June 2023

BEACON WIND PROJECT:
BEACON WIND 1 AND BEACON WIND 2

CONSTRUCTION AND OPERATIONS PLAN

VOLUME 2A: PHYSICAL RESOURCES

Prepared for

Beacon Wind LLC

Submitted to

Bureau of Ocean Energy Management

Prepared by

AECOM

Photo credit: Andrew Saunders, Equinor

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PROJECT QUICK REFERENCE GUIDE

Key Project Term	Description
Beacon Wind	Beacon Wind LLC.
Beacon Wind 1	The portion of the Project and Lease Area which will be considered a single wind farm dedicated to the Astoria power complex Point of Interconnection (POI) for provision of power to New York Independent System Operator (NY ISO). Also referred to as "BW1."
Beacon Wind 2	The portion of the Project and Lease Area which will be considered a single wind farm dedicated to a POI in Queens, New York or Waterford, Connecticut to be determined for provision of power to NY ISO or the New England ISO (ISO-NE). Also referred to as "BW2."
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.
Foundation	Support structure for a wind turbine generator, offshore substation or other offshore structures, including the structural and geotechnical components, extending into the seabed.
Interarray cable	Up to 150 kilovolt (kV) HVAC submarine export cable interconnecting the wind turbines and offshore converter station. The cable consists of a three-core copper or aluminum conductor with a fiber-optic cable integrated into the cable.
Interconnection cable	138 kV HVAC onshore cables connecting the onshore converter station to the POI.
J-tubes	Metal tubes that route and protect cables against sea and wind forces as the cables travel from the seabed, up the foundation, to the base of the wind turbine tower or offshore substation topside.
Landfall	Area where the submarine export cable is brought onshore.
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0520).
Lease Area	The geographic area defined in the Lease OCS-A 0520.
Metocean facilities	Includes one floating light and detection ranging (floating LiDAR) buoy, two wave and meteorological buoys, and two subsurface current meters installed in the Lease Area. These were permitted under the Site Assessment Plan and installed in November 2021. Beacon Wind is also proposing to temporarily moor a metocean buoy within the Lease Area during construction and installation operations to provide real-time weather conditions.

PROJECT QUICK REFERENCE GUIDE (continued)

Key Project Term	Description
Offshore installation corridor	Minimum 1,640 ft (500 m) wide siting corridor for the offshore cables from the Lease Area to the landfalls which will be temporarily disturbed during installation activities. The siting corridor serves as the maximum extent for the submarine export cable installation corridor.[1]
Offshore substation facilities	Topside structure which receives the power from the wind turbines through the interarray cables. This includes all primary auxiliary and supporting systems. Each offshore substation facility 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. The offshore substation facilities include the offshore substation and the offshore converter station that converts the HVAC power received from the interarray cables into HVDC power for transmission through the submarine export cables.
Offshore wind facility	Includes those facilities and wind energy development activities permitted by the Bureau of Ocean Energy Management through an outer continental shelf renewable energy lease.
Onshore construction corridor	Onshore cable corridor and additional area required for construction to install the onshore export cables from landfall to the onshore substation facility, as well as the interconnection cables from the onshore substation facility to the POI.
Onshore export cable	For BW1 and BW2, up to 400 kV HVDC cables connecting from the onshore landfall locations to the onshore substation facilities.
Onshore substation facility	The onshore substation facility collects the power from the submarine export cable and adjusts the voltage to support the interconnection into the existing grid. The onshore substation facility includes the onshore substation and the onshore converter station that converts the HVDC power received from the submarine export cable into HVAC power for connection to the existing power grid.
Point of Interconnection (POI)	The existing substation where the Project is interconnected to distribute power into the grid. For BW1: Location where BW1 interconnects into the New York Independent System Operator electricity grid at the Astoria power complex in Queens, New York. For BW2: Location where BW2 interconnects into electricity grid either in Queens, New York or Waterford, Connecticut.
Project	The offshore wind project for OCS-A 0520 proposed by Beacon Wind LLC consisting of BW1 and BW2.
Project Area	Lease Area, BW1 and BW2 submarine export cable routes, and onshore project facility locations including the onshore export and interconnection cables, and onshore substation facilities.

[1] Installation corridor does not include the additional space required for anchor spread in areas where anchored installation vessels will be used.

PROJECT QUICK REFERENCE GUIDE (continued)

Key Project Term	Description
Project Design Envelope (PDE)	The reasonable range of project designs associated with various components of the Project.
Scour protection	Material, typically stone or rocks, placed around/on top of a structure, if required, to prevent seabed sediment from being transported as a result of water flow.
Seabed penetration	The value specifies the required penetration depth of original seabed for the monopile, piled jacket, or suction bucket jacket foundations.
Seabed preparation	Preparation of the seabed for installation of scour material. For all foundation types, filter layer and armor layer scour protection will be evaluated and installed where required.
Submarine export cables	Up to 400 kV HVDC electric power transmission system used for the transmission of electrical power from offshore substation facilities to the onshore substation facilities.
Submarine export cable routes	For BW1, the path of the submarine export cable from the offshore substation facilities in the Lease Area to the POI in Queens, New York. For BW2, two options for the linear path of the submarine export cable from the offshore substation facilities in the Lease Area to a POI in Queens, New York or Waterford, Connecticut.
Take	Term related to the United States Fish and Wildlife Service from Section 3(18) of the Federal Endangered Species Act which refers to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.
Transition Piece (TP)	The portion of the foundation which 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, which 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.

Abbreviations and Acronyms

Acronym	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
AADT	Average Annual Daily Traffic
ac	acre
AC	alternating current
ACPARS	Atlantic Coast Port Access Route Study
ACK	Nantucket airport
ACS	American Community Survey
AD	Anno Domini
ADCP	Acoustic Doppler Current Profiler
ACHP	Advisory Council on Historic Preservation
ADLS	Aircraft Detection Lighting System
AECOM	AECOM Technical Services, Inc.
AFS	Air Force Station
AGL	above ground level
AIS	Automatic Identification System
ALARP	as low as reasonably practical
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ANSI	American National Standards Institute
AOCS	U.S. Atlantic Outer Continental Shelf
APE	area of potential effects
APEM	APEM, Inc.
APSLVI	Area of Potential Seascape, Landscape and Visual Impact
ARPA	Archaeological Resources Protection Act
ARTCC	Air Route Traffic Control Center
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
AWWI	American Wind Wildlife Institute
BACT	Best Available Control Technology
BBA	Breeding Bird Atlas
Beacon Wind	Beacon Wind LLC
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement

Abbreviations and Acronyms	
Acronym	Definition
BSF	below sea floor
BW	Beacon Wind
BW1	Beacon Wind 1
BW2	Beacon Wind 2
ca.	circa
CAA	Clean Air Act
CAG	Capitol Airspace Group
CBRA	Cable Burial Risk Assessment
CDIP	Coastal Data Information Program
CEMSA	Confederation of European Shipmaster's Associations
CEQ	Council on Environmental Quality
CeTAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CHH	Complex Heterogeneous Habitat
CH_4	methane
CLDS	Central Long Island Sound Disposal Site [also CLIS]
cm	centimeter
CMECS	Coastal and Marine Ecological Classification Standard
CMR	Code of Massachusetts Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
COMDTINST	Commandant Instruction
ConEd	Consolidated Edison
COP	Construction and Operations Plan
COVID-19	SARS-CoV2-2019
CPTU	cone penetration testing
CRIS	Cultural Resources Information System
CSA	Continental Shelf Associates, Inc.
CSDS	Cornfield Shoals Disposal Site
CTV	Crew Transfer Vessel
CWA	Clean Water Act
CWIS	cooling water intake system
CZM	Coastal Zone Management
DAMOS	Disposal Area Monitoring System
dBA	decibels, A-scale
DC	direct current

Abbreviations and Acronyms	
Acronym	**Definition**
DDT	dichlorodiphenyltrichloroethane
DF	Direction Finding
DFE	Design Flood Elevation
DFO	Fisheries and Oceans Canada
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DMA	Dynamic Management Area
DMON	digital acoustic monitoring
DMR	Division of Marine Resources
DO	dissolved oxygen
DoD	U.S. Department of Defense
DoN	Department of the Navy
DP	dynamic positioning
DOI	Department of the Interior
DPS	distinct population segments
DSM	digital surface model
DZ/RA	Danger Zones/Restricted Areas
EcoMon	Ecosystems Monitoring
ECO-PAM	Ecosystem and Passive Acoustic Monitoring
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Assessment
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EJ	environmental justice
ELDS	Eastern Long Island Sound Disposal Site
EMF	electric and magnetic field
EMS	emergency medical services
Empire	Empire Offshore Wind LLC
ENC	Electronic Navigational Charts
ENGO	environmental nongovernmental organization
EPA	U.S. Environmental Protection Agency
ERC	Emission Reduction Credits
ERDC	United States Army Environmental Research and Development Center
ERM	Environmental Resource Mappers
ERP	Emergency Response Plan
ESA	Endangered Species Act of 1973
EWR	Early Warning Radar

Abbreviations and Acronyms

Acronym	Definition
E2	Environmental Entrepreneurs
EM&CP	Environmental Management and Construction Plan
FAA	Federal Aviation Administration
FDR	Facility Design Report
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWG	Fisheries Hydroacoustic Working Group
FOIA	Freedom of Information Act
FIR	Fabrication and Installation Report
FLO	Fisheries Liaison Officers
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group
FMC	Fishery Management Council
FMP	fishery management plan
FOTF	Fuel Oil Tank Farm
FR	Federal Register
FSA	Formal Safety Assessment
FWRAM	Full Wave Range Dependent Acoustic Model
ft	feet
GARFO	NOAA Fisheries Greater Atlantic Regional Fisheries Office
GHG	greenhouse gas
GIS	geographic information system
GLD	geographic location description
GPS	Global Positioning System
GSD	ground sampling distance
GW	gigawatt
GWSA	Global Warming Solutions Act
ha	hectare
HAP	hazardous air pollutant
HAPC	Habitat Areas of Particular Concern
HAT	Highest Astronomical Tide
HD	high-definition
HDD	horizontal directional drilling
HF	high-frequency
HFC	hydrofluorocarbon
HMS	highly migratory species
HPS	High Priority Species of Greatest Conservation Need
hr	hour
HRG	High-Resolution Geophysical

Abbreviations and Acronyms

Acronym	Definition
HRVEA	Historic Resources Visual Effects Assessment
HTL	High Tide Line
HVAC	heating, ventilation, and air conditioning
HVCRC	Hudson Valley Cultural Resource Consultants
HVDC	high-voltage direct-current
Hz	hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IBA	Important Bird Area
IBTrACS	International Best Track Archive for Climate Stewardship
ICPC	International Cable Protection Committee
IEC	Interstate Environmental Commission
IEMA	Institute of Environmental Management and Assessment
IFR	instrument flight rules
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
in	inch
IOOS	Integrated Ocean Observing System
IPaC	Information for Planning and Conservation
ISO	International Organization for Standardization
ITA	Incidental Take Authorization
IUCN	International Union for Conservation of Nature
km	kilometer
km/hr	kilometers per hour
KOP	Key Observation Point
kV	kilovolt
kVA	kilovolt ampere
LAER	Lowest Achievable Emission Rate
lbs	pounds
lb/MWh	pounds per megawatt-hour
Lease Area	designated Renewable Energy Lease Area OCS-A 0520
LF	low-frequency
LI	Landscape Institute
LiDAR	light detection and ranging
LIPA	Long Island Power Authority
LISCMP	Long Island Sound Coastal Management Program
LISS	Long Island Sound Study
LISICOS	Long Island Sound Integrated Coastal Observing System

