA-6	NSA7	NSA8	NSA-9
63	72	35	40	41	42	46	44	45	36	37
125	67	40	45	46	48	49	48	50	41	43
250	59	37	44	45	47	46	47	48	38	40
500	52	30	36	38	39	36	38	40	31	33
1,000	46	29	36	37	39	33	37	39	31	33
2,000	40	24	31	32	34	30	32	35	25	27
4,000	34	13	24	26	28	20	25	28	15	18
8,000	32	0	11	13	16	12	15	18	0	0
	Average (dBA)	30	37	38	40	36	38	41	31	33

4.4.1.2.3 Decommissioning

Impacts during decommissioning are expected to be similar or less than those experienced during construction, as described in Section 4.4.1.2.1. It is important to note that advances in decommissioning methods/technologies are expected to occur throughout the operations phase of the Project. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.4.1.3 Summary of Avoidance, Minimization, and Mitigation Measures

In order to mitigate the potential impact-producing factors described in Section 4.4.1.2, Empire is proposing to implement the following avoidance, minimization, and mitigation measures.

4.4.1.3.1 Construction

During construction, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.4.1.2.1:

- Construction equipment will be well-maintained and vehicles using internal combustion engines equipped with mufflers will be routinely checked to ensure they are in good working order;
- Quieter-type adjustable backup alarms will be used for vehicles as feasible;
- Noisy equipment will be located as far as possible from NSAs;
- A noise complaint hotline will be made available to help actively address all noise related issues;
- HDD construction activities will occur during daytime period unless otherwise deemed acceptable from the appropriate regulatory authority;
- In the case of night operations, only the HDD drill rig and power unit will be used, unless deemed acceptable from the appropriate regulatory authority; and
- The vessels used for nearshore work and vessels transiting between Project ports and the Lease Area will comply with IMO noise standards, as applicable.

In addition, during construction, Empire will consider implementing following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.4.1.2.1:

- If any noise issues are identified, Empire will work to identify suitable methods to mitigate (e.g., move inside, operate during less sensitive timeframes, etc.).

4.4.1.3.2 Operations and Maintenance

During operations, Empire will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.4.1.2.2:

- The vessels used for nearshore work and vessels transiting between Project ports and the Lease Area will comply with IMO noise standards, as applicable.

In addition, during operations, Empire will consider implementing following avoidance, minimization, and mitigation measures to mitigate the impacts described in Section 4.4.1.2.2:

- If necessary, subject to regulatory requirements and stakeholder engagement, noise-generating equipment (e.g., reactors and transformers) may be located inside or outside with the use of noise barriers.

4.4.1.3.3 Decommissioning

Avoidance, minimization, and mitigation measures proposed to be implemented during decommissioning are expected to be similar to those implemented during construction and operations, as described in Section 4.4.1.3.1 and Section 4.4.1.3.2. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and avoidance, minimization, and mitigation measures for decommissioning activities will be proposed at that time.

4.4.1.4 References

Table 4.4-17 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coastal/crm.html	N/A

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4.4.2 Underwater Acoustic Environment

This section describes the regulatory framework for underwater noise, as applicable to the Project, and the affected underwater acoustic environment. Potential impacts to the underwater noise environment resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Empire are also described, which are intended to avoid, minimize, and/or mitigate potential impacts resulting from underwater noise.

Other resources and assessments detailed within this COP that are related to noise include:

- In-Air Acoustic Environment (Section 4.4.1);
- Benthic Resource and Finfish, Invertebrates, and Essential Fish Habitat (Section 5.5);
- Marine Mammals (Section 5.6);
- Sea Turtles (Section 5.7);
- In-Air Acoustic Assessment (Appendix L); and
- Underwater Acoustic Assessment (Appendix M).

Under the Marine Mammal Protection Act (MMPA), with certain exceptions, the "take" of marine mammals is prohibited, with certain exceptions. NOAA and USFWS both share jurisdiction for overseeing the MMPA regulations; however, NOAA is responsible for issuing take permits under MMPA, upon a request, for authorization of incidental but not intentional "taking" of small numbers of cetaceans and pinnipeds by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region. The term "take," as defined in Section 3 (16 U.S.C. § 1362 [13]) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". "Harassment" was further defined in the 1994 amendments to the MMPA, with the designation of two levels of harassment: Level A and Level B. By definition, Level A harassment is any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock, while Level B harassment is any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. NOAA defines the threshold level for Level B harassment at a sound pressure level (SPL) of 160 dB referenced at 1 microPascal (re 1 µPa) for impulsive sound, averaged over the duration of the signal and at 120 dB re 1 µPa for non-impulsive sound, with no relevant acceptable distance specified.

NOAA Fisheries provided guidance for assessing the impacts of anthropogenic sound on marine mammals under their regulatory jurisdiction, which includes whales, dolphins, seals, and sea lions; this was updated in 2018 (NOAA Fisheries 2018) from the previous 2016 guidance. The guidance specifically defines marine mammal hearing groups, develops auditory weighting functions, and identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (permanent threshold shift, PTS, or temporary threshold shift, TTS) for acute, incidental exposure to underwater sound. Under this guidance, any occurrence of PTS constitutes a Level A harassment, or injury, take. The sound emitted by manmade sources may induce TTS or PTS in an animal in two ways: peak sound pressure levels (L_{PK}) may cause damage to the inner ear, and the accumulated sound energy the animal is exposed to (cumulative sound exposure levels, SEL) over the entire duration of a discrete or repeated noise exposure has the potential to induce auditory damage if it exceeds distinct threshold levels.

Research demonstrates that the frequency content of the sound plays a role in causing damage. Sound outside the hearing range of the animal would be unlikely to affect its hearing, while the sound energy within the hearing range could be harmful. Under the NOAA Fisheries 2018 guidance, recognizing that marine mammal species do not have equal hearing capabilities, five hearing groups of marine mammals are defined as follows:

- Low-frequency (LF) Cetaceans—this group consists of the baleen whales (*mysticetes*) with a collective generalized hearing range of 7 Hz to 35 kilohertz (kHz).
- Mid-frequency (MF) Cetaceans—this group includes most of the dolphins, all toothed whales except for Kogia spp., and all the beaked and bottlenose whales with a generalized hearing range of approximately 150 Hz to 160 kHz (renamed High-frequency cetaceans by Southall et al. [2019] because their best hearing sensitivity occurs at frequencies of several tens of kHz or higher. Note that this categorization of "high-frequency cetacean" is distinct from the NOAA Fisheries 2018 guidance as outlined in the next bullet).
- High-frequency (HF) Cetaceans—this group incorporates all the true porpoises, the river dolphins, plus Kogia spp., Cephalorhynchid spp. (genus in the dolphin family Delphinidae), and two species of Lagenorhynchus (Peale's and hourglass dolphins) with a generalized hearing range estimated from 275 Hz to 160 kHz (renamed Very high-frequency cetaceans by Southall et al. [2019] since some species have best sensitivity at frequencies exceeding 100 kHz).
- Phocids Underwater (PW)—this group consists of true seals with a generalized underwater hearing range from 50 Hz to 86 kHz (renamed Phocids carnivores in water by Southall et al. [2019]).
- Otariids Underwater (OW)—this group includes sea lions and fur seals with a generalized underwater hearing range from 60 Hz to 39 kHz (termed Other marine carnivores in water by Southall et al. [2019] and includes otariids, as well as walrus [Family Odobenide], polar bear [*Ursus maritimus*], and sea and marine otters [Family Mustelidae]).

Within these generalized hearing ranges, the ability to hear sounds varies with frequency, as demonstrated by examining audiograms of hearing sensitivity (NOAA Fisheries 2018; Southall et al. 2019). To reflect higher noise sensitivities at particular frequencies, auditory weighting functions were developed for each functional hearing group that reflected the best available data on hearing ability (composite audiograms), susceptibility to noise-induced hearing loss, impacts of noise on hearing, and data on equal latency (NOAA Fisheries 2018). These weighting functions are applied to individual sound received levels to reflect the susceptibility of each hearing group to noise-induced threshold shifts, which is not the same as the range of best hearing (**Figure 4.4-6**).

NOAA Fisheries (2018) defined acoustic threshold levels at which PTS and TTS are predicted to occur for each hearing group for impulsive and non-impulsive signals (**Table 4.4-18**), which are presented in terms of dual metrics; cumulative sound energy level (SEL_{cum}) and L_{PK}. The Level B harassment thresholds are also provided in Table M-1 of **Appendix M Underwater Acoustic Assessment**. The TTS threshold is defined as 20 dB less than the PTS threshold.