Abbreviations and Acronyms

Acronym	Definition
LISMaRC	Long Island Sound Mapping and Research Collaborative
LNM	Local Notice to Mariners
LOMR	Letter of Map Revision
LORAN	long-range navigation
NROC	Northeast Regional Ocean Council
LWRP	Local Waterfront Revitalization Program
m	meters
m/s	meters per second
MA	Massachusetts
MA DMF	Massachusetts Department of Marine Fisheries
MAEEA	Massachusetts' Executive Office of Energy and Environmental Affairs
MAFMC	Mid-Atlantic Fishery Management Council
MAIB	Marine Accident Investigation Branch
MARACOOS	Mid-Atlantic Regional Association Coastal Ocean Observing System ()
MARCO	Mid-Atlantic Regional Council on the Ocean
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MA/RI WEA	Massachusetts Rhode Island Wind Energy Area
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection
MATS	Mid-Atlantic Tursiops Surveys
MBES	multibeam echosounder
MBTA	Migratory Bird Treaty Act of 1918
MDAT	Marine-life Data and Analysis Team
MEC	munitions and explosives of concern
MF	mid-frequency
mgd	million gallons per day
mg/m^3	milligrams per cubic meter
MGN	Maritime Guidance Note
MGEL	Duke University Marine Geospatial Ecology Lab
MHC	Massachusetts Historical Commission
MHHW	Mean Higher High Water
mi	statute mile
MIA	minimum instrument altitude
MLLW	mean lower low water
mph	miles per hour
MRT	mitigation response team
MSA	Minimum Safe Altitudes
MSD	Marine Sanitation Device

Abbreviations and Acronyms

Acronym	Definition
MFSCMA	Magnuson-Stevens Fisheries Conservation and Management Act
MSL	mean sea level
MW	megawatt
MVA	megavolt ampere
MVA	minimum vectoring altitude
MVCMA	Martha's Vineyard Camp Meeting Association
MVCO	Martha’s Vineyard Coastal Observatory
MVY	Martha’s Vineyard airport
$\mu g/m^3$	micrograms per standard cubic meter
µmol/L	micromoles per liter
µPa	micropascal
N/A	Not Applicable
NAA	Nonattainment Area
NAAQS	National Ambient Air Quality Standards
NARWSS	North Atlantic Right Whale Sighting Surveys
NASCA	North American Submarine Cable Association
NATCP	Native American Tribes Communications Plan
NAVAID	Navigational Aid
NAVTEX	Navigational Telex
NCCA	National Coastal Condition Assessment
NCEI	National Centers for Environmental Information
NDZ	No-Discharge Zone
NEA	New England Aquarium
NEAMAP	Northeast Area Monitoring and Assessment Program
NED	National Elevation Dataset
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NERACOOS	Northeastern Regional Association of Coastal Ocean Observing Systems
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act of 1966
NJDEP	New Jersey Department of Environmental Protection
NLCD	National Land Cover Dataset
NLDS	New London Disposal Site
nm	nautical mile
NMFS	National Marine Fisheries Service
NNYBPARS	Northern New York Bight Port Access Route Study
NOAA	National Oceanic and Atmospheric Administration

Abbreviations and Acronyms	
Acronym	**Definition**
NOAA NDBC	NOAA National Data Buoy Center
NOAA-SEFSC	National Marine Fisheries Service-Southeast Fisheries Science Center
NODE	U.S. Navy OPAREA Density Estimates
NORAD	North American Aerospace Defense Command
NOI	Notice of Intent
NOx	oxides of nitrogen
NO_2	nitrogen dioxide
NPDES	National Pollutant Discharge Elimination System
NPLSC	Northeast Large Pelagic Survey Collaborative
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NROC	Northeast Regional Ocean Council
NSA	noise-sensitive area
NSR	New Source Review
NSRA	Navigation Safety Risk Assessment
NTU	nephelometric turbidity units
NVIC	Navigation and Vessel Inspection Circular
NWI	National Wetlands Inventory
NY	New York
NYBPARS	Northern New York Bight Port Access Route Study
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York Codes, Rules and Regulations
NYD	New York District
NYDOS	New York Department of State
NY ISO	New York Independent System Operator
NYNHP	New York Natural Heritage Program
NYPA	New York Power Authority
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDEC-DFW NHP	New York State Department of Environmental Conservation, Division of Fish and Wildlife, Natural Heritage Program
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
NYSHPO	New York State Historic Preservation Office

Abbreviations and Acronyms

Acronym	Definition
NYS WQS	New York State Water Quality Standards
NYVTS	New York Vehicle Traffic Service
N_2O	nitrous oxide
OBIS	Ocean Biodiversity Information System
O&M	operations and maintenance
OBCF	octave band center frequency
OCM	Office for Coastal Management
OCS	Outer Continental Shelf
OFLR	Offshore Fisheries Liaison Representatives
OPAREA	Boston Operating Area
OPRHP	New York State Office of Parks, Recreation, and Historic Preservation
OREI	Offshore Renewable Energy Installation
OSAMP	Ocean Special Area Management Plan
OSHA	Occupational Health and Safety Act of 1970
OSRP	Oil Spill Response Plan
OW	otariid pinnipeds underwater
PAM	Passive Acoustic Monitoring
PAPE	preliminary APE
PARS	Port Access Route Study
PATON	Private Aids to Navigation
Pb	lead
PBR	potential biological removal
PCB	polychlorinated biphenyl
PDE	Project Design Envelope
PFC	perfluorocarbon
PK	peak sound level
PM	particulate matter
$PM_{2.5}$	particulate matter with aerodynamic diameter 2.5 micrometers or less
PM_{10}	particulate matter with aerodynamic diameter 10 micrometers or less
POI	Point of Interconnection
ppb	parts per billion
ppm	parts per million
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 BW1 and BW2.
psu	practical salinity unit
PSO	Protected Species Observers
PTS	permanent threshold shifts
PV	plan view images/imaging

Abbreviations and Acronyms	
Acronym	**Definition**
PW	phocid pinnipeds underwater
QA	quality assurance
QMA	Qualified Marine Archaeologist
RICRMC	Rhode Island Coastal Resources Management Council
RIDEM	Rhode Island Department of Environmental Management
RINHS	Rhode Island Natural History Survey
ROD	Record of Decision
RODA	Responsible Offshore Development Alliance
ROSA	Responsible Offshore Science Alliance
RSZ	Rotor Swept Zone
RWSAS	Right Whale Sighting Advisory System
RWSC	Regional Wildlife Science Collaborative
SAFMC	South Atlantic Fishery Management Council
SAMP	Rhode Island Ocean Special Area Management Plan
SAP	Site Assessment Plan
SAR	search and rescue
SAV	submerged aquatic vegetation
SBMT	South Brooklyn Marine Terminal
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure level
SEL_{CUM}	cumulative sound exposure level
SF_6	sulfur hexafluoride
SGCN	species of greatest conservation need
SHPO	State Historic Preservation Office
SIMPROF	similarity profile routine
SLCU	Seascape and Landscape Character Units
SLVIA	Seascape, Landscape, and Visual Impact Assessment
SMA	Seasonal Management Area
SMAST	University of Massachusetts Dartmouth – School for Marine Science and Technology
SMS	Safety Management System
SO_2	sulfur dioxide
SOLAS	International Convention for the Safety of Life at Sea
SOV	Service Operations Vessel
SPCC	Spill Prevention, Control, and Countermeasures
SPI	sediment profile images/imaging
SPI/PV	sediment profile/plan view imaging
SPL	sound pressure level

Abbreviations and Acronyms

Acronym	Definition
SPL RMS	root mean square sound pressure
SQI	Sediment Quality Index
STSSN	Sea Turtle Stranding and Salvage Network
SWPPP	Stormwater Pollution Prevention Plan
TCEQ	Texas Commission on Environmental Quality
TCP	Traditional Cultural Properties
TDWR	Terminal Doppler Weather Radar
THPO	Tribal Historic Preservation Office
TNC	The Nature Conservancy
TP	total phosphorus
tpy	tons per year
TRACON	Consolidated Terminal Radar Approach Control
TRI	Terrain Ruggedness Index
TSS	Traffic Separation Scheme
TTS	temporary threshold shift
UDP	Unanticipated Discovery Plan
UER-WLIS	Upper East River–Western Long Island Sound
UKHO	United Kingdom Hydrographic Office
UME	unusual mortality event
U.S.	United States
U.S.C.	United States Code
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
VHF	very-high frequency
VFR	visual flight rules
VIA	Visual Impact Assessment
VMS	Vessel Management System
VLSFO	Very Low Sulphur Fuel Oil
VOC	volatile organic compound
VTR	Vessel Trip Report
WEA	Wind Energy Area
WHOI	Woods Hole Oceanographic Institution
WI/PWL	Water Inventory/Priority Waterbodies List
WLDS	Western Long Island Sound Disposal Site [also WLIS]
WMS	white nose syndrome

Abbreviations and Acronyms	
Acronym	**Definition**
WPA	Works Progress Administration
WQI	Water Quality Index
WSC	World Shipping Council
WSR	Weather Surveillance Radar
YOY	young-of-the-year
ZTR	Zone of theoretical visibility

4. Physical Resources

The following sections provide an assessment of the physical resources, water quality and air quality in the vicinity of the Project Area, which includes the Lease Area, submarine export cable route, onshore export and interconnection cable routes, and onshore substation facilities for BW1 and BW2. Physical resources assessed include the oceanographic and meteorological environment, geological conditions, and natural and anthropogenic hazards. Oceanographic and meteorological environment includes wind, waves, currents, water level, sea temperature and salinity, air temperature and ice and fog. Water quality reviewed includes evaluation of the physical, chemical, and biological attributes of water in the vicinity of the Project Area and air quality assessed includes a review of the current regulatory framework and existing attainment status to federal air quality standards. Along with characterization of the affected environment, potential Project-related impacts to the physical resources, water quality and air quality as a result of construction, operations, and decommissioning of the Project are also discussed.

Beacon Wind proposes to develop the entire Lease Area with up to two individual wind farms for BW1 and BW2, with a submarine export cable route for BW1 to Queens, New York and a submarine export cable route for BW2 to either Queens, New York or to Waterford, Connecticut. Two locations are under consideration in Queens, New York (NYPA and AGRE, which includes AGRE East and AGRE West) for the single proposed BW1 landfall and onshore substation facility. The Queens, New York onshore substation facility sites that are not used (NYPA, AGRE East, or AGRE West) for BW1 will remain under consideration, in addition to the Waterford, Connecticut site, for the single proposed BW2 onshore substation facility.

Resources reviewed as part of this physical resources assessment, include a combination of publicly available data sources and targeted field surveys. These resources are referenced throughout the following sections.

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. Potential impacts to the oceanographic and meteorological environment resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Beacon Wind are also described, which are intended to avoid, minimize, and/or mitigate potential impacts to the oceanographic and meteorological environment.

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

- Geological Conditions (**Section 4.1.2**);
- Water Quality (**Section 4.2**);
- Public Health and Safety (e.g., extreme weather events, **Section 8.12**);
- Metocean Design Basis (**Appendix H**); and
- Sediment Transport Analysis (**Appendix I**).

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the coastal areas that may be directly and/or indirectly impacted by the offshore components, including the foundations, wind turbines, offshore substation facilities, and submarine export cables associated with the construction, operations, and decommissioning of the Project (**Figure 4.1-1**, below).

This section relies upon the following data sources:

- NE-US hindcast model operated by Kjeller Vindteknikk (2020);
- GROW-FINE EC5km hindcast model operated by Oceanweather Inc. (2018);
- NOAA National Data Buoy Center assets (NOAA 2019; NOAA 2020a, b, c, d);
- NOAA National Oceanographic Data Center World Ocean Atlas 2013 (NOAA 2013);
- Mayflower Wind buoy data taken from: ERDDAP data provided by NOAA Integrated Ocean Observing System (IOOS) Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) (NOAA 2021c); and
- United Kingdom Hydrographic Office's (UKHO) "Admiralty Sailing Directions, East Coast of the United States Pilot" (2009).

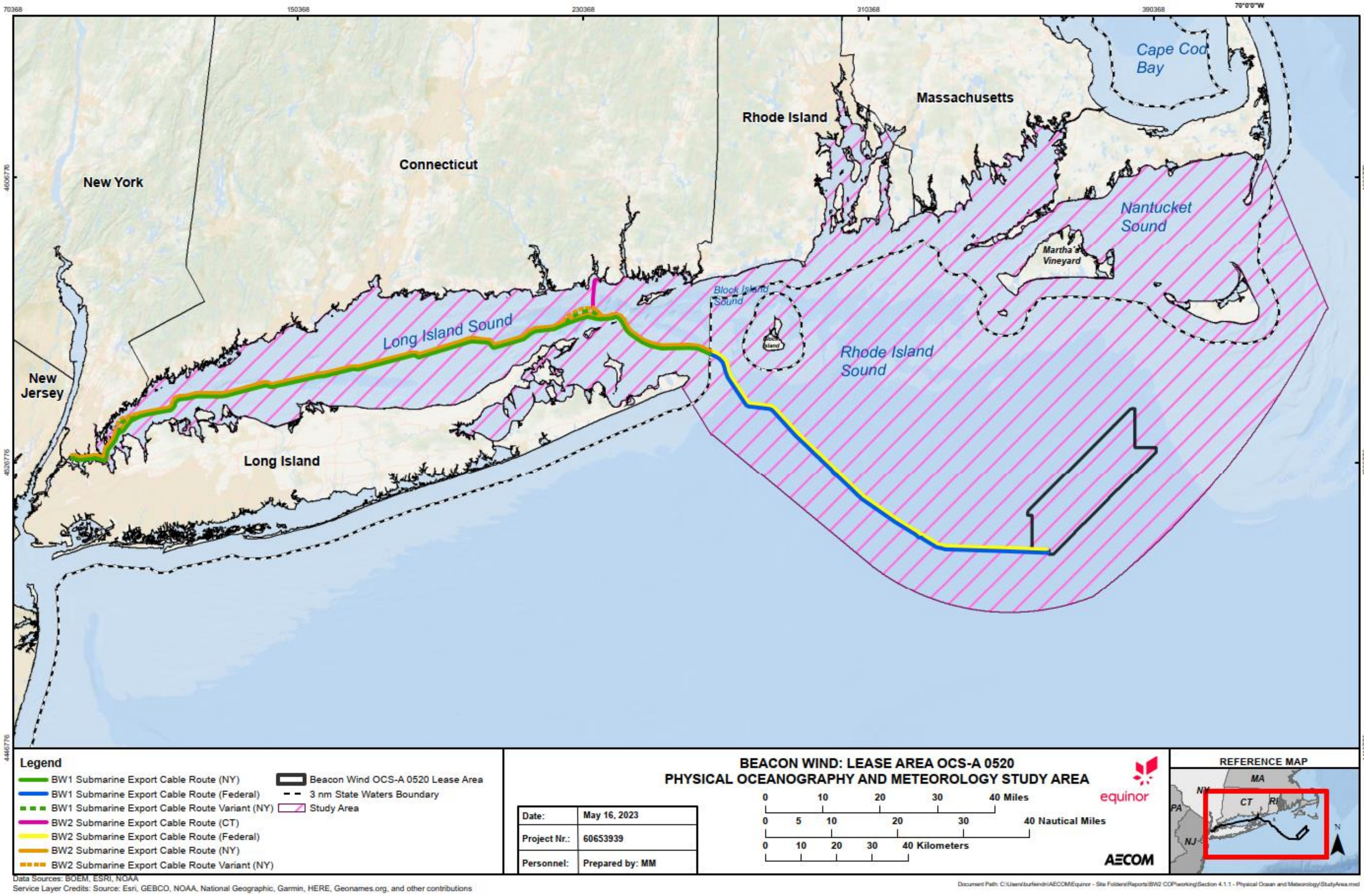
Note that the data reviewed from the Mayflower Wind Buoy was not quality-assured and, thus, if data appeared to be outside of a reasonable range for a given variable, it was considered inaccurate and not applied to the evaluation. As an example of data excluded, monthly average measured air temperature in October was significantly lower than November and lower than nearby examined buoys for that same time period. This data thus was excluded since accuracy was questioned. A similar trend was seen for monthly average sea water temperature for October where the average measured temperature was significantly lower than what as measured for November and was lower than nearby buoys. The magnitude of the differences was seen as significant enough to question accuracy and thus the data was excluded.

In November 2021, Beacon Wind deployed one floating light detection and ranging buoy (Floating LiDAR), two metocean buoys, and two subsurface current meter moorings within the Lease Area, with the Floating LiDAR buoy located in block 6128, one metocean and one subsurface current meter buoy in block 6129 and one metocean and one subsurface current meter mooring in block 6178, in accordance with the BOEM-approved SAP. Deployment of these metocean facilities is planned for a two-year operation to collect data on wave height and direction, meteorological conditions, sea water temperature and conductivity, and currents. Data collected will be used to inform siting and design of the Project and will be included as an additional metocean analysis in the FDR. A detailed metocean analysis will be submitted with the FDR prior to construction, in accordance with 30 CFR § 585.701.

Historical and near-real time data from the Beacon Wind metocean facilities detailing wind speed, wind direction, air temperature, relative humidity, barometric pressure, directional waves, current velocity, water temperature, salinity, and depth sensors can be publicly viewed at the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) website[2].

[2] MARACOOS OceansMap and ERDDAP - Search (maracoos.org)

FIGURE 4.1-1. PHYSICAL OCEANOGRAPHY AND METEOROLOGY STUDY AREA



4.1.1.1 *Affected Environment*

The affected environment, as described below, is defined as the Project Area that includes the Lease Area, the submarine export cable routes, the submarine export cable route areas, and coastal and offshore areas in the vicinity of the Study Area 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. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities.

4.1.1.1.1 *Wind*

To evaluate winds within the Study Area, wind data was taken from the NE-US hindcast model operated by Kjeller Vindteknikk (2020) and consists of 17.8 years of data from January 2002-October 2019. Wind speeds 10 m above MSL in the Study Area average between 13 and 21 miles per hour (mph) (6 and 9 m/s) annually (**Figure 4.1-2**). Mean wind speed was higher within the Lease Area and open ocean verses closer to shore and within the Long Island Sound.

There are also several NOAA National Data Buoy Center (NOAA NDBC) assets in the region that provide wind data for review. Wind data was taken from Buoy 44017 (Montauk Point), Buoy 44039 (Central Long Island Sound), Station BUZM3 (Buzzards Bay), and Buoy 44020 (Nantucket Sound). Wind data from these locations are collected between 11.5 ft (3.5 m) and 81.4 ft (24.8 m) above MSL with reported speeds at the measured heights. Buoys 44017 and 44039 were selected to represent areas where construction and operation and maintenance vessels will traverse and along the submarine export cable routes, while Station BUZM3 and Buoy 44020 were the closest available to Lease Area. In addition to the NOAA buoys and station, available wind speed data from the Mayflower Wind buoy was reviewed (NOAA 2021c). The Mayflower Wind buoy is located 5.2 mi (4.5 nm, 8.4 km) southeast of the Lease Area. **Figure 4.1-3** depicts their locations.

Based on the aforementioned NOAA NDBC and Mayflower Wind data, **Table 4.1-1** and **Figure 4.1-4** show monthly average wind speed and gust speed for each of the buoys and station. Wind and gust speeds are typically lower in the summer months and higher in the winter. For example, average wind speeds between June and August ranged from 9.0 mph (4.0 m/s) to 14.5 mph (6.5 m/s) with average gusts between 11.5 mph (5.1 m/s) and 15.6 mph (7.0 m/s). Average wind speeds between December and February ranged from 14.0 mph (6.3 m/s) to 20.3 mph (9.1 m/s) with gusts between 18.0 mph (8.1 m/s) to 24.7 mph (11.1 m/s).

Wind roses for NOAA NDBC buoys and station with available wind direction data (Station BUZM3, Buoy 44020, and Buoy 44017) and the Mayflower Wind buoy are provided in and **Figure 4.1-5** and **Figure 4.1-6**. Note, wind directional data was limited to the latest five years available (2016-2020) for the NOAA NDBC buoys for the purposes of creating wind roses and the Mayflower Wind buoy is only from Spring 2021 due to limited wind speed data. As shown, winds are primarily from the southwest from Station BUZM3, Buoy 44020, and the Mayflower Wind buoy, with winds primarily from the southeast from Buoy 44017 (Montauk Point).

Lease Area and Open Ocean Wind Speed

Buoy 44017 is near a likely construction and operation and maintenance vessel route south of Long Island, New York. Average wind speed, measured at 13.5 ft (4.1 m) above site elevation between years 2002 and 2020, ranged from 10.6 mph (4.7 m/s) in July and 19.8 mph (8.9 m/s) in January (NOAA 2020a). Average gusts ranged from 12.8 mph (5.7 m/s) in July and 24.7 mph (11.1 m/s) in January (NOAA 2020a).

Station BUZM3 is approximately 37 mi (32 nm, 60 km) north-northwest of the Lease Area, near the Rhode Island and Massachusetts border and within the Rhode Island Sound. Average wind speed, measured at 81.4 ft (24.8 m) above site elevation between years 2000 and 2020, ranged from 13.2 mph (5.9 m/s) in August and 20.3 mph (9.1 m/s) in December (NOAA 2020d). Average gusts ranged from 14.2 mph (6.3 m/s) in July and 22.7 mph (10.2 m/s) in December (NOAA 2020d).

Buoy 44020 is approximately 26 mi (23 nm, 42 km) north-northeast of the Lease Area, within the Nantucket Sound. Average wind speed, measured at 12.5 ft (3.8 m) above site elevation between years 2009 and 2020, ranged from 12.1 mph (5.4 m/s) in July and 16.8 mph (7.5 m/s) in January (NOAA 2020b). Average gusts ranged from 14.6 mph (6.5 m/s) in July and 20.7 mph (9.2 m/s) in January (NOAA 2020b).

In addition to the NOAA buoys and station, available wind speed data from the Mayflower Wind buoy, measured at 13.1 ft (4 m) above site elevation, was reviewed (NOAA 2021c). These measurements were taken immediately east of the Lease Area (as shown in **Figure 4.1-3**). Data collection began in March 2021 and show similar trends as the NOAA buoy data. That is, the average monthly wind speeds were comparable to the average monthly wind speeds at the evaluated NOAA buoys. Wind gusts measurements were not available. Note that this data has not been quality-assured and measurements that were not deemed reasonable were not included in the evaluation. An example of data seen as not reasonable include negative wind speeds or large spans of the same wind speed that is significantly different than the wind speeds before and after this uniform time span.

Long Island Sound Wind Speed

Buoy 44039 is north of Long Island, approximately 1 mi (0.9 nm, 1.6 km) north of the BW 1 submarine export cable route and the BW2 submarine export cable route to Queens, New York. Average wind speed, measured at 11.5 ft (3.5 m) above site elevation between years 2004 and 2009, ranged from 9.0 mph (4.0 m/s) in July and 15.8 mph (7.1 m/s) in December (NOAA 2019). Average gusts ranged from 11.5 mph (5.1 m/s) in July and 20.3 mph (9.1 m/s) in December (NOAA 2019).