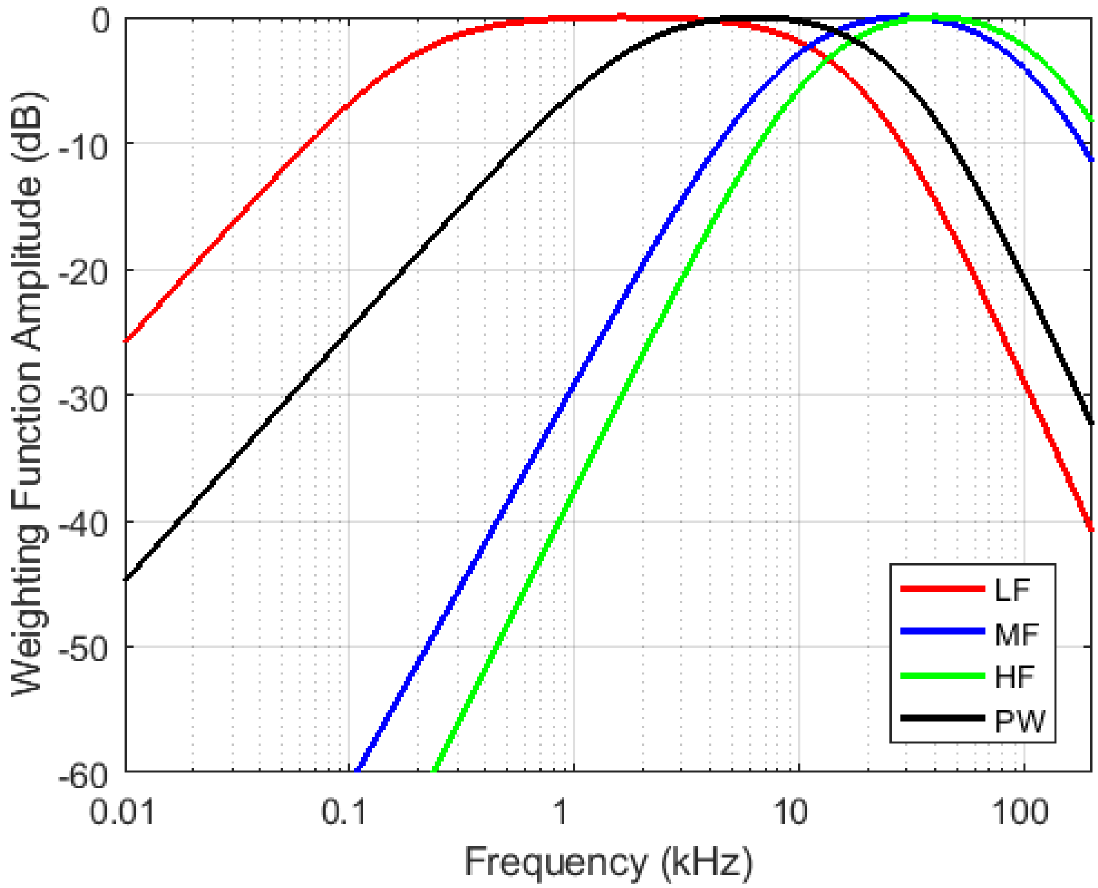

Figure 4.4-6 Auditory Weighting Functions for Cetaceans (LF, MF, and HF Species) and Pinnipeds in water (PW) from NOAA Fisheries (2018).

Table 4.4-18 Acoustic Threshold Levels for Marine Mammals

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds		
	PTS Onset	TTS Onset	Behavior	PTS Onset	TTS Onset	Behavior
Low-frequency cetaceans (LF)	219 dB (L_{PK}) 183 dB SEL	213 dB (L_{PK}) 168 dB SEL	160 dB SPL RMS	199 dB SEL	179 dB SEL	120 dB SPL RMS
Mid-frequency cetaceans (MF)	230 dB (L_{PK}) 185 dB SEL	224 dB (L_{PK}) 170 dB SEL		198 dB SEL	178 dB SEL	
High-frequency cetaceans (HF)	202 dB (L_{PK}) 155 dB SEL	196 dB (L_{PK}) 140 dB SEL		173 dB SEL	153 dB SEL	
Phocid pinnipeds underwater (PW)	218 dB (L_{PK}) 185 dB SEL	212 dB (L_{PK}) 170 dB SEL		201 dB SEL	181 dB SEL	

Sources: NOAA Fisheries 2018; Southall et al. 2019

Notes:
SEL = sound exposure level (dB re 1 μPa^2·s); *Lpk* = peak sound pressure (dB re 1 μPa); *RMS SPL* = root mean square sound pressure (dB re 1 μPa); TTS = temporary threshold shift; PTS = permanent threshold shift

For sea turtles, NOAA Fisheries has considered injury onset beginning at SPL RMS 180 dB re 1 µPa to prevent mortalities, injuries, and most auditory impacts and behavioral response from impulsive sources such as impact pile driving at SPL RMS 166 dB re 1 µPa, which has elicited avoidance behavior of sea turtles (**Table 4.4-19**; Blackstock et al. 2018). There is limited information available on the effects of noise on sea turtles, and the hearing capabilities of sea turtles are still poorly understood. However, NOAA Fisheries recently updated the prescribed behavioral response threshold for sea turtles to SPL RMS 175 dB re 1 µPa.

Table 4.4-19 Acoustic Threshold Levels for Fishes and Sea Turtles for Injury and Behavior

Hearing Group	Injury	Behavior
Fishes	206 dB (L_{PK}) 187 dB SEL	150 dB SPL RMS
Sea turtles	180 dB SPL RMS	166 dB SPL RMS 175 dB SPL RMS (NOAA)

Sources: Stadler and Woodbury 2009; GARFO 2016, 2019; Blackstock et al. 2018

Notes:
SEL = sound exposure level (dB re 1 µPa2·s); *L*pk = peak sound pressure (dB re 1 µPa); *RMS SPL* = root mean square sound pressure (dB re 1 µPa)

In a cooperative effort between federal and state agencies, interim criteria were developed to assess the potential for injury to fishes and sea turtles exposed to pile driving sounds. These noise injury thresholds have been established by the Fisheries Hydroacoustic Working Group (FHWG), which was assembled by NOAA Fisheries with thresholds subsequently adopted by NOAA Fisheries. The NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) has applied these standards for assessing the potential effects of Endangered Species Act (ESA)-listed fish species and sea turtles exposed to elevated levels of underwater sound produced during pile driving, which were just recently updated (GARFO 2019). These noise thresholds are based on sound levels that have the potential to produce injury or illicit a behavioral response from fishes (**Table 4.4-19**).

A Working Group organized under the ANSI-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, also developed sound exposure guidelines for fish and sea turtles (**Table 4.4-20**; Popper et al. 2014). They identified three types of fishes depending on how they might be affected by underwater sound. The categories include fishes with no swim bladder or other gas chamber (e.g., dab and other flatfish); fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., salmonids); and fishes with a swim bladder that is involved in hearing (e.g., channel catfish).

Table 4.4-20 Acoustic Threshold Levels for Fishes and Sea Turtles for Onset of Mortality, Potential Mortal Injury, Recovery Injury, and TTS

Hearing Group	Impulsive Sounds			Non-Impulsive Sounds	
	Mortality and Potential Mortal Injury	Recoverable Injury	TTS	Recoverable Injury	TTS
Fishes without swim bladders	> 213 dB (L_{PK}) > 219 dB SEL_{cum}	> 213 dB (L_{PK}) > 216 dB SEL_{cum}	>> 186 dB SEL_{cum}	--	--
Fishes with swim bladder not involved in hearing	207 dB (L_{PK}) 210 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	186 dB SEL_{cum}	--	--
Fishes with swim bladder involved in hearing	207 dB (L_{PK}) 207 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	186 dB SEL_{cum}	170 dB RMS SPL	158 dB RMS SPL
Sea turtles	207 dB (L_{PK}) 210 dB SEL_{cum} 232 dB (L_{PK}) PTS 204 dB SEL_{cum} PTS	(N) High (I) Low (F) Low	226 dB (L_{PK}) 189 dB SEL_{cum}	--	--
Eggs and larvae	207 dB (L_{PK}) 210 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	--	--

Sources: GARFO 2019; Popper et al.2014

Notes:
SEL = sound exposure level (dB re 1 μPa2·s); *L*pk = peak sound pressure (dB re 1 μPa); *RMS SPL* = root mean square sound pressure (dB re 1 μPa); TTS = temporary threshold shift., N = near (10s of meters), I = intermediate (100s of meters), and F = far (1,000s of meters); -- = not applicable

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the offshore and coastal waters associated within and in the vicinity of the Lease Area and EW 1 and EW 2 submarine export cable routes (see **Figure 4.4-7**).

In addition, an Underwater Acoustic Assessment report was prepared in support of the COP. The report presents the acoustic modeling methodologies, as applied, to estimate the expected underwater noise levels generated during construction and operation of the proposed Project. Underwater sound propagation modeling was completed using dBSea, a software developed by Marshall Day Acoustics for the prediction of underwater noise in a variety of environments. Additional information on the modelling methodology, assumptions, and results are detailed in **Appendix M**.

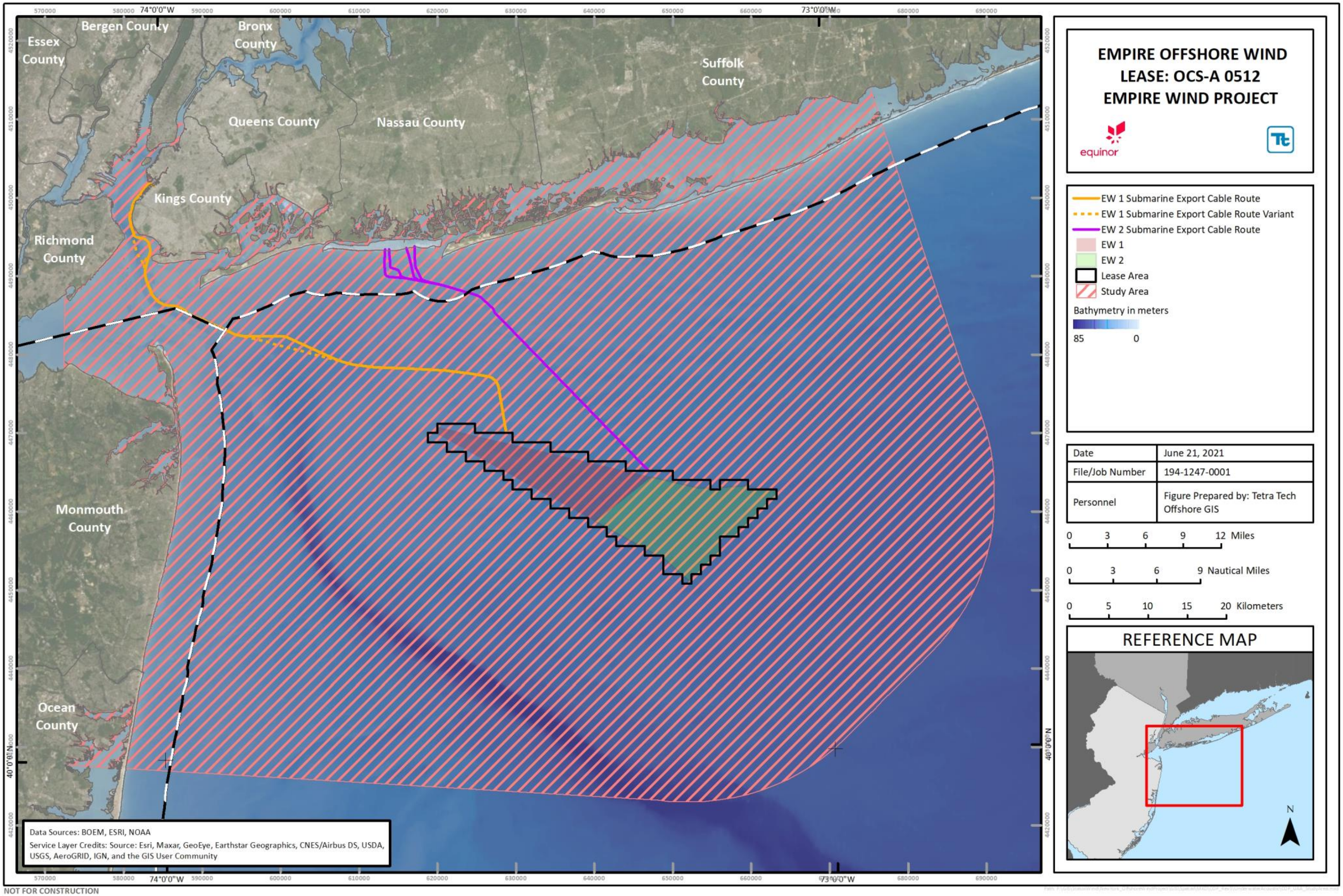

Figure 4.4-7 Underwater Acoustic Study Area

4.4.2.1 Affected Environment

The affected environment is defined as the offshore underwater acoustic environment that has the potential to be directly and/or indirectly affected by the construction, operations, and decommissioning of the Project. This includes the Lease Area and the submarine export cable routes. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Empire expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Empire will comply with in using the facilities.

Noise in the ocean associated with natural sources is generated by physical and biological processes. Examples of physical noise sources are tectonic seismic activity, wind, and waves; examples of biological noise sources are the vocalizations of marine mammals and fish. There can be a strong minute-to-minute, hour-to-hour, or seasonal variability in sounds from biological sources. The ambient noise for frequencies above 1 kHz is due largely to waves, wind, and heavy precipitation (Simmonds et al. 2004). Surface wave interaction and breaking waves with spray have been identified as significant sources of noise. Wind-induced bubble oscillations and cavitation are also near-surface noise sources. At areas within distances of 4 to 5 mi (8 to 10 km) of the shoreline, surf noise will be prominent in the frequencies ranging up to a few hundred Hz (Richardson et al. 2013).

A considerable amount of background noise may also be caused by biological activities. Aquatic animals generate sounds for communication, echolocation, prey manipulation, and as by-products of other activities such as feeding. Biological sound production usually follows seasonal and diurnal patterns, dictated by variations in the activities and abundance of the vocal animals. The frequency content of underwater biological sounds ranges from less than 10 Hz to beyond 150 kHz. Source levels show a great variation, ranging from below 50 dB to more than 230 dB SPL RMS re 1 µPa at 1 m. Likewise, there is a significant variation in other source characteristics such as the duration, temporal amplitude, frequency patterns, and the rate at which sounds are repeated (Wahlberg 2008). Typical underwater noise levels show a frequency dependency in relation to different noise sources; the classic curves are given in Wenz (1962).

Anthropogenic noise sources can consist of contributions related to industrial development, offshore oil industry activities, naval or other military operations, and marine research. A predominant contributing anthropogenic noise source is generated by commercial ships and recreational watercraft. Noise from these vessels dominates coastal waters and emanates from the ships' propellers and other dynamic positioning (DP) propulsion devices such as thrusters. The sound generated from main engines, gearboxes, and generators transmitted through the hull of the vessel into the water column is considered a secondary sound source to that of vessel propulsion systems, as is the use of sonar and depth sounders, which occur at generally high frequencies and attenuate rapidly. Typically, shipping vessels produce frequencies below 1 kHz, although smaller vessels such as fishing, recreational and leisure craft may generate sound at somewhat higher frequencies (Simmonds et al. 2004).

A study contracted by the NYSDEC to conduct passive acoustic monitoring within the New York Bight to assess marine mammal occurrence and patterns of ambient noise in the region was completed from October 2017 to July 2018 (Estabrook et al. 2019). For this study, 15 archival autonomous recording devices were deployed along two lines paralleling the major shipping lanes of the New York Bight to record ambient noise and marine mammal vocalizations for six whale species: the blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), humpback whale (*Megaptera novaeangliae*), minke whale (*B. acutorostrata*), North Atlantic right whale (*Eubalaena glacialis*), and sei whales (*B. borealis*). Sperm whales (*Physeter microcephalus*) were also recorded but the passive acoustic monitoring system was not optimally designed to detect vocalizations of this species. A goal of the study was to determine the ambient noise levels at the frequency ranges that corresponded to the hearing ranges of the whales. Therefore, the ambient noise levels presented in the study were limited to those frequency bands associated with the different target whale species. **Table 4.4-21** summarizes the ambient noise ranges based on whale species for the study period.

Table 4.4-21 New York Bight Underwater Ambient Noise Levels

Species with Hearing Range Corresponding to Measured Frequency Range	Measured Frequency Range (Hz)	Ambient Noise Level Recorded in Frequency Range (dB re 1 µPa)
North Atlantic Right Whale	70 – 224	84 to 143
Humpback Whale	28 – 708	90 to 152
Minke Whale	44 – 355	86 to 147
Sei Whale	28 – 89	83 to 149
Fin Whale	17 – 28	82 to 148
Blue Whale	14 – 22	74 to 146

Source: Estabrook et al. 2019

The study found that the highest noise levels were associated with a monitoring location nearest to the harbor, which experiences the highest volume of shipping traffic. The study concluded that the noise levels at each of the monitoring sites were relatively consistent throughout the survey period, with the exception of several loud shipping events.

4.4.2.2 Impacts Analysis for Construction, Operations, and Decommissioning

The potential impacts resulting from the construction, operations, and decommissioning of the Project are based on the maximum design scenario from the Project Design Envelope (see **Section 3 Project Description**). The maximum design scenario for assessments associated with the full build-out of the Lease Area of EW 1 and EW 2 and incorporates a total of up to 176 structures within the Lease Area (made up of up to 174 wind turbines and 2 offshore substations; see **Table 4.4-22**).

Table 4.4-22 Summary of Maximum Design Scenario Parameters for Underwater Noise

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of EW 1 and EW 2 (174 wind turbines and 2 offshore substations). EW 1: 71 wind turbines and 1 offshore substation. EW 2: 103 wind turbines and 1 offshore substation.	Representative of the maximum number of structures for EW 1 and EW 2.
Wind turbine foundation	Monopile	Representative of the foundation option that has an installation method that would result in the maximum introduction of underwater noise.