FIGURE 4.1-2. BEACON WIND PROJECT AREA: MEAN WIND SPEED

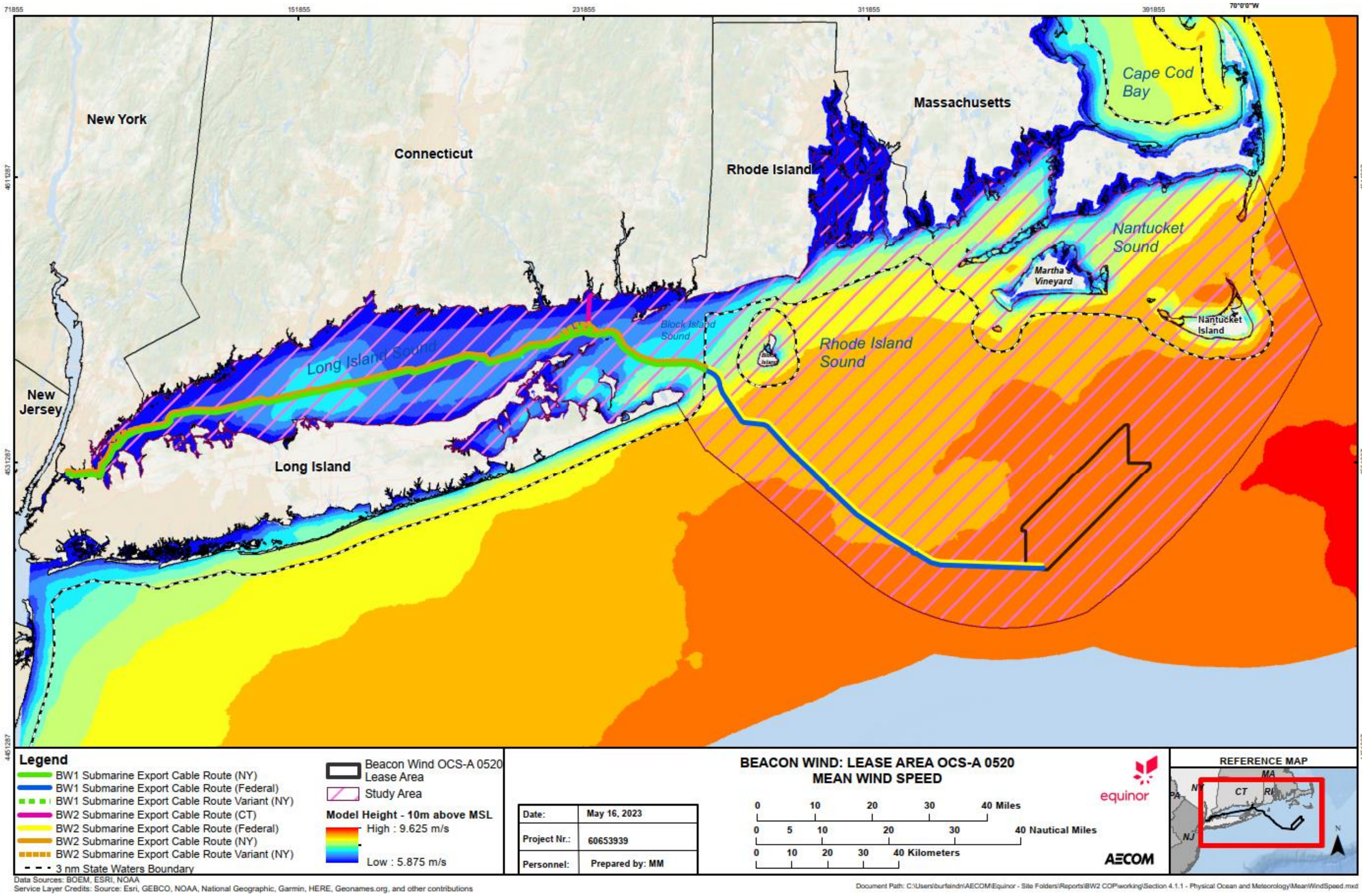


FIGURE 4.1-3. BEACON WIND PROJECT AREA: NOAA NATIONAL DATA CENTER BUOY AND MAYFLOWER WIND BUOY LOCATIONS

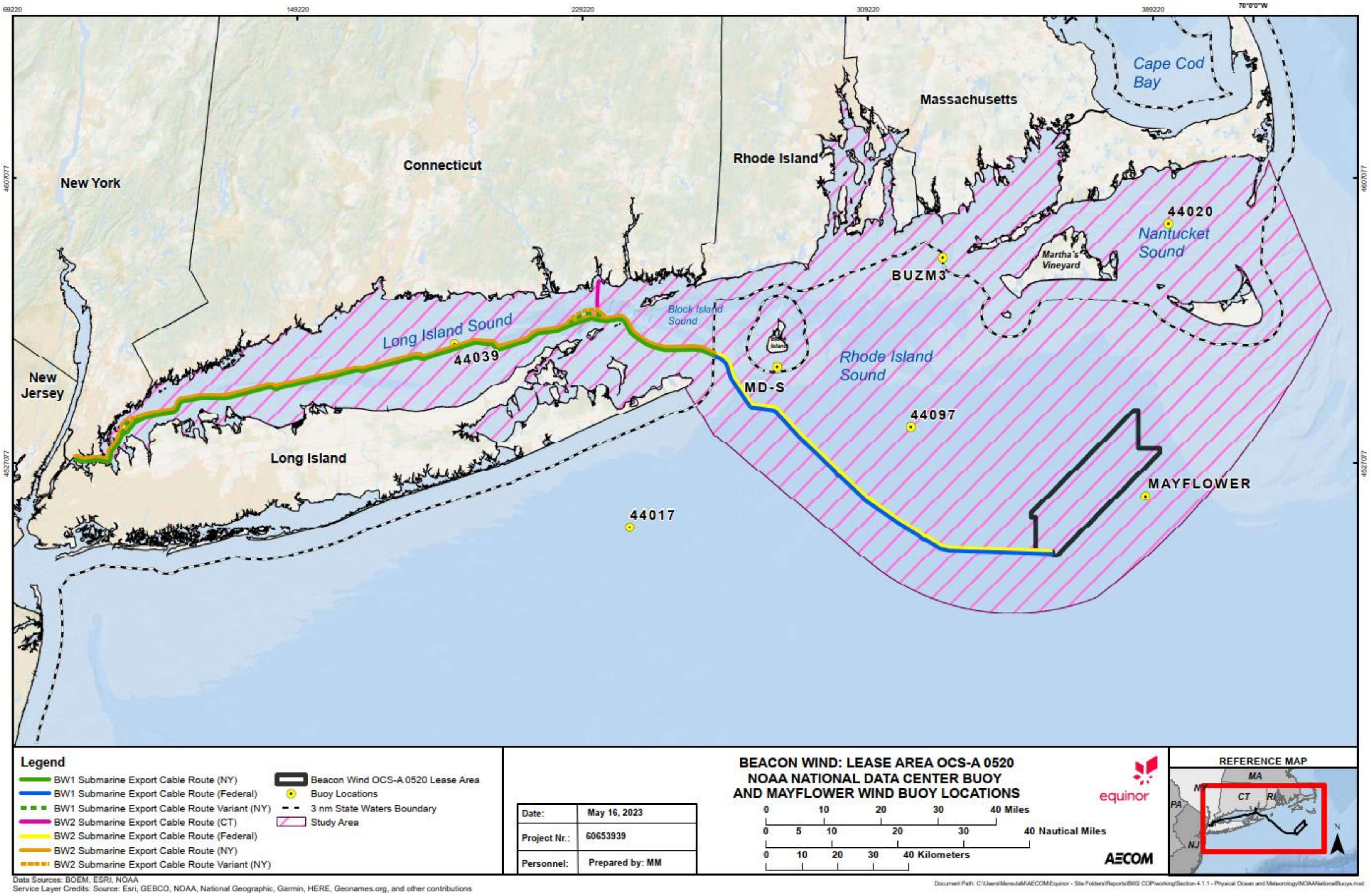
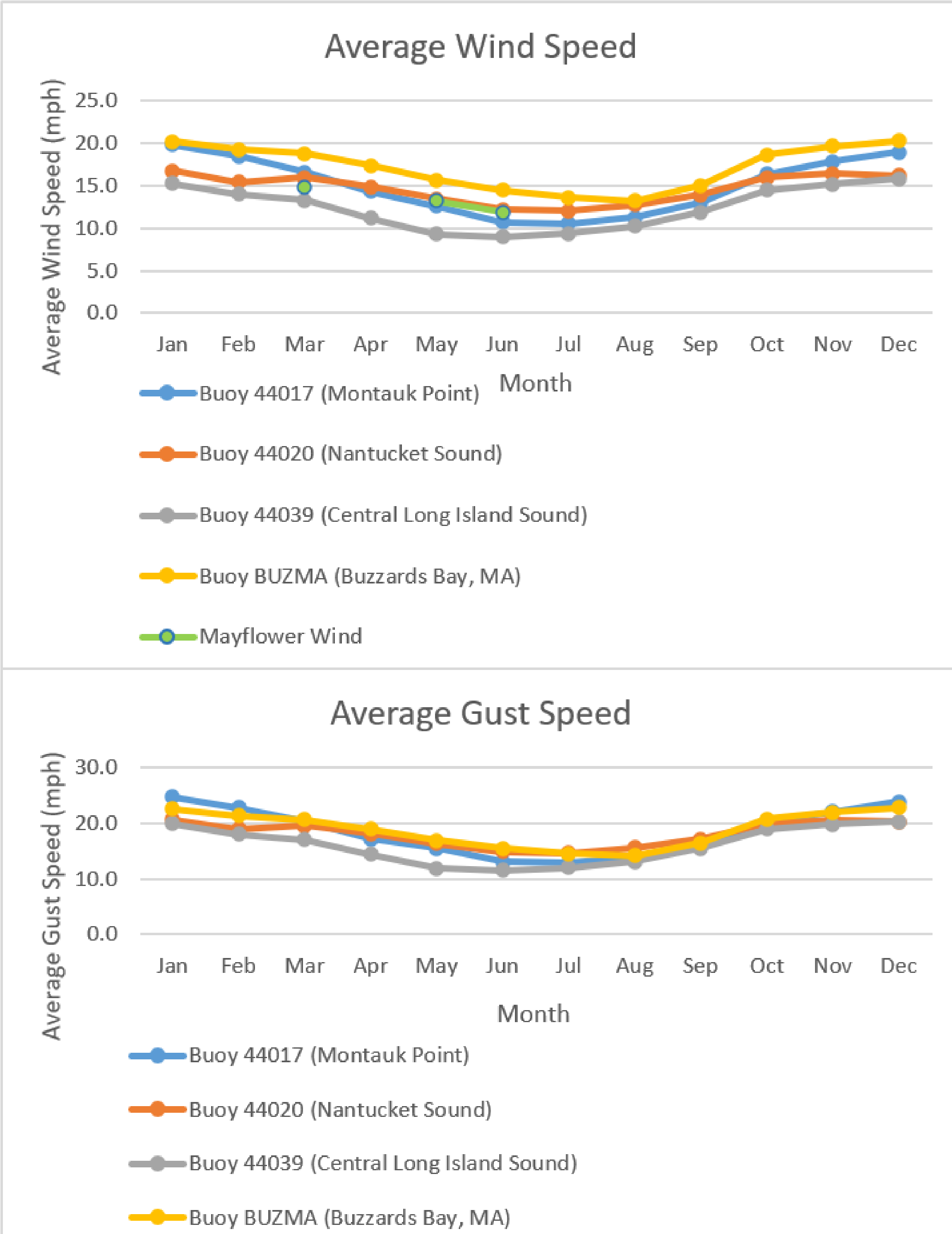