Table 4.4-22 Summary of Maximum Design Scenario Parameters for Underwater Noise (continued)

Parameter	Maximum Design Scenario	Rationale
Wind turbine foundation Installation method Underwater noise	Pile driving	Representative of the installation method that would result in the loudest underwater noise generated.
Duration Offshore construction	Based on full build-out of EW 1 and EW 2. Based on the maximum number of structures (174 wind turbines and 2 offshore substations) and maximum period of cumulative duration for installation.	Representative of the maximum period required to install the offshore components, which has the potential to impact resources in, access to, or enjoyment of the Project Area.
Underwater noise Pile driving – monopiles	Pile diameter: 49 ft (15 m) Max penetration: 180 ft (55 m) Max hammer energy: 5,500 kJ Soft-start duration: 0.5 hour Soft-start hammer energy: 825 kJ Total max pile driving duration per foundation: 5 hours 30 minutes (full force time per pile 5 hours, soft-start 30 minutes) Total duration: 957 hours EW 1: 390.5 hours EW 2: 566.5 hours	The longest temporal duration of impact for monopiles, which equates to the maximum number of pile-driving events.
Underwater noise Pile driving – piled offshore substations (EW 1 and EW 2)	Pile diameter: 13 ft (4 m) Max penetration: 295 ft (90 m) Number of piles per foundation: 16 Max hammer energy: 4,000 kJ Soft-start duration: 0.5 hour Soft-start hammer energy: 600 kJ Total max pile driving duration: 5 hours 30 minutes (full force time per pile 5 hours, soft-start 30 minutes) Total number of piles for: EW 1: 16 EW 2: 16 Total duration of pile driving: EW 1: 88 hours EW 2: 88 hours	The longest temporal duration of impact for piled jackets for offshore substations, which would result in the maximum of two offshore substations. 176 hours is considered the maximum amount of time required to pile all pile driven jackets for offshore substations (active pile driving; for EW 1 and EW 2).
Alternate foundation Installation method	Drilling	Representative of the alternate or supplemental installation method that would generate underwater noise.

Table 4.4-22 Summary of Maximum Design Scenario Parameters for Underwater Noise (continued)

Parameter	Maximum Design Scenario	Rationale
Cofferdam Installation method	Vibratory pile driving	Representative of the installation method that would generate underwater noise in the nearshore environment.
Operations		
Wind turbines	Based on full build-out of EW 1 and EW 2 (174 wind turbines). EW 1: 71 wind turbines. EW 2: 103 wind turbines.	Representative of the maximum underwater noise generated by operational wind turbines.
Project-related vessels Underwater noise	Based on full build-out of EW 1 and EW 2, which corresponds to the maximum number of structures (174 wind turbines and 2 offshore substations), submarine export and interarray cables, and the maximum number of vessels and movements for servicing and inspections.	Representative of the maximum predicted Project-related vessels for underwater noise.

4.4.2.2.1 Construction

During construction, the potential impact-producing factors to the underwater noise environment may include:

- Construction of the offshore components, including foundations, wind turbines, offshore substations, submarine export and interarray cables, and cofferdams.

With the following potential consequential impacts:

- Short-term increase in underwater noise levels associated with monopile and jacketed impact pile driving activities required for the installation of wind turbine and offshore substation foundations;
- Short-term increase in underwater noise levels associated with drilling required for installation of wind turbine and offshore substation foundations;
- Short-term increase in underwater noise levels associated with vibratory pile driving activities for cofferdams;
- Short-term increase in underwater noise levels associated with the installation of submarine export and interarray cables; and
- Short-term increase in underwater noise levels associated with Project-related vessels.

Increase in underwater noise levels associated with monopile and jacketed impact pile driving activities required for the installation of wind turbines and offshore substation foundations: Installation of the two foundation types were considered in the underwater acoustic analysis: a wind turbine monopile foundation with a diameter of 49 ft (15 m), as well as an offshore substation jacketed pin pile foundation with a diameter of 13 ft (4 m). Propagation modeling was conducted using the maximum projected blow energy of 5,500 kJ for the monopile and 2,300 kJ for the pin pile; a soft start was also incorporated assuming 30 minutes using the reduced soft start hammer energy for all pile driving activities[10]. The monopile and pin pile driving scenarios were both modeled using a vertical array of 5-point sources for the shallow location and 10-point sources for the deep location, distributing the sound emissions from pile driving throughout the water column. The apparent sound levels developed for each scenario corresponded to 254 L_{PK}/235 SEL for the 49-ft (15-m) monopile, 253 L_{PK}/232 SEL for the 39-ft (12-m) monopile, and 242 L_{PK}/216 SEL for the pin pile. The vertical array was assigned third-octave band sound characteristics adjusted for site-specific parameters discussed above, including expected hammer energy and number of blows. Third-octave band center frequencies from 12.5 Hz up to 20 kHz were used in the modeling. In addition, a constant 15 dB/decade roll-off was applied to the modeled spectra after the second spectral peak. A roll-off is a filter, which can be imposed on a signal at either the low or high frequency range in order to more closely match expected sound propagation characteristics of that signal indicated by modeling or measurement results.

The results for impact pile driving (monopile and pin pile) for the representative wind turbine location at the deepest water depth, are shown in **Table 4.4-23**, **Table 4.4-24**, **Table 4.4-25**, **Table 4.4-26**, and **Table 4.4-27**. Results are presented without mitigation and with two different levels of mitigation; an 8 dB reduction and a 12 dB reduction. Noise mitigation requirements and methods have not been finalized at this stage of permitting; therefore, these two levels of reduction were applied to potentially mimic the use of noise mitigation options, such as bubble curtains. The results in **Table 4.4-23** indicate the unmitigated distances to the L_{PK} thresholds are generally below 656 ft (200 m) with the exception of results for the HF cetaceans' group. Thresholds to the PTS onset thresholds in terms of SEL are also provided. Similar results are given for fish and sea turtles, with ranges to applicable thresholds varying depending on the threshold value and sound level weighting. Expectedly, the largest ranges to thresholds are the ones for the marine mammal and fish behavioral response, which is 160 dB RMS and 150 dB RMS, respectively. **Figure 4.4-8** and **Figure 4.4-9** show the unweighted and unmitigated underwater received sound pressure levels for the 49-ft (15-m) monopile and 13-ft (4-m) pin pile impact pile driving scenarios, respectively, at the deep location. Underwater sound pressure level ranges are displayed in 10 dB increments and sound propagation characteristics are shown throughout the lease area and beyond, as applicable.

[10] Empire has since revised the expected soft start hammer energy to be 825 kJ for the monopile pile driving scenarios and 345 kJ for the pin pile driving scenarios. The revised soft start hammer energy assumptions are anticipated to result in negligible changes to the distances to criteria impact thresholds as reported in **Table 4.4-23** through **Table 4.4-27**.

Table 4.4-23 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group a/							
		LF cetaceans		MF cetaceans		HF cetaceans		Phocid pinnipeds	
		219 L_{PK}	183 SEL	230 L_{PK}	185 SEL	202 L_{PK}	155 SEL	218 L_{PK}	185 SEL
15-meter Monopile	Unmitigated	141	8,138	52	163	2,324	2,689	168	1,089
	Mitigation (-8 dB)	66	3,551	26	127	680	1,469	69	383
	Mitigation (-12 dB)	49	2,243	20	108	406	1,017	54	300
4-meter Pile Jacket	Unmitigated	65	808	29	87	485	590	68	159
	Mitigation (-8 dB)	37	317	<10	53	155	294	41	127
	Mitigation (-12 dB)	<10	158	<10	<10	105	150	<10	113

Source: NOAA Fisheries 2018

Note: a/ Injury and Potential Mortality

Table 4.4-24 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group a/									
		Fish: No Swim Bladder		Fish: Swim bladder not involved in hearing		Fish: Swim bladder involved in hearing		Eggs and Larvae		Sea Turtles	
		213 L_{PK}	219 SEL	207 L_{PK}	210 SEL	207 L_{PK}	207 SEL	207 L_{PK}	210 SEL	207 L_{PK}	210 SEL
15-meter Monopile	Unmitigated	452	305	1,184	1,250	1,184	2,001	1,184	1,250	1,184	1,250
	Mitigation (-8 dB)	100	138	370	331	370	542	370	331	370	331
	Mitigation (-12 dB)	74	123	144	157	144	305	144	157	144	157
4-meter Pile Jacket	Unmitigated	86	87	199	118	199	127	199	118	199	118
	Mitigation (-8 dB)	78	60	101	90	101	100	101	90	101	90
	Mitigation (-12 dB)	72	<10	84	77	84	86	84	77	84	77

Source: Popper et al. 2014

Note: a/ Injury and Potential Mortality

Table 4.4-25 Fishes Acoustic Injury Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group			
		Small Fish		Large Fish	
		206 L_{PK}	183 SEL	206 L_{PK}	187 SEL
15-meter Monopile	Unmitigated	1,326	14,769	1,326	12,964
	Mitigation (-8 dB)	406	9,597	406	6,946
	Mitigation (-12 dB)	166	7,634	166	4,984
4-meter Pile Jacket	Unmitigated	339	1,338	339	799
	Mitigation (-8 dB)	105	390	105	302
	Mitigation (-12 dB)	87	302	87	155

Source: Stadler and Woodbury 2009

Table 4.4-26 Sea Turtles in NOAA Fisheries Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Species				
		Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS	
		175 L_P	226 L_{PK}	189 SEL	232 L_{PK}	204 SEL
15-meter Monopile	Unmitigated	7,720	69	10,522	47	2,664
	Mitigation (-8 dB)	3,017	38	6,504	21	832
	Mitigation (-12 dB)	2,039	26	3,630	22	386
4-meter Pile Jacket	Unmitigated	329	41	585	24	138
	Mitigation (-8 dB)	93	<10	162	<10	110
	Mitigation (-12 dB)	76	<10	148	<10	97

Source: GARFO 2019

Table 4.4-27 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Impact Pile Driving – Deep Location

Pile Type	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
15-meter Monopile	Unmitigated	23,537	16,840
	Mitigation (-8 dB)	17,790	11,235
	Mitigation (-12 dB)	15,529	9,259
4-meter Pile Jacket	Unmitigated	7,435	2,409
	Mitigation (-8 dB)	3,084	794
	Mitigation (-12 dB)	1,925	519

Source: GARFO 2019

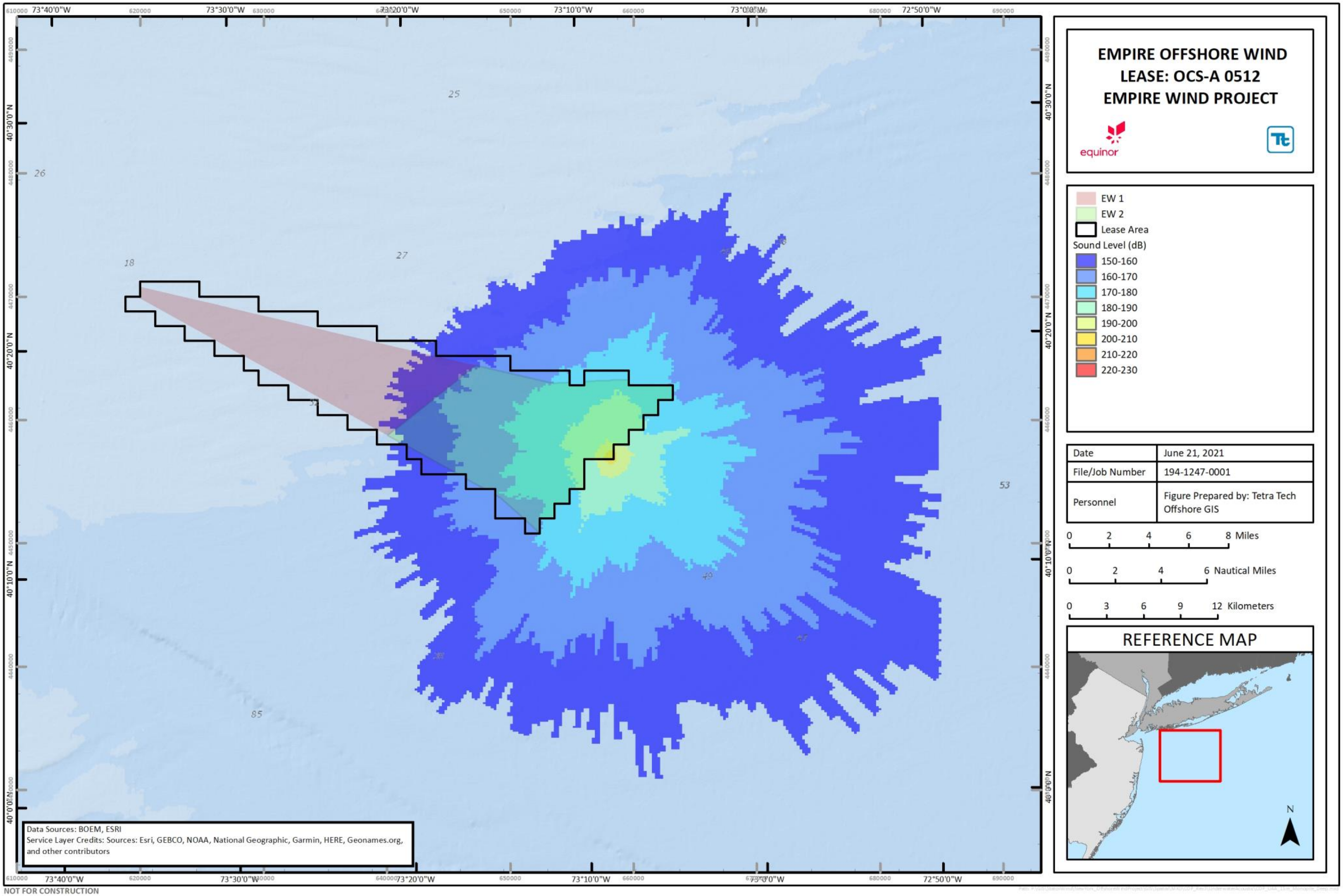

Figure 4.4-8 Unweighted Received SPL for 49-ft (15-m) Monopile Impact Pile Driving at the Deepest Depth

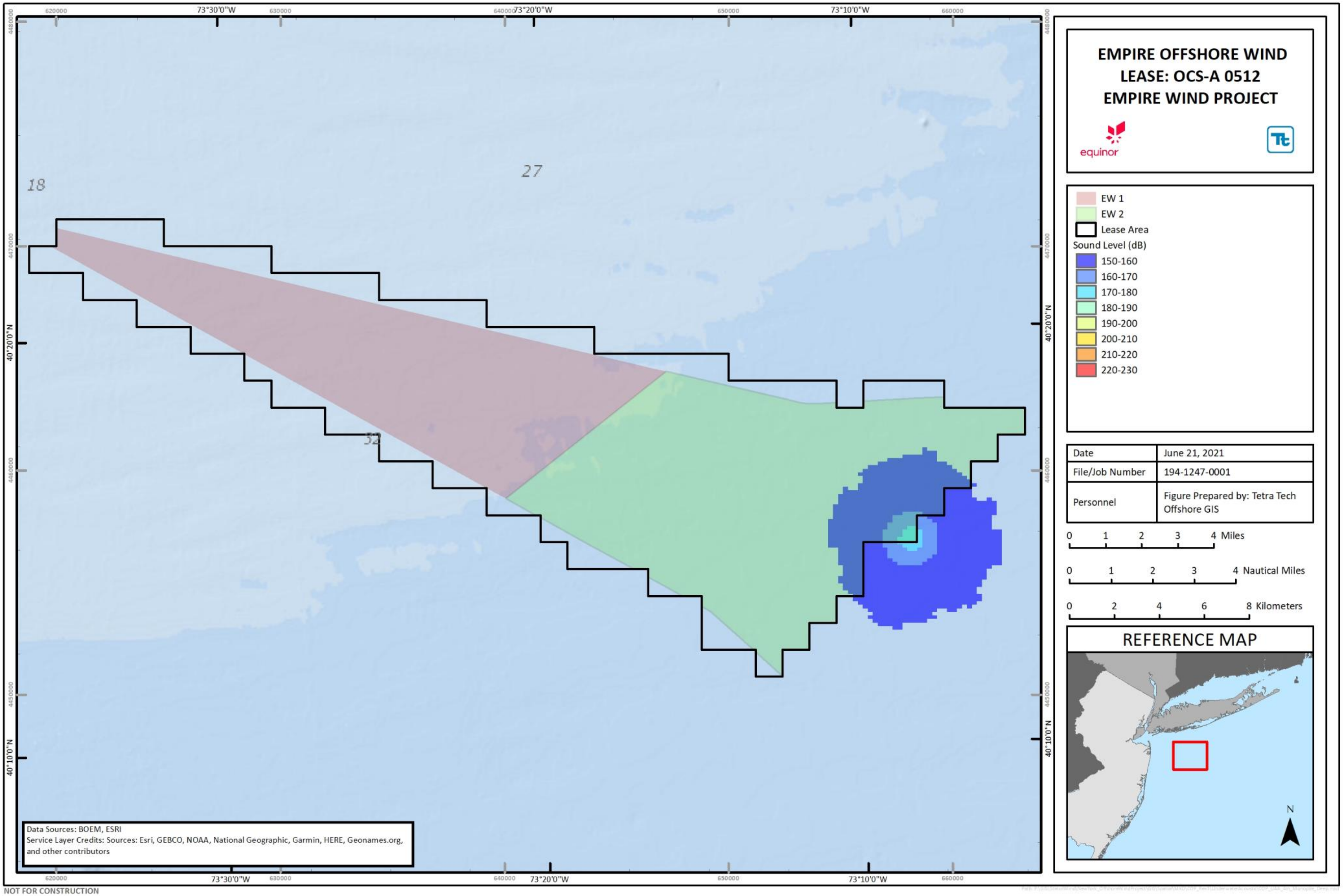

Figure 4.4-9 Unweighted Received SPL for 13-ft (4-m) Pin Pile Impact Pile Driving at the Deepest Depth

Similar trends in results were observed for modeling results of impact pile driving at the shallow wind turbine location although in most cases distances to thresholds were less, likely due to the boundary layers affecting sound propagation and absorption through the seabed. Results for the representative wind turbine location in shallow water are given in **Table 4.4-28**, **Table 4.4-29**, **Table 4.4-30**, **Table 4.4-31** and **Table 4.4-32**. **Figure 4.4-10** and **Figure 4.4-11** show the unweighted and unmitigated underwater received sound pressure levels for the 49-ft (15-m) monopile and 13-ft (4-m) pin pile impact pile driving scenarios, respectively, at the shallow location.