TABLE 4.1-1. BEACON WIND STUDY AREA: AVERAGE WIND SPEED AND AVERAGE GUST SPEED

Average Wind Speed in mph (m/s)															
Buoy	Buoy Name	Years	Measured Height ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area and Open Ocean															
44017	Montauk Point	2002-2010, 2013-2020	13.5 (4.1)	19.8 (8.9)	18.5 (8.3)	16.6 (7.4)	14.3 (6.4)	12.6 (5.6)	10.7 (4.8)	10.6 (4.7)	11.3 (5.0)	13.0 (5.8)	16.3 (7.3)	17.8 (8.0)	18.9 (8.5)
44020	Nantucket Sound	2009-2020	12.5 (3.8)	16.8 (7.5)	15.4 (6.9)	15.9 (7.1)	14.9 (6.7)	13.4 (6.0)	12.2 (5.4)	12.1 (5.4)	12.8 (5.7)	13.9 (6.2)	15.9 (7.1)	16.5 (7.4)	16.2 (7.3)
BUZM3	Buzzards Bay, Massachusetts	2000-2020	81.4 (24.8)	20.2 (9.0)	19.3 (8.6)	18.8 (8.4)	17.4 (7.8)	15.7 (7.0)	14.5 (6.5)	13.6 (6.1)	13.2 (5.9)	15.0 (6.7)	18.6 (8.3)	19.6 (8.8)	20.3 (9.1)
Mayflower Wind		2021	13.1 (4)	---	---	14.8 (6.6)	---	13.2 (5.9)	11.9 (5.3)	---	---	---	---	---	---
Long Island Sound															
44039	Central Long Island Sound	2004-2019	11.5 (3.5)	15.2 (6.8)	14.0 (6.3)	13.3 (5.9)	11.2 (5.0)	9.3 (4.2)	9.0 (4.0)	9.4 (4.2)	10.2 (4.6)	11.9 (5.3)	14.5 (6.5)	15.1 (6.8)	15.8 (7.1)
Average Gust Speed in mph (m/s)															
Buoy	Buoy Name	Years	Measured Height ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area and Open Ocean															
44017	Montauk Point	2002-2010, 2013-2020	13.5 (4.1)	24.7 (11.1)	22.8 (10.2)	20.2 (9.0)	17.2 (7.7)	15.4 (6.9)	13.0 (5.8)	12.8 (5.7)	13.7 (6.1)	16.0 (7.1)	20.3 (9.1)	22.1 (9.9)	23.9 (10.7)
44020	Nantucket Sound	2009-2020	12.5 (3.8)	20.7 (9.2)	18.9 (8.5)	19.5 (8.7)	18.1 (8.1)	16.4 (7.3)	14.8 (6.6)	14.6 (6.5)	15.6 (7.0)	17.2 (7.7)	19.8 (8.9)	20.6 (9.2)	20.2 (9.1)
BUZM3	Buzzards Bay, Massachusetts	2000-2020	81.4 (24.8)	22.6 (10.1)	21.3 (9.5)	20.6 (9.2)	18.9 (8.4)	16.9 (7.6)	15.5 (6.9)	14.5 (6.5)	14.2 (6.3)	16.4 (7.3)	20.7 (9.3)	21.9 (9.8)	22.7 (10.2)
Long Island Sound															
44039	Central Long Island Sound	2004-2019	11.5 (3.5)	19.9 (8.9)	18.0 (8.1)	17.1 (7.6)	14.4 (6.5)	11.8 (5.3)	11.5 (5.1)	12.0 (5.4)	13.1 (5.9)	15.4 (6.9)	18.9 (8.5)	19.8 (8.9)	20.3 (9.1)

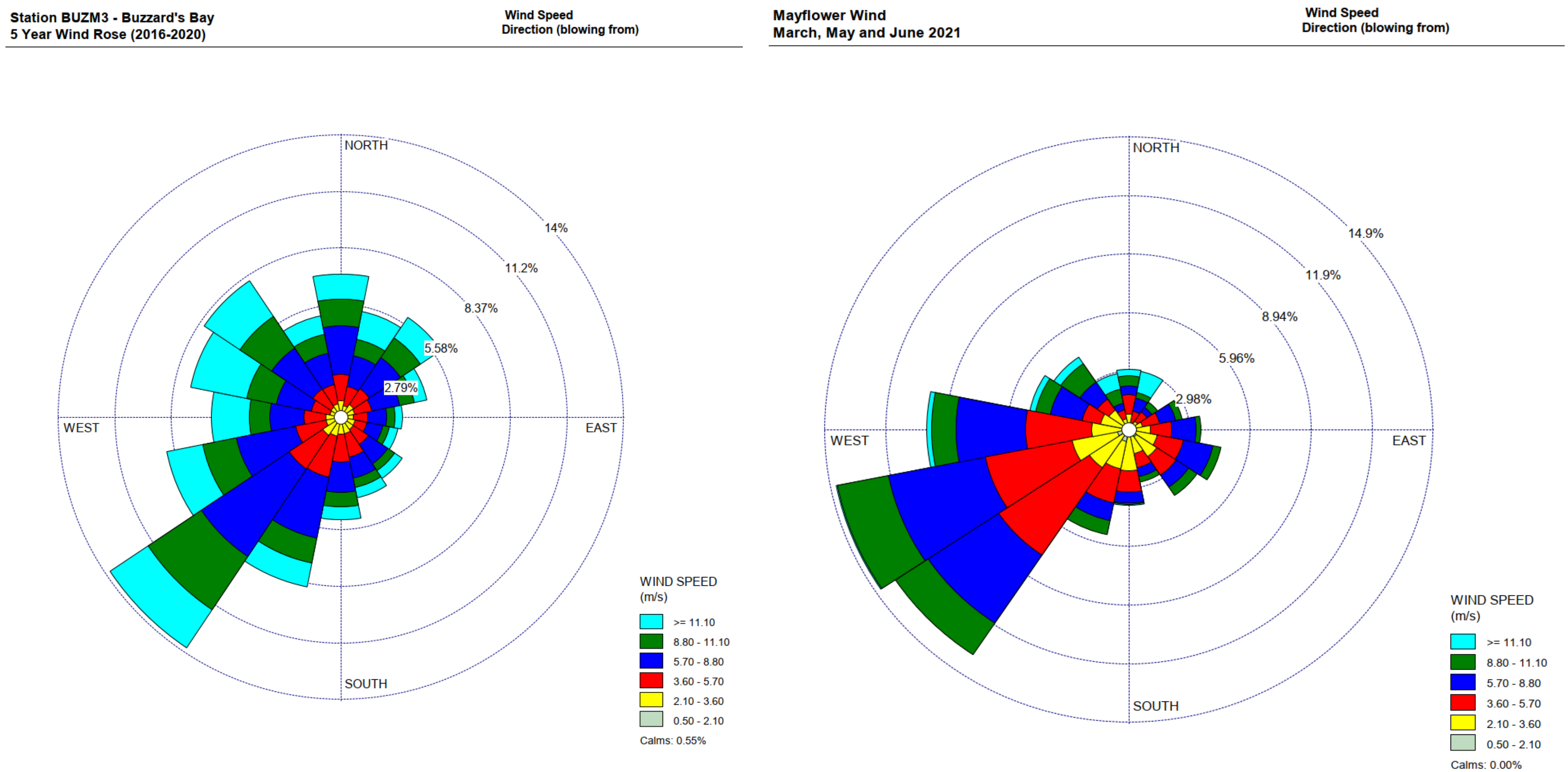
Note:
--- Signifies data was either unavailable or was outside of reasonable range and, thus, assumed to be inaccurate.
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-4. AVERAGE WIND SPEED AND AVERAGE GUST SPEED



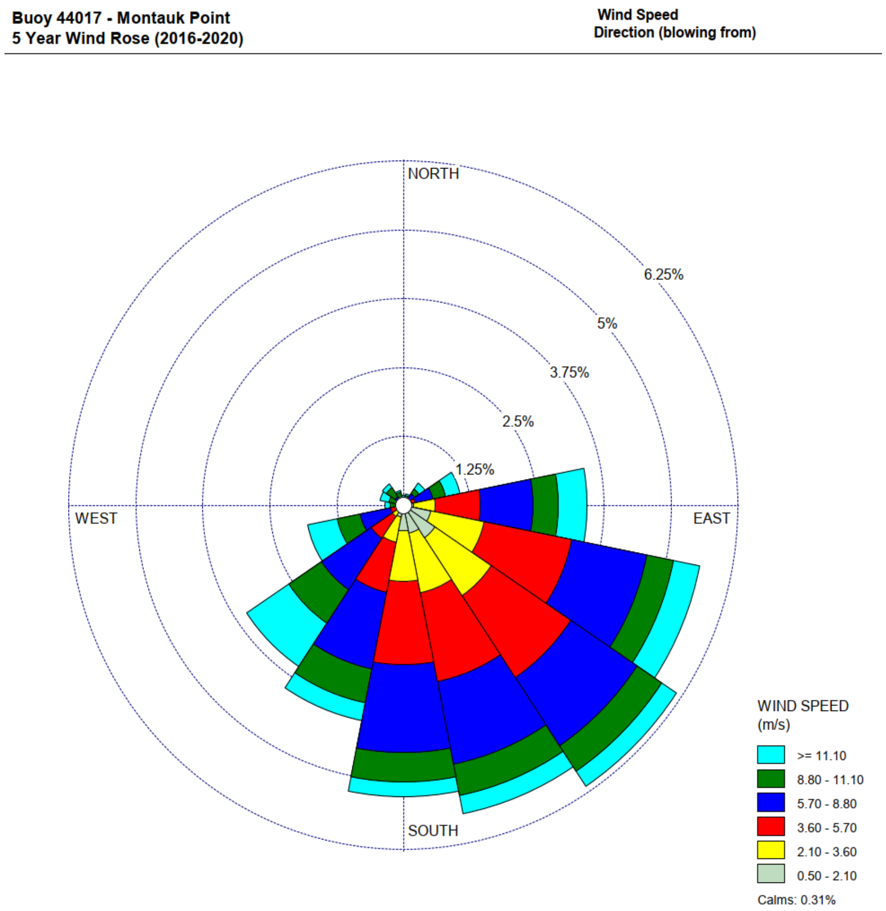
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

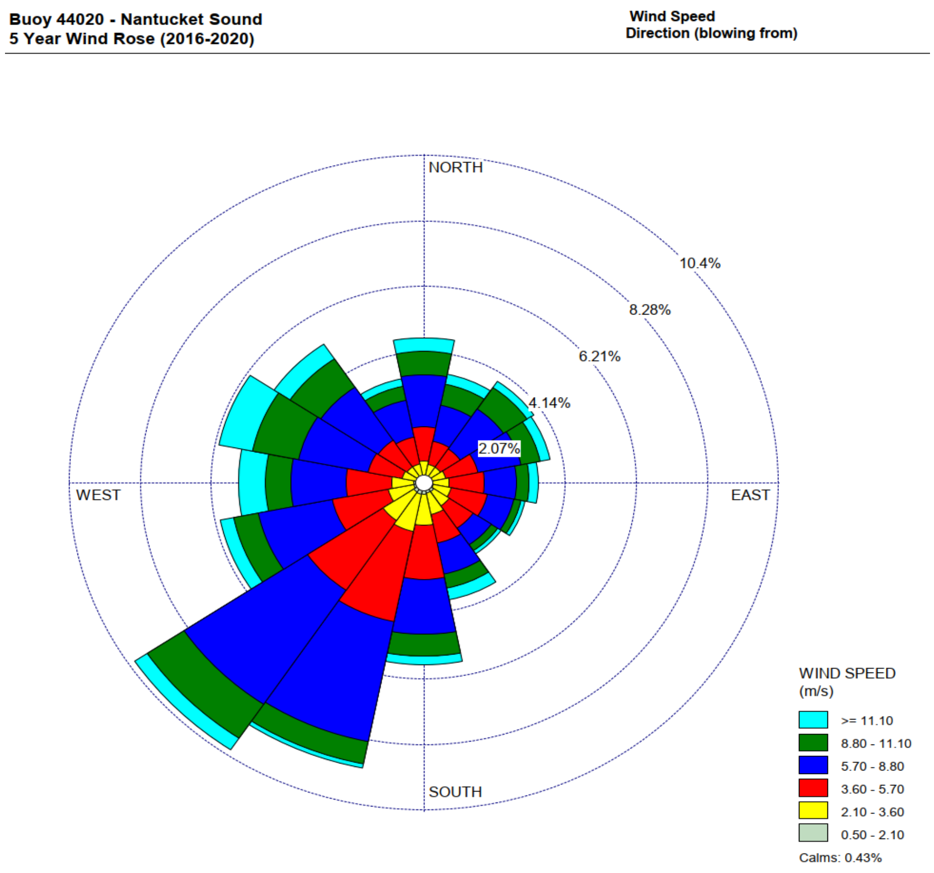
FIGURE 4.1-5. WIND ROSES AT BUOYS



Source: NOAA National Data Buoy Center [https://www.ndbc.noaa.gov/] and Mayflower Wind (NOAA IOOS NERACOOS) http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html

FIGURE 4.1-6. WIND ROSES AT BUOYS





Source: NOAA National Data Buoy Center [https://www.ndbc.noaa.gov/] and Mayflower Wind (NOAA IOOS NERACOOS) http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html

4.1.1.1.2 *Waves*

Wave data was taken from the Global Reanalysis of Ocean Waves U.S. East Coast dataset (GROW-FINE EC5km), provided by Oceanweather Inc., and consists of data from January 1979 to December 2018 (40 years) (GROW-FINE EC5km 2018). Significant wave height is the mean wave height (trough to crest) of the highest third of the waves over a given time period. In the vicinity of the Lease Area, annual average significant wave height ranges from 4.3 to 7.2 ft (1.3 to 2.2 m) over the 40-year hindcast with a sample interval of 1 hour. Specifically, monthly average significant wave heights are greater during winter months, with average heights up to 7.2 ft (2.2 m) in January, and less during summer months, with average heights up to 4.3 ft (1.3 m) in June through August. Significant wave height maximums of the 1 hour intervals in the Lease Area region range from 14.4 to 37.4 ft (4.4 to 11.4 m) annually. Significant wave heights within the Lease Area over the 40-year hindcast are shown in **Table 4.1-2** (GROW-FINE EC5km 2018).