Table 4.4-28 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group a/							
		LF cetaceans		MF cetaceans		HF cetaceans		Phocid pinnipeds	
		219 L_{PK}	183 L_E	230 L_{PK}	185 L_E	202 L_{PK}	155 L_E	218 L_{PK}	185 L_E
15-meter Monopile	Unmitigated	133	3,262	55	187	1,229	1,552	148	640
	Mitigation (-8 dB)	69	1,538	20	154	438	807	74	344
	Mitigation (-12 dB)	50	1,153	11	137	241	591	50	200
4-meter Pile Jacket	Unmitigated	69	443	23	121	439	384	74	189
	Mitigation (-8 dB)	34	206	<10	<10	154	194	39	160
	Mitigation (-12 dB)	19	192	<10	<10	92	177	22	145

Source: NOAA Fisheries 2018
Note: a/ Injury and Potential Mortality

Table 4.4-29 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group a/									
		Fish: No Swim Bladder		Fish: Swim bladder not involved in hearing		Fish: Swim bladder involved in hearing		Eggs and Larvae		Sea Turtles	
		213 L_{PK}	219 SEL	207 L_{PK}	210 SEL	207 L_{PK}	207 SEL	207 L_{PK}	210 SEL	207 L_{PK}	210 SEL
15-meter Monopile	Unmitigated	284	348	674	1,044	674	1,137	674	1,044	674	1,044
	Mitigation (-8 dB)	103	181	205	370	205	433	205	370	205	370
	Mitigation (-12 dB)	79	162	133	202	133	349	133	202	133	202
4-meter Pile Jacket	Unmitigated	102	121	208	152	208	162	208	152	208	152
	Mitigation (-8 dB)	61	32	87	124	87	134	87	124	87	124
	Mitigation (-12 dB)	43	<10	69	110	69	121	69	110	69	110

Source: Popper et al. 2014

Note: a/ Injury and Potential Mortality

Table 4.4-30 Fishes Acoustic Injury Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group			
		Small Fish		Large Fish	
		206 L_{PK}	183 SEL	206 L_{PK}	187 SEL
15-meter Monopile	Unmitigated	773	6,207	773	4,687
	Mitigation (-8 dB)	241	4,151	241	3,191
	Mitigation (-12 dB)	149	3,191	149	2,042
4-meter Pile Jacket	Unmitigated	244	840	244	447
	Mitigation (-8 dB)	92	371	92	206
	Mitigation (-12 dB)	69	206	74	191

Source: Stadler and Woodbury 2009

Table 4.4-31 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Species				
		Sea Turtle Behavioral	Sea Turtle TTS		Sea Turtle PTS	
		175 L_{P}	226 L_{PK}	189 SEL	232 L_{PK}	204 SEL
15-meter Monopile	Unmitigated	4,046	74	4,393	47	1,343
	Mitigation (-8 dB)	1,790	37	2,716	13	678
	Mitigation (-12 dB)	1,315	20	1,600	<10	412
4-meter Pile Jacket	Unmitigated	153	39	409	15	173
	Mitigation (-8 dB)	124	11	199	<10	144
	Mitigation (-12 dB)	111	<10	184	<10	131

Source: GARFO 2019

Table 4.4-32 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Impact Pile Driving – Shallow Location

Pile Type	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
15-meter Monopile	Unmitigated	14,776	9,200
	Mitigation (-8 dB)	9,960	5,827
	Mitigation (-12 dB)	8,155	4,507
4-meter Pile Jacket	Unmitigated	645	207
	Mitigation (-8 dB)	338	178
	Mitigation (-12 dB)	200	163

Source: GARFO 2019

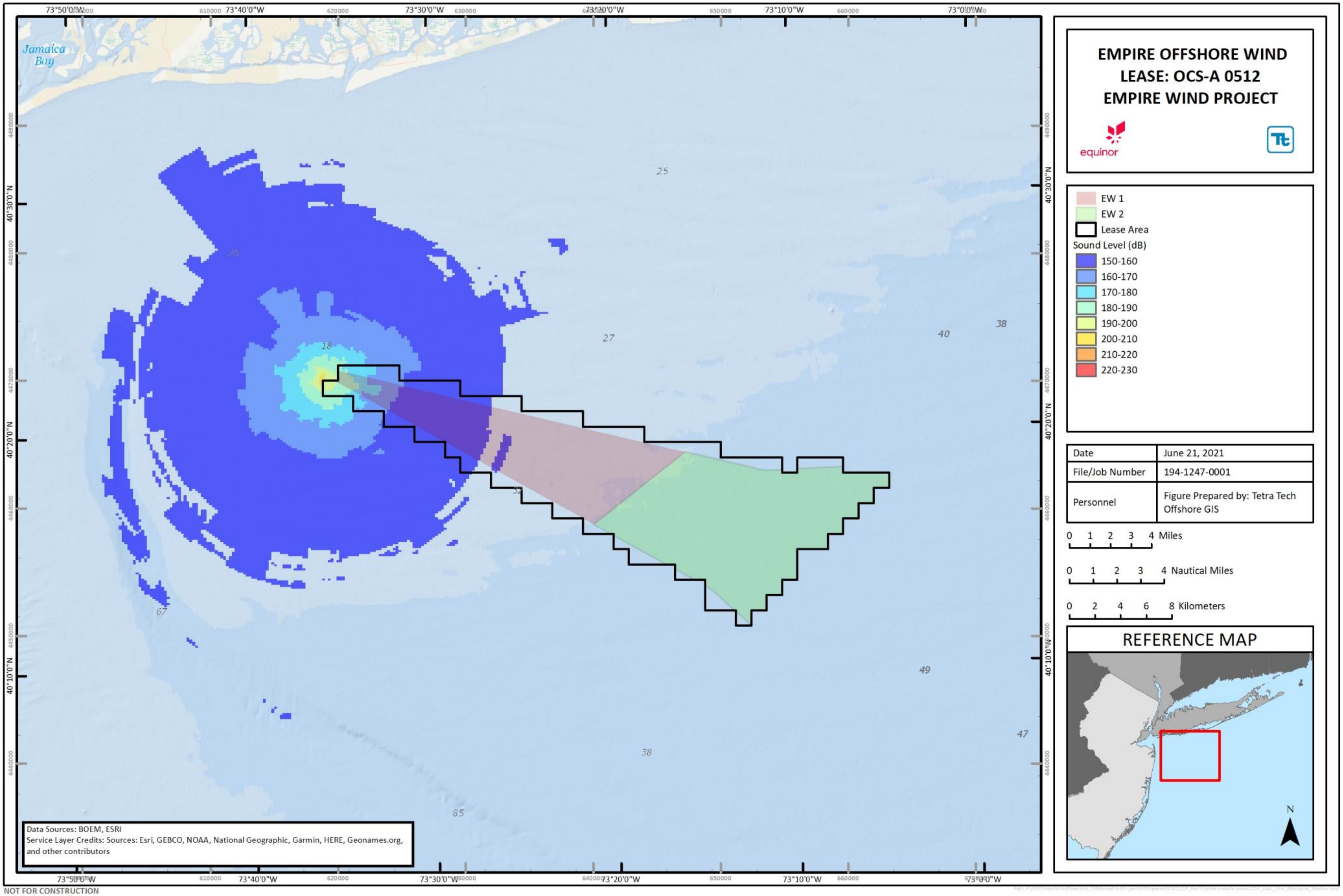

Figure 4.4-10 Unweighted Received SPL for 49-ft (15-m) Monopile Impact Pile Driving at the Shallowest Depth