To further confirm this analysis, wave height data from NOAA NDBC Buoys 44017, 44020, 44039, 44097, and Station BUZM3 were analyzed (**Table 4.1-3** and **Figure 4.1-7**). Buoy 44097, chosen due to proximity to Lease Area, is located approximately 24 mi (21 nm, 39 km) northwest of the Lease Area, south of the Rhode Island Sound (see **Figure 4.1-3**). These buoys provide wave heights as close as 24 mi (21 nm, 39 km) of the Lease Area and along the vessel and cable routes. The buoys measured larger wave heights in the winter months, with the largest monthly wave heights occurring at buoys 44017 and 44097, which are furthest offshore. These buoys saw maximum average monthly wave heights of 5.5 ft (1.7 m) and 6 ft (1.8 m). The more protected Buoy 44039 saw a smaller maximum monthly average wave height of 2.1 ft (0.6 m). The higher wave heights measured at the buoys in the less protected, offshore locations align with the analysis provided by the GROW-FINE EC5km data.

The Mayflower Wind buoy wave height measurements were also reviewed and included in **Table 4.1-3** for comparisons. Significant wave heights at this buoy generally followed similar patterns as the NOAA buoys, except during June and December when significant wave heights were much larger at the Mayflower Wind buoy. In June, average significant wave height was 7.4 ft (2.3 m), while maximum average wave height at the other evaluated buoys was 3.3 ft (1.0 m). In December the average significant wave height was 7.4 ft (2.2 m), while maximum average at the other evaluated buoys was 5.8 ft (1.8 m). This could be due to storms during the measurement period for which the related data were not reduced through averaging over a larger data set. The wave data from the NOAA NDBC buoys are averaged over 5 to 20 years, whereas the wave data collected at the Mayflower Wind buoy is only from March 2020 through July 2021 (note: Mayflower Wind buoy wave height data was determined to not be complete for October 2020 and, thus, was not included). The wave height data described in this and the previous paragraph consistent with information from NOAA’s Office for Coastal Management Wave Energy Period data (Office for Coastal Management 2021), as shown in **Figure 4.1-8**. Based on this data, which represent monthly summaries for the time period from January 1980 to December 2009 (30 years), the annual mean significant wave height in the Lease Area is in the range of 4.7-5.3 ft (1.4-1.6 m).

In terms of wave direction, waves in the less protected, offshore locations are primarily from the south (southeast [135 degrees] through southwest [225 degrees]) throughout the year. Waves within the Nantucket Sound are more variable in direction depending on the season, with more southerly direction in Spring and Summer months and northerly in the Fall and Winter months. This is shown in **Table 4.1-4**, which includes monthly average wave direction from the aforementioned NOAA buoys. A wave direction rose for Buoy 44097, also known as Station 154 and provided by the Coastal Data Information Program (CDIP) through University of California - San Diego (CDIP 2021), also indicates that wave trends near the Lease Area are from the south (**Figure 4.1-9**). Note the wave direction rose spans only 2017 through 2020 based on a limited amount of data allowed for wave rose generation.

Table 4.1-2. Monthly and Annual Sample Distributions of Non-Exceedance (Percent) of Significant Wave Height Near OCS-A 0520 Lease Area based on 40 years of Data

Hs	Month												All-Year
ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
< 1.6 (0.5)	2.92 (0.89)	2.85 (0.87)	3.51 (1.07)	1.90 (0.58)	1.12 (0.34)	0.52 (0.16)	0.13 (0.04)	0.00 (0.00)	0.52 (0.16)	2.30 (0.70)	3.31 (1.01)	2.95 (0.90)	**1.84 (0.56)**
< 3.3 (1.0)	35.43 (10.80)	43.47 (13.25)	52.92 (16.13)	58.79 (17.92)	73.20 (22.31)	92.09 (28.07)	90.78 (27.67)	97.15 (29.61)	63.65 (19.40)	58.73 (17.90)	46.46 (14.16)	41.31 (12.59)	**62.96 (19.19)**
< 4.9 (1.5)	101.57 (30.96)	110.33 (33.63)	130.22 (39.69)	159.02 (48.47)	211.65 (64.51)	241.08 (73.48)	251.21 (76.57)	249.41 (76.02)	190.78 (58.15)	160.40 (48.89)	128.08 (39.04)	110.10 (33.56)	**170.67 (52.02)**
< 6.6 (2.0)	168.60 (51.39)	178.31 (54.35)	196.10 (59.77)	229.89 (70.07)	281.10 (85.68)	297.34 (90.63)	307.41 (93.70)	299.87 (91.40)	265.75 (81.00)	236.94 (72.22)	199.64 (60.85)	174.11 (53.07)	**236.55 (72.1)**
< 8.2 (2.5)	221.49 (67.51)	234.22 (71.39)	244.13 (74.41)	276.31 (84.22)	307.64 (93.77)	319.52 (97.39)	322.24 (98.22)	317.32 (96.72)	300.75 (91.67)	278.35 (84.84)	247.28 (75.37)	225.92 (68.86)	**274.77 (83.75)**
< 9.8 (3.0)	258.60 (78.82)	272.47 (83.05)	279.17 (85.09)	301.48 (91.89)	320.64 (97.73)	325.59 (99.24)	326.38 (99.48)	324.31 (98.85)	315.16 (96.06)	300.33 (91.54)	279.79 (85.28)	264.24 (80.54)	**297.44 (90.66)**
< 11.5 (3.5)	285.86 (87.13)	297.47 (90.67)	301.15 (91.79)	315.03 (96.02)	325.79 (99.30)	327.33 (99.77)	327.53 (99.83)	326.61 (99.55)	321.46 (97.98)	311.78 (95.03)	301.31 (91.84)	289.73 (88.31)	**310.96 (94.78)**
< 13.1 (4.0)	305.45 (93.10)	312.11 (95.13)	313.75 (95.63)	322.11 (98.18)	327.56 (99.84)	327.85 (99.93)	327.76 (99.90)	327.33 (99.77)	324.41 (98.88)	319.62 (97.42)	314.30 (95.80)	306.79 (93.51)	**319.09 (97.26)**
< 14.8 (4.5)	316.99 (96.62)	320.05 (97.55)	320.87 (97.80)	325.39 (99.18)	328.08 (100.0)	327.95 (99.96)	327.85 (99.93)	327.53 (99.83)	326.31 (99.46)	323.75 (98.68)	321.42 (97.97)	317.75 (96.85)	**323.69 (98.66)**
< 16.4 (5.0)	322.97 (98.44)	324.51 (98.91)	323.85 (98.71)	327.10 (99.70)		328.08 (100.0)	327.92 (99.95)	327.69 (99.88)	327.00 (99.67)	325.92 (99.34)	324.87 (99.02)	323.46 (98.59)	**325.95 (99.35)**
< 18.0 (5.5)	325.62 (99.25)	327.03 (99.68)	325.69 (99.27)	327.76 (99.90)			327.99 (99.97)	327.76 (99.9)	327.40 (99.79)	326.80 (99.61)	326.64 (99.56)	325.69 (99.27)	**327.03 (99.68)**
< 19.7 (6.0)	327.17 (99.72)	327.69 (99.88)	326.74 (99.59)	327.92 (99.95)			328.05 (99.99)	327.79 (99.91)	327.56 (99.84)	327.20 (99.73)	327.49 (99.82)	326.67 (99.57)	**327.53 (99.83)**
< 21.3 (6.5)	327.79 (99.91)	327.92 (99.95)	327.59 (99.85)	328.02 (99.98)			328.08 (100.0)	327.85 (99.93)	327.76 (99.9)	327.56 (99.84)	327.85 (99.93)	327.26 (99.75)	**327.82 (99.92)**
< 23.0 (7.0)	328.02 (99.98)	328.02 (99.98)	327.89 (99.94)	328.08 (100.0)				327.85 (99.93)	327.89 (99.94)	327.99 (99.97)	328.05 (99.99)	327.59 (99.85)	**327.95 (99.96)**
< 24.6 (7.5)	328.05 (99.99)	328.08 (100.0)	327.95 (99.96)					327.89 (99.94)	327.92 (99.95)	328.02 (99.98)	328.08 (100.0)	327.76 (99.9)	**328.02 (99.98)**
< 26.2 (8.0)	328.08 (100.0)		327.99 (99.97)					327.92 (99.95)	327.99 (99.97)	328.02 (99.98)		327.99 (99.97)	**328.05 (99.99)**
< 27.9 (8.5)			327.99 (99.97)					327.95 (99.96)	328.05 (99.99)	328.05 (99.99)		328.08 (100.0)	**328.05 (99.99)**

Hs	Month												All-Year
ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
< 29.5 (9.0)			328.05 (99.99)					328.02 (99.98)	328.08 (100.0)	328.08 (100.0)			**328.08 (100.0)**
< 31.2 (9.5)			328.08 (100.0)					328.05 (99.99)					**328.08 (100.0)**
< 32.8 (10.0)								328.05 (99.99)					**328.08 (100.0)**
< 34.4 (10.5)								328.05 (99.99)					**328.08 (100.0)**
< 36.1 (11.0)								328.08 (100.0)					**328.08 (100.0)**
< 37.7 (11.5)								328.08 (100.0)					**328.08 (100.0)**
Total	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**	**328.08 (100.0)**
Mean	**7.22 (2.2)**	**6.89 (2.1)**	**6.56 (2.0)**	**5.58 (1.7)**	**4.59 (1.4)**	**4.27 (1.3)**	**4.27 (1.3)**	**4.27 (1.3)**	**4.92 (1.5)**	**5.58 (1.7)**	**6.23 (1.9)**	**6.89 (2.1)**	**5.58 (1.7)**
Maximum	**24.61 (7.5)**	**23.62 (7.2)**	**30.18 (9.2)**	**22.64 (6.9)**	**14.44 (4.4)**	**16.40 (5.0)**	**21.65 (6.6)**	**37.40 (11.4)**	**29.20 (8.9)**	**28.87 (8.8)**	**23.29 (7.1)**	**27.89 (8.5)**	**37.40 (11.4)**