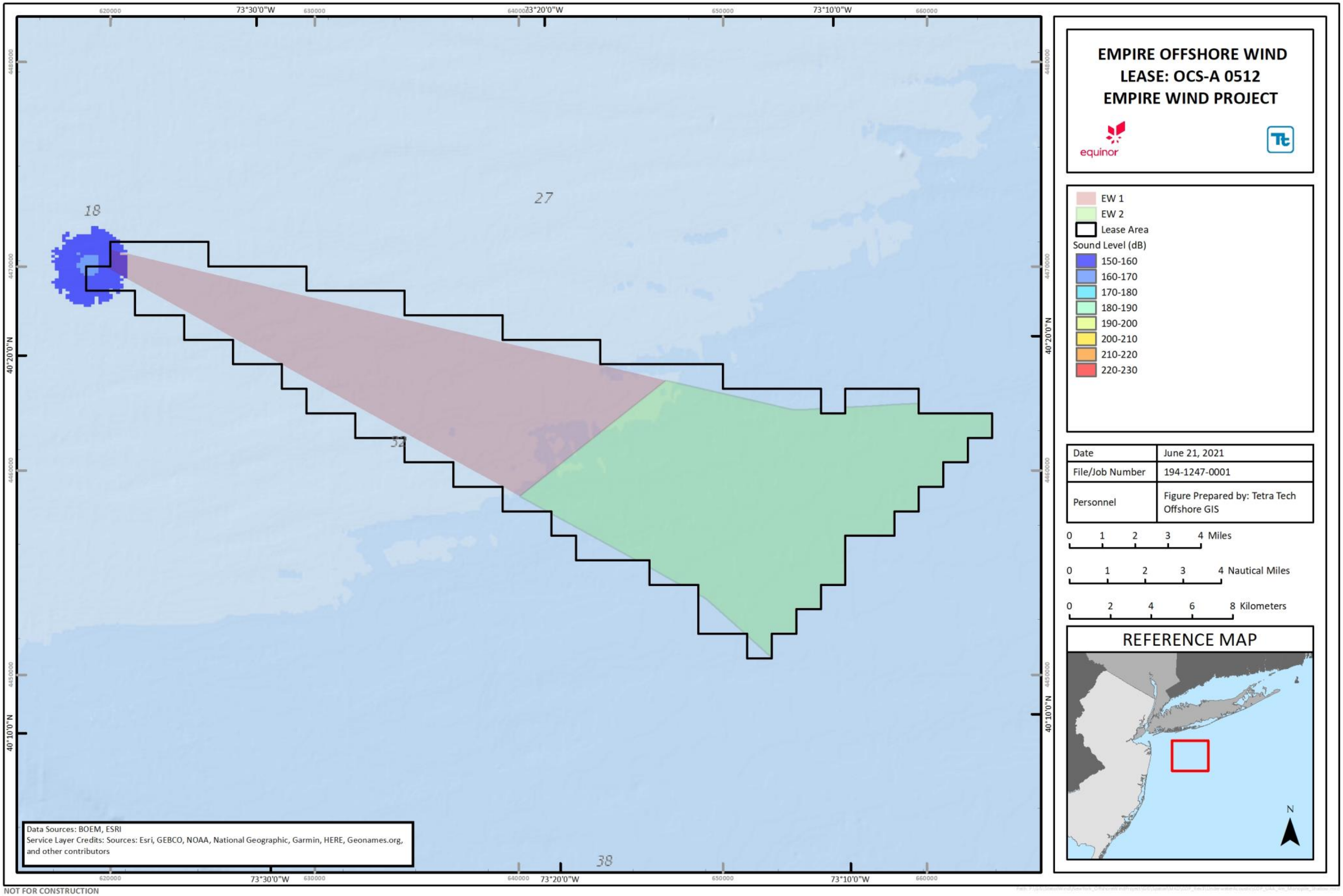

Figure 4.4-11 Unweighted Received SPL for 13-ft (4-m) Pin Pile Impact Pile Driving at the Shallowest Depth

Elevated underwater noise levels associated with drilling of the wind turbine and offshore substation foundations: If pile driving for the entire piling installation is not possible due to the presence of rock or hard soil in some lower part of the substrate, the drive and drill method will be used. When the pile meets refusal, the pile will be drilled out below the pile tip (a couple of meters). Then the piling will be re-established again and piled to its final position. If refusal appears again, however, the drilling/driving will continue until the monopile has reached its final position. Drilling may produce low-frequency noise, and this may contribute slightly to the overall ambient noise, with an estimated source level of 180 dB SEL based on data from the underwater acoustic assessment completed in support of permitting the Virginia Offshore Wind Technology Advancement Project (Tetra Tech 2013).

Potential sound impacts were evaluated for drilling at the two representative wind turbine locations. Results for the deep location are given in **Table 4.4-33**, **Table 4.4-34**, **Table 4.4-35**, **Table 4.4-36**, and **Table 4.4-37**. The results for the shallow location are given in **Table 4.4-38**, **Table 4.4-39**, **Table 4.4-40**, **Table 4.4-41** and **Table 4.4-42**. As you can see, due to the low sound source level associated with drilling, distances to the acoustic thresholds in most cases is less than 328 ft (100 m). There are only a select few unmitigated scenarios where potential sound impacts are expected to extend beyond 328 ft (100 m).

Table 4.4-33 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group a/			
		LF cetaceans	MF cetaceans	HF cetaceans	Phocid pinnipeds
		199 SEL	198 SEL	173 SEL	201 SEL
Drilling	Unmitigated	111	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100	<100

Source: NOAA Fisheries 2018

Note:
a/ Injury and Potential Mortality

Table 4.4-34 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group a/				
		Fish: No Swim Bladder	Fish: Swim bladder not involved in hearing	Fish: Swim bladder involved in hearing	Eggs and Larvae	Sea Turtles
		219 SEL	210 SEL	210 SEL	210 SEL	210 SEL
Drilling	Unmitigated	<100	<100	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100	<100	<100

Source: Popper et al. 2014

Note:
a/ Injury and Potential Mortality

Table 4.4-35 Fishes Acoustic Injury Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group	
		Small Fish	Large Fish
		183 SEL	187 SEL
Drilling	Unmitigated	160	138
	Mitigation (-8 dB)	<100	<100
	Mitigation (-12 dB)	<100	<100

Source: Stadler and Woodbury 2009

Table 4.4-36 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Species		
		Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
		175 RMS SPL	189 SEL	204 SEL
Drilling	Unmitigated	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100

Source: GARFO 2019

Table 4.4-37 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Drilling – Deep Location

Activity	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
Drilling	Unmitigated	157	119
	Mitigation (-8 dB)	<100	<100
	Mitigation (-12 dB)	<100	<100

Source: GARFO 2019

Table 4.4-38 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group a/			
		LF cetaceans	MF cetaceans	HF cetaceans	Phocid pinnipeds
		199 SEL	198 SEL	173 SEL	201 SEL
Drilling	Unmitigated	111	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100	<100

Source: NOAA Fisheries 2018

Note:
a/ Injury and Potential Mortality

Table 4.4-39 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group a/				
		Fish: No Swim Bladder	Fish: Swim bladder not involved in hearing	Fish: Swim bladder involved in hearing	Eggs and Larvae	Sea Turtles
		219 SEL	210 SEL	210 SEL	210 SEL	210 SEL
Drilling	Unmitigated	<100	<100	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100	<100	<100

Source: Popper et al. 2014

Note:
a/ Injury and Potential Mortality

Table 4.4-40 Fishes Acoustic Injury Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group	
		Small Fish	Large Fish
		183 SEL	187 SEL
Drilling	Unmitigated	162	170
	Mitigation (-8 dB)	<100	<100
	Mitigation (-12 dB)	<100	<100

Source: Stadler and Woodbury 2009

Table 4.4-41 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Species		
		Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
		175 SPL RMS	189 SEL	204 SEL
Drilling	Unmitigated	<100	<100	<100
	Mitigation (-8 dB)	<100	<100	<100
	Mitigation (-12 dB)	<100	<100	<100

Source: GARFO 2019

Table 4.4-42 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Drilling – Shallow Location

Activity	Scenario	Hearing Group	
		Fish	Marine Mammals
		150 SPL RMS	160 SPL RMS
Drilling	Unmitigated	<100	<100
	Mitigation (-8 dB)	<100	<100
	Mitigation (-12 dB)	<100	<100

Source: GARFO 2019

Elevated underwater noise levels associated with vibratory pile driving needed for cofferdam installation: The exit point of the long-distance HDD will be offshore. Should this option be selected, temporary offshore cofferdams may be required. If required, the temporary offshore cofferdams will be constructed by installing steel sheet piles in a tight configuration around an area of approximately 100 ft by 100 ft (30 m by 30 m). Vibratory pile drivers install piling into the ground by applying a rapidly alternating force to the pile. This is generally accomplished by rotating eccentric weights about shafts. Each rotating eccentric produces a force acting in a single plane and directed toward the centerline of the shaft. The weights are set off-center of the axis of rotation by the eccentric arm. If only one eccentric is used, in one revolution a force will be exerted in all directions, giving the system a significant amount of lateral whip. To avoid this problem, the eccentrics are paired so the lateral forces cancel each other out, leaving only axial force for the pile.

In general, vibratory pile driving is less noisy than impact pile driving. Impact pile driving produces a loud impulse sound that can propagate through the water and substrate whereas vibratory pile driving produces a continuous sound with peak pressures lower than those observed in pulses generated by impact pile driving. For estimating source levels and frequency spectra, the vibratory pile driver was estimated assuming an 1,800 kilonewton vibratory force. Modeling was accomplished using adjusted one-third-octave band vibratory pile driving source levels cited for similar vibratory pile driving activities planned for the Block Island Wind Farm (Tetra Tech 2012). The assumed sound source level for vibratory pile driving corresponded to 195 dB SEL.

Results for the vibratory pile driving scenarios for cofferdam installation along the EW 1 and EW 2 export cable HDD exit points are similar to the results for drilling, in that distances to the acoustic thresholds in most cases is less than 328 ft (100 m) (**Table 4.4-43**, **Table 4.4-44**, **Table 4.4-45**, **Table 4.4-46**, **Table 4.4-47**). As Empire is in the process of finalizing the export cable landfall for EW 2, three representative locations were modeled to demonstrate the potential range of underwater noise impacts associated with cofferdam installation for EW 2. Cofferdam location EW 2-1 is representative of EW 2 Landfall A and EW 2 Landfall B. Cofferdam location EW 2-2 is representative of a shallow water option for the EW 2 Landfall C and EW 2 Landfall D, while EW 2-3 is representative of a deep water option for the EW 2 Landfall C and EW 2 Landfall D. There are only a select few scenarios where potential sound impacts are expected to extend beyond 328 ft (100 m): thresholds to the fishes acoustic injury criteria (**Table 4.4-45**) and marine mammal and fish behavioral response criteria (**Table 4.4-47**).

Table 4.4-43 Marine Mammal PTS Onset Criteria Threshold Distances (meters) for Vibratory Pile Driving

Location	Hearing Group a/			
	LF cetaceans	MF cetaceans	HF cetaceans	Phocid pinnipeds
	199 SEL	198 SEL	173 SEL	201 SEL
EW 1	<100	<100	<100	<100
EW 2-1	<100	<100	<100	<100
EW 2-2	<100	<100	<100	<100
EW 2-3	<100	<100	<100	<100

Source: NOAA Fisheries 2018

Note:
a/ Injury and Potential Mortality

Table 4.4-44 Sea Turtles and Fish Onset of Injury Threshold Distances (meters) for Vibratory Pile Driving

Location	Hearing Group				
	Fish: No Swim Bladder	Fish: Swim bladder not involved in hearing	Fish: Swim bladder involved in hearing	Eggs and Larvae	Sea Turtles
	219 SEL	210 SEL	210 SEL	210 SEL	210 SEL
EW 1	<100	<100	<100	<100	<100
EW 2-1	<100	<100	<100	<100	<100
EW 2-2	<100	<100	<100	<100	<100
EW 2-3	<100	<100	<100	<100	<100

Source: Popper et al. 2014

Table 4.4-45 Fishes Acoustic Injury Threshold Distances (meters) for Drilling – Vibratory Pile Driving

Location	Hearing Group	
	Small Fish	Large Fish
	183 SEL	187 SEL
EW 1	687	311
EW 2-1	808	261
EW 2-2	884	408
EW 2-3	363	324

Source: Stadler and Woodbury 2009

Table 4.4-46 Sea Turtles Behavioral and Acoustic Injury Criteria Threshold Distances (meters) for Vibratory Pile Driving

Location	Species		
	Sea Turtle Behavioral	Sea Turtle TTS	Sea Turtle PTS
	175 L_P	189 SEL	204 SEL
EW 1	<100	266	<100
EW 2-1	<100	318	<100
EW 2-2	115	376	136
EW 2-3	<100	305	<100

Source: GARFO 2019

Table 4.4-47 Marine Mammals and Fish Behavioral Response Criteria Threshold Distances (meters) for Drilling – Vibratory Pile Driving

Location	Hearing Group	
	Fish	Marine Mammals
	150 SPL RMS	120 SPL RMS
EW 1	412	1,880
EW 2-1	390	14,817
EW 2-2	608	17,268
EW 2-3	337	16,717

Source: GARFO 2019

The results of the analysis will be used to inform development of evaluation and mitigation measures that may be applied during construction of the Project, in consultation with BOEM and NOAA Fisheries. The Project will obtain necessary permits to address potential impacts to marine mammals, sea turtles, and fisheries resources from underwater noise and will establish appropriate and practicable mitigation and monitoring measures through discussions with regulatory agencies.

Increase in underwater noise levels associated with submarine export and interarray cable laying activities: During construction, specialist vessels specifically designed for laying and burying cables on the seabed will be used to install the submarine export and interarray cables, which is proposed to be completed through the use of a jet plow or plow (for a complete list of the equipment proposed to install and bury the submarine export and interarray cables, see Section 3.4.1.4). Throughout the cable lay process, a dynamic-positioning-enabled cable lay vessel maintains its position (fixed location or predetermined track) by means of its propellers and thrusters using a global positioning system (GPS), which describes the ship's position by sending information to an onboard computer that controls the thrusters. The underwater noise produced by subsea trenching operations depends on the equipment used and the nature of the seabed sediments but will be predominantly generated by vessel thruster use.

Thruster sound source levels may vary in part due to technologies employed and are not necessarily dependent on either vessel size, propulsion power, or the activity engaged. Dynamic positioning thruster noise is non-impulsive and continuous in nature and is not expected to result in harassment. Recent guidance from NOAA Fisheries indicates that they do not expect use of directional thrusters to impact marine species in any material way and no longer require that those activities and their potential noise impacts be included in requests for Incidental Harassment Authorization.

Increase in underwater noise levels associated with Project-related vessels: During construction, it is anticipated that additional traffic from construction-related vessels will slightly increase oceanic noise from its current baseline (Blair et al 2016). The New York Bight is known to have a significant baseline noise level due to shipping lanes that occur in the area (Muirhead et al. 2018; Estabrook et al. 2016). Based on the maximum design scenario in the PDE for Project-related construction vessels, there will be an insignificant increase in vessel traffic associated with the Project. The increase in Project vessel activity will not be a combined increase occurring all at once but will be sporadic throughout the construction period (both in the 24-hour work period, and the season). It is unlikely that the noise impact of vessel traffic from Project construction vessels will create a significant increase in baseline conditions in underwater noise.

4.4.2.2.2 Operations and Maintenance

During operations, the potential impact-producing factors to the underwater noise environment may include:

- The presence of fixed structures (e.g. wind turbines and offshore substations); and
- Operations and maintenance activities associated with the offshore components of the Project.

With the following potential consequential impacts:

- Long-term increase in underwater noise levels associated with wind turbine and offshore substation operations; and
- Increased underwater noise levels associated with Project-related vessels.

Increase in underwater noise levels associated with wind turbine and offshore substation operations: During operations, the main source of underwater noise will be from the working of the gears in the nacelle at the top of the tower (Nedwell et al. 2004). This noise/vibration is transmitted into the sea by the structure of the tower itself, and manifests as low-frequency noise. Other transmission pathways are via the tower and the seabed, or through the air and air/water interface (Nedwell et al. 2004). A review of other published studies indicates source levels from operating offshore wind turbines with monopile foundations show peak frequencies occurring predominantly below 500 Hz, and the apparent source level range from 140 to 153 dB re 1 µPa at 1 m (Nedwell et al. 2004). Similar measurements by Nedwell indicate the steady-state background in an offshore oceanic environment also occurs within this frequency range, which implies masking effects. The available field data showed that although the absolute level of wind turbine noise increases with increasing wind speed, the noise level relative to background noise (i.e., from wave action, entrained bubbles) remained relatively constant. Furthermore, studies have shown the main impacts of noise and vibrations occur during the construction phases. Therefore, impacts from underwater sound due to Project operations are expected to be negligible.

Increase in underwater noise levels associated with Project-related vessels: During operations, underwater noise from Project-related operations and support vessel traffic is not anticipated to be greater than the ambient noise levels in the Study Area, as vessel traffic is expected to have an insignificant increase above the existing baseline conditions as a result of the Project. Vessel traffic during operation will mainly consist of the transportation of supplies and maintenance crews. Given the amount of existing vessel traffic in the area, the noise associated with supply vessels transiting to the offshore facilities will have a negligible contribution to total ambient underwater sound levels. Similarly, nearshore vessel activity will be generally concentrated in established shipping channels and near industrial port areas and will be consistent with the existing noise environment in those areas. Therefore, impacts from and underwater sound due to Project-related vessel activity are not expected to be significantly greater than baseline conditions.

4.4.2.2.3 Decommissioning

Impacts during decommissioning are expected to be similar to or less than those experienced during construction, as described in Section 4.4.2.2.1. It is important to note that advances in decommissioning methods/technologies are expected to occur throughout the operations phase of the Project. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time. For additional information on the decommissioning activities that Empire anticipates will be needed for the Project, please see **Section 3**.

4.4.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

Avoidance, minimization, and mitigation measures for underwater noise are addressed for each receptor, resource, or effect as appropriate in the relevant COP section, for example **Section 5.6 Marine Mammals**, and are not described further here. In addition to the measures described in the relevant COP sections, Empire is evaluating a turbine layout, as described in **Section 8.8 Commercial and Recreational Fisheries**, that reflects the installation of fewer wind turbines for EW 1 and EW 2 and that would result in reduced impacts, such as the duration of pile driving activities.

4.4.2.4 References

Table 4.4-48 Data Sources

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coastal/crm.html	N/A

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