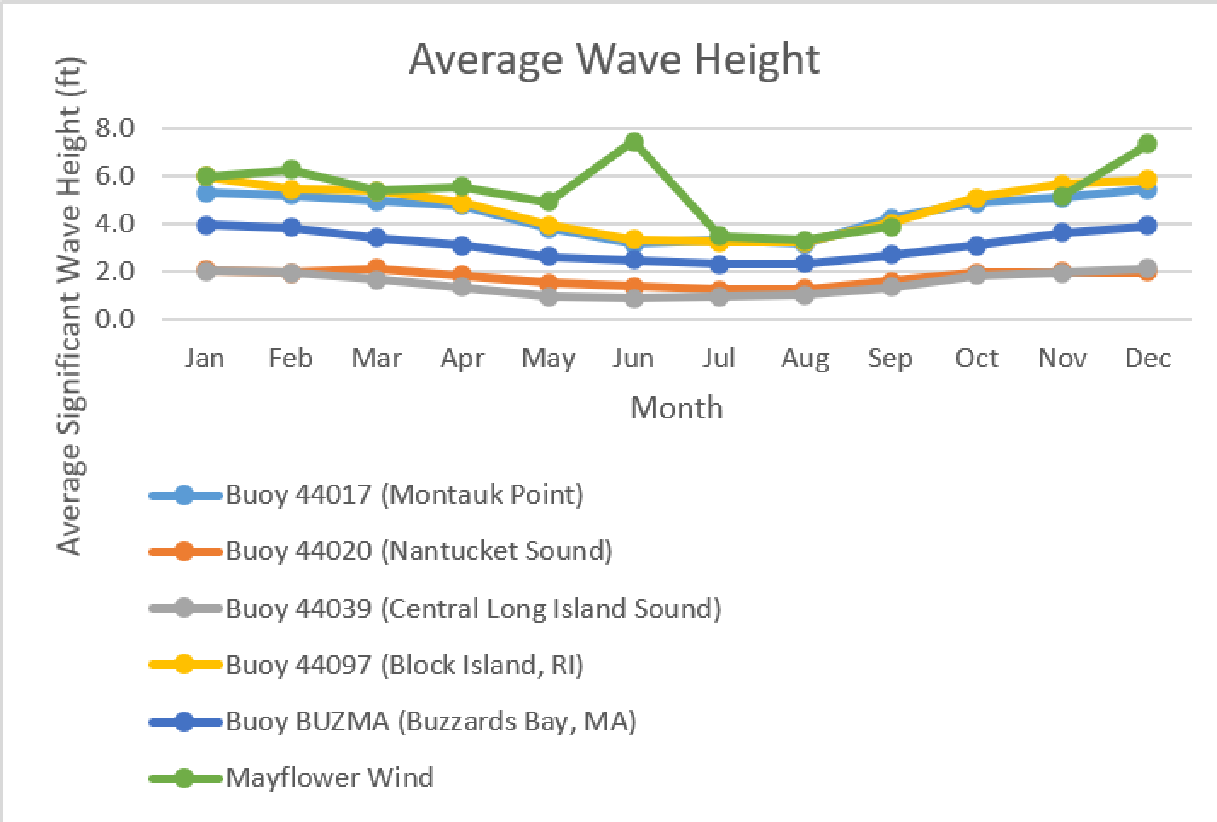
Source: (GROW-FINE EC5km 2018)

TABLE 4.1-3. MONTHLY AVERAGE SIGNIFICANT WAVE HEIGHT AT BUOYS

			Average Wave Height in ft (m)											
Buoy	**Buoy Name**	**Years**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Lease Area and Open Ocean														
44017	Montauk Point	2002-2011, 2013-2020	5.3 (1.6)	5.2 (1.6)	5.0 (1.5)	4.8 (1.5)	3.8 (1.2)	3.2 (1.0)	3.3 (1.0)	3.1 (1.0)	4.2 (1.3)	4.9 (1.5)	5.1 (1.6)	5.5 (1.7)
44020	Nantucket Sound	2009-2020	2.1 (0.6)	1.9 (0.6)	2.1 (0.6)	1.8 (0.6)	1.5 (0.5)	1.4 (0.4)	1.2 (0.4)	1.2 (0.4)	1.6 (0.5)	1.9 (0.6)	2.0 (0.6)	2.0 (0.6)
44097	Block Island, Rhode Island	2009-2020	6.0 (1.8)	5.5 (1.7)	5.4 (1.6)	4.9 (1.5)	3.9 (1.2)	3.3 (1.0)	3.2 (1.0)	3.2 (1.0)	4.0 (1.2)	5.1 (1.6)	5.7 (1.7)	5.8 (1.8)
BUZM3	Buzzards Bay, Massachusetts	2000-2003, 2005-2006	3.9 (1.2)	3.8 (1.2)	3.4 (1.0)	3.1 (0.9)	2.6 (0.8)	2.5 (0.8)	2.3 (0.7)	2.3 (0.7)	2.7 (0.8)	3.1 (0.9)	3.6 (1.1)	3.9 (1.2)
Mayflower Wind		March 2020-July 2021	6.0 (1.8)	6.3 (1.9)	5.4 (1.6)	5.6 (1.7)	4.9 (1.5)	7.4 (2.3)	3.5 (1.1)	3.3 (1.0)	3.9 (1.2)	---	5.2 (1.6)	7.4 (2.2)
Long Island Sound														
44039	Central Long Island Sound	2006-2017	2.0 (0.6)	1.9 (0.6)	1.6 (0.5)	1.3 (0.4)	0.9 (0.3)	0.9 (0.3)	0.9 (0.3)	1.0 (0.3)	1.3 (0.4)	1.8 (0.6)	1.9 (0.6)	2.1 (0.6)

Note:
--- Signifies data was either unavailable or was outside of reasonable range and thus assumed to be inaccurate.
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-7. AVERAGE SIGNIFICANT WAVE HEIGHT AT BUOYS



Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-8. BEACON WIND PROJECT AREA: SIGNIFICANT WAVE HEIGHT ANNUAL MEAN

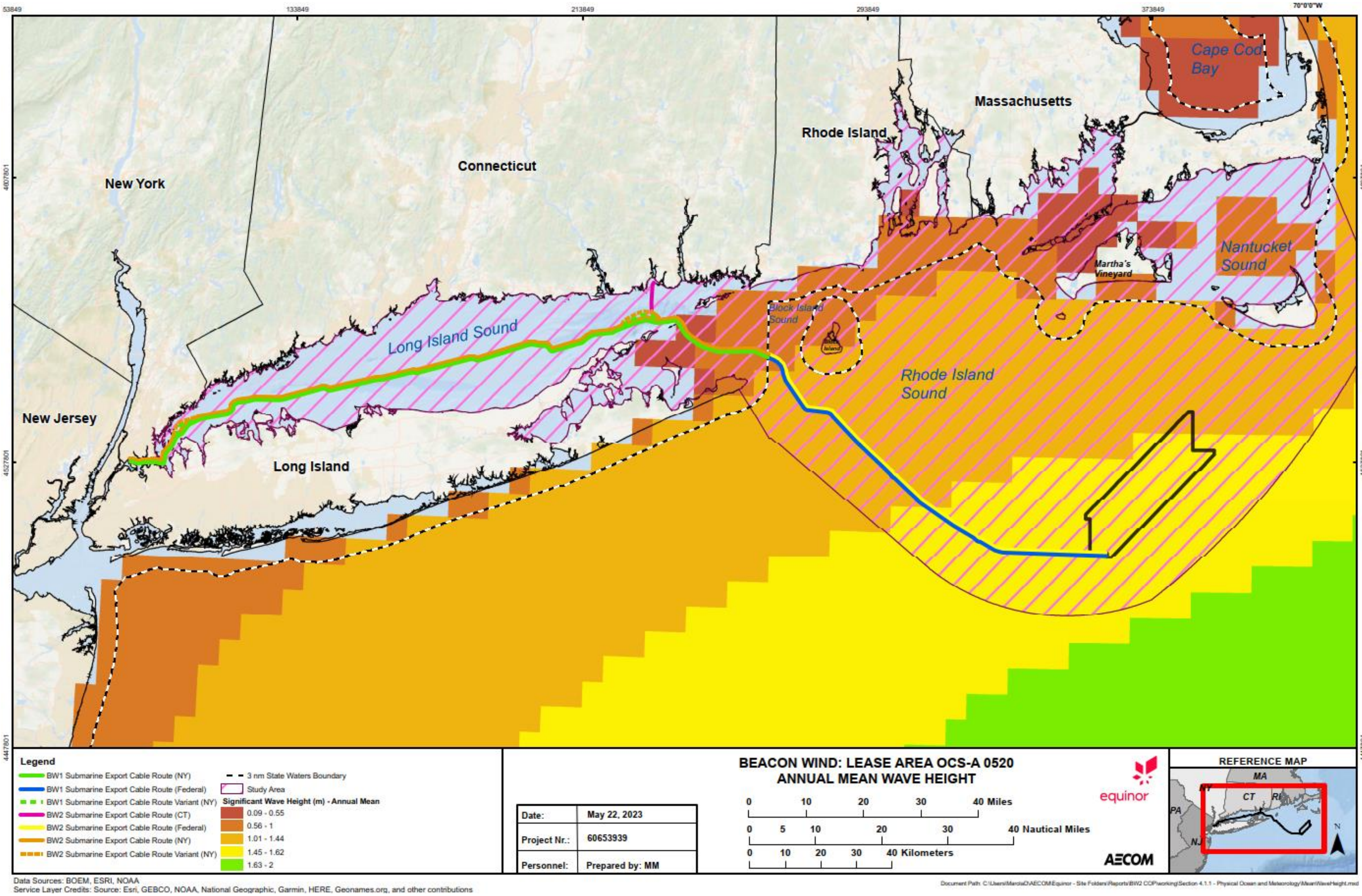
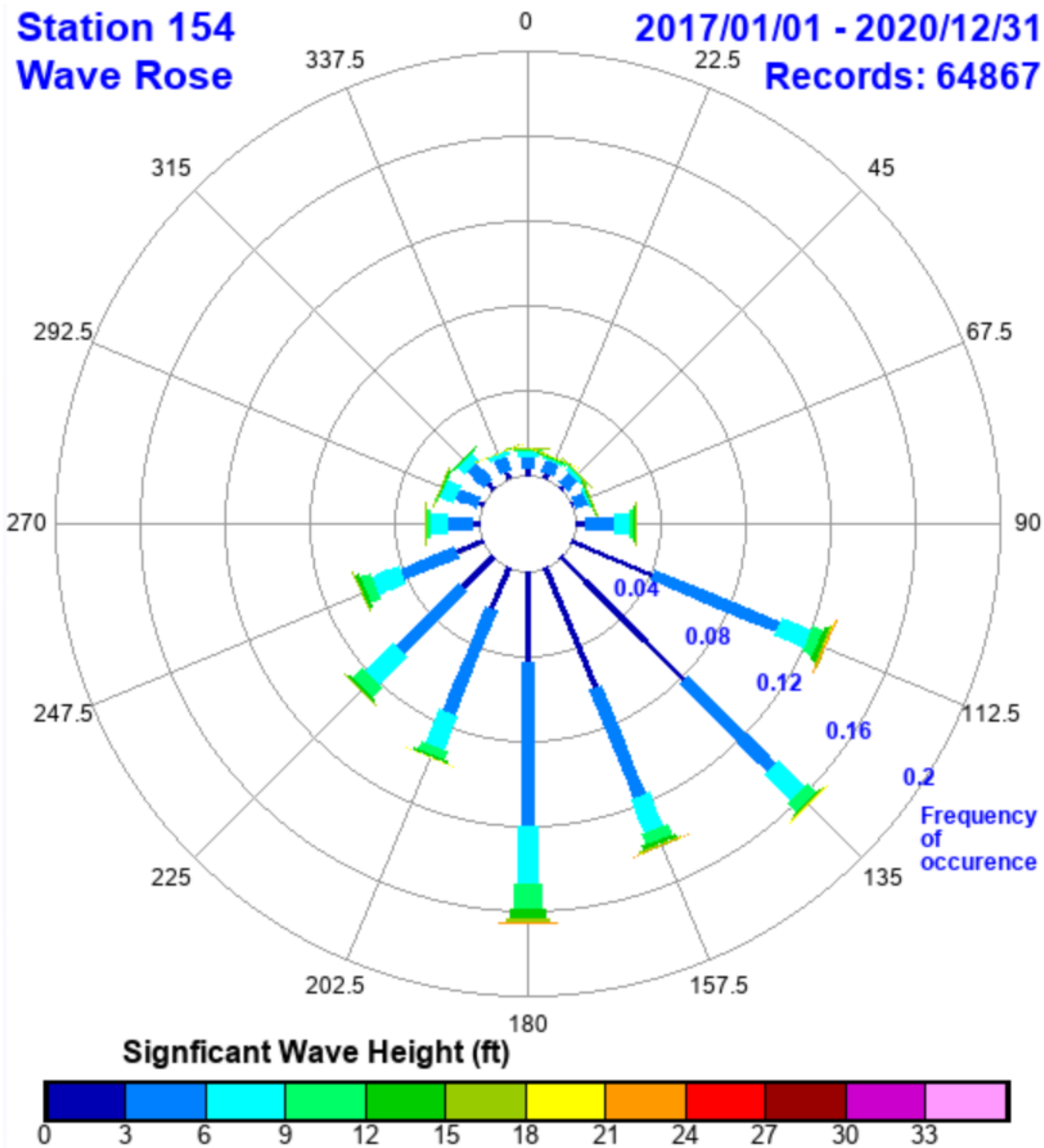


TABLE 4.1-4. AVERAGE WAVE DIRECTION AT BUOYS

Average Wave Direction in Degrees														
Buoy	**Buoy Name**	**Years**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
44017	Montauk Point	2008-2009, 2013-2020	179	173	151	149	151	154	164	156	135	146	162	167
44020	Nantucket Sound	2009-2020	288	287	357	104	137	156	217	213	68	5	304	296
44097	Block Island, Rhode Island	2009-2020	211	196	178	174	172	173	184	174	155	174	193	201
Mayflower Wind		March 2020-July 2021	221	167	176	192	190	171	179	194	135	---	221	228

Note:
--- Signifies data was either unavailable or was outside of reasonable range and thus assumed to be inaccurate.
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-9. BUOY 44097 ROSE DETAILING SIGNIFICANT WAVE HEIGHT AND DIRECTION



4.1.1.1.3 *Currents*

The Lease Area is located within the Mid-Atlantic Bight, which extends from Cape Hatteras, North Carolina to the Cape Cod region of Massachusetts. The Mid-Atlantic Bight is a coastal region where both warmer tropical waters brought northward by the Gulf Stream and cooler arctic waters flowing southward via the Labrador Current can be observed (see **Figure 4.1-10**). Current data taken from UKHO (2009, **Figure 4.1-11** and **Figure 4.1-12**) show the currents in the Lease Area are generally neither strong nor constant and are mainly the result of strong and persistent winds and the southwest extension of the Labrador Current. **Figure 4.1-11** illustrates the predominate current direction, consistency, and mean rate during the winter and **Figure 4.1-12** illustrates the same parameters for summer months. The mean rate of the currents is between 1.0 feet per second (ft/s) (0.3 m/s) and 1.6 ft/s (0.5 m/s), with less than 15 percent of observations reporting 2.0 ft/s (0.6 m/s) and only a very few exceeding 3.3 ft/s (1.0 m/s) (UKHO 2009).

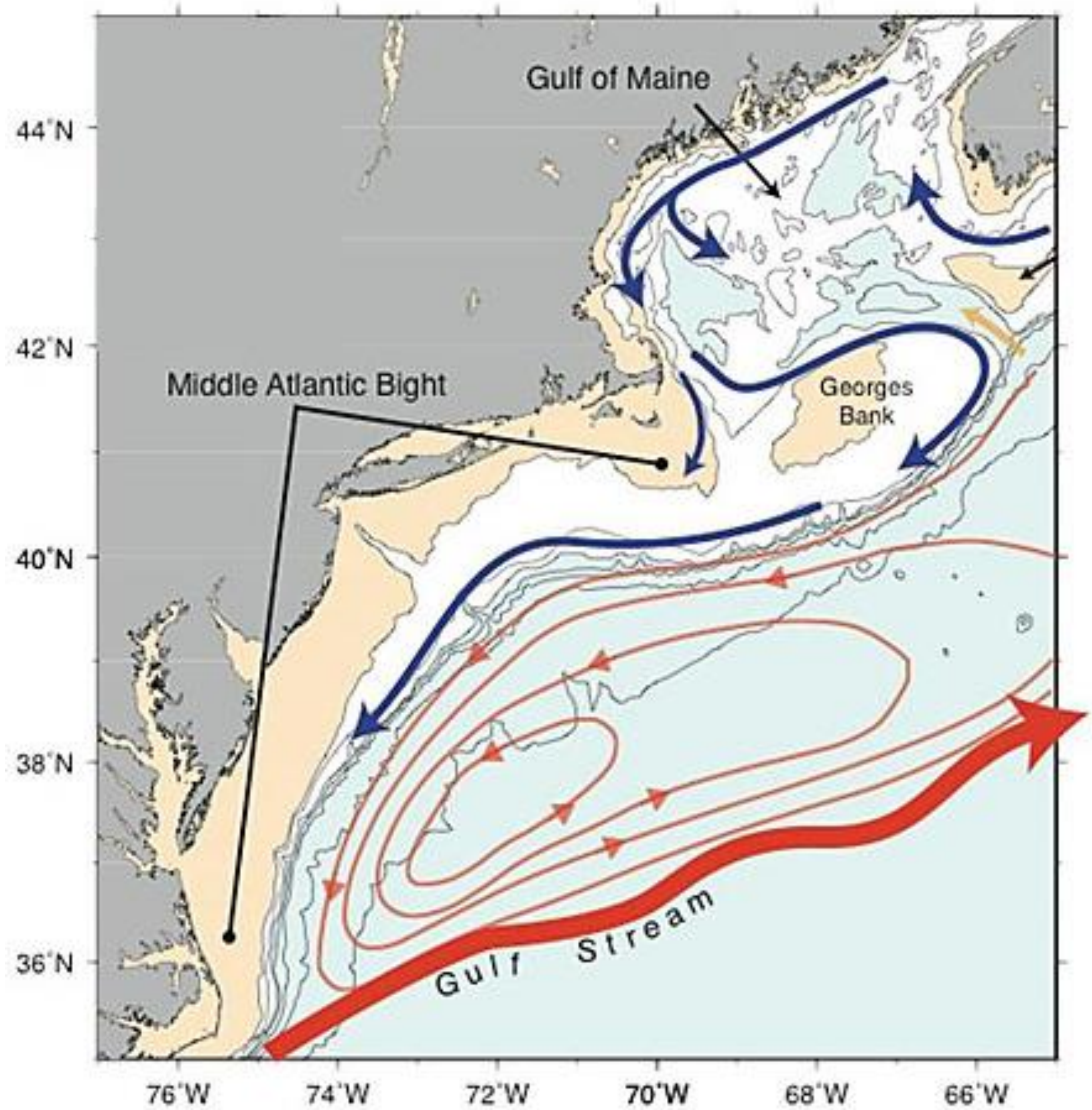
Current data from a location within Long Island Sound and a location just south of Block Island, Rhode Island were collected to further understand water currents within the Study Area. Both datasets were collected using semi-permanent moorings outfitted with Acoustic Doppler Current Profilers (ADCPs), which measure the magnitude and direction of velocity at defined depth increments through the water column. As part of the University of Connecticut's Long Island Sound Integrated Coastal Observing System (LISICOS), a series of moorings are deployed throughout the Long Island Sound to collect a suite of measurements, including atmospheric, wave, current, and nutrient data. Buoy 44039 is also a LISICOS mooring (referred to as "CLIS Buoy") and was outfitted with a surface-mounted RDI 600kHz ADCP unit, which measures currents through the approximately 98 ft (30 m) of depth at the mooring's location. Observed current profile measurements collected at this mooring during the months of December 2018 to February 2019 were provided by the principal investigator of the LISICOS project, Dr. James O'Donnell of the University of Connecticut (O'Donnell 2021). A similar dataset was collected from a mooring just south of Block Island as part of the Rhode Island Ocean Special Area Management Plan (OSAMP) initiative. As part of the data collection efforts in support of the OSAMP project, several moorings were deployed within Rhode Island State Territorial Waters between 2009 and 2010. These moorings were outfitted with ADCP sensors that collected depth-variable velocity profiles through the water column at the mooring location. While several buoys were deployed as part of this project, data from only one of the moorings (MD-S Buoy) is publicly available, with observed currents between October 2009 and October 2010 (OSAMP 2010).

Figure 4.1-13 and **Figure 4.1-14** show depth-averaged current roses within the Long Island Sound (CLIS Buoy) and just south of Block Island, Rhode Island (MD-S Buoy). Currents generally flow east-west and have a mean speed of less than 1.0 ft/s (0.3 m/s) (see also Table 4.1-5 for monthly mean speed).

The Mayflower Wind buoy also collected current data. The data from this buoy were available through NERACOOS (NOAA 2021c). This buoy began reporting real-time current data at 3.3 ft (1 m) depth increments in May of 2021. **Figure 4.1-15** depicts the depth-averages current rose for the Mayflower Wind buoy between September 1, 2021 and October 1, 2021 and shows a more variable current direction but a similar mean current speed of approximately 0.6 ft/s (0.2 m/s) (also included in **Table 4.1-5**) (NOAA 2021c).

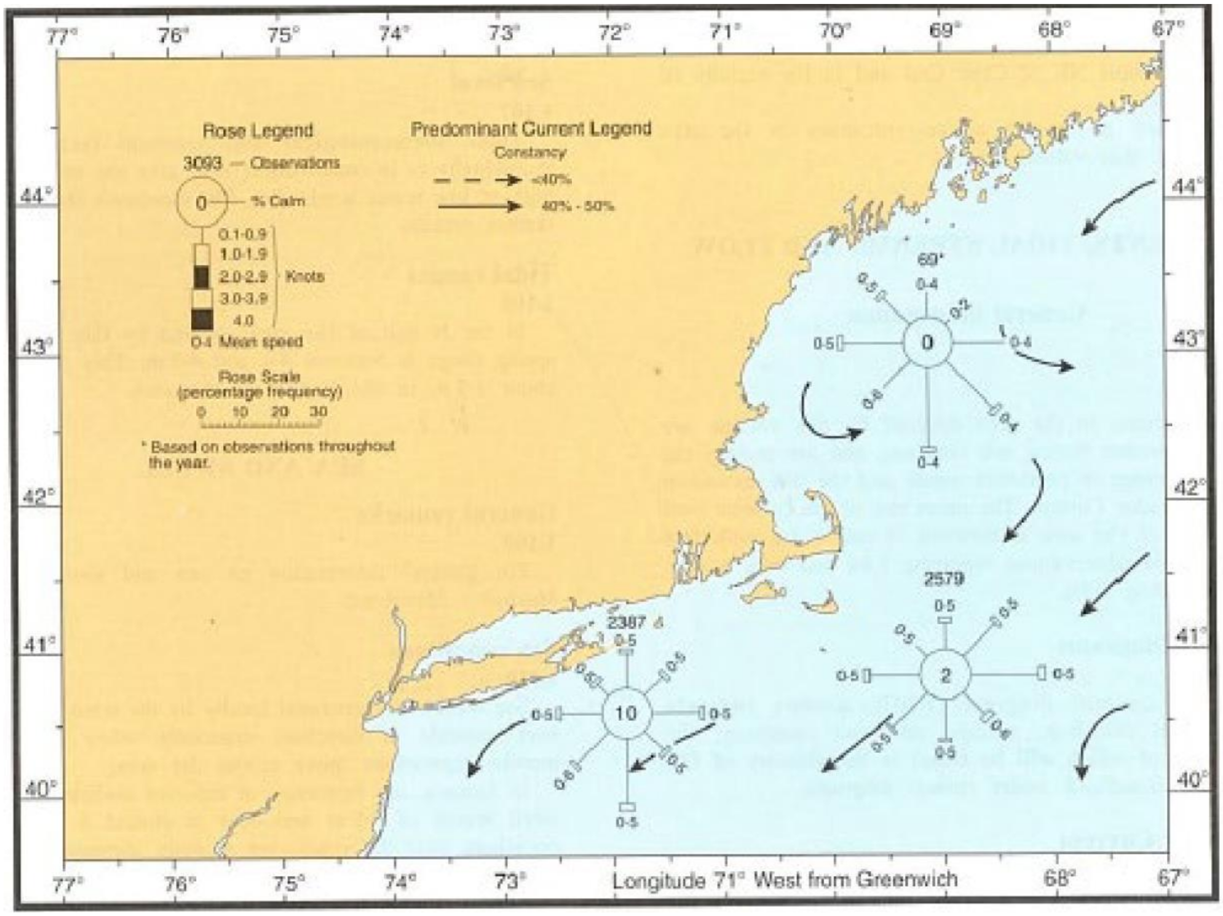
Appendix I Sediment Transport Analysis includes comprehensive details regarding the current regime in the Project Area.

FIGURE 4.1-10. MID-ATLANTIC BIGHT DOMINANT CIRCULATIONS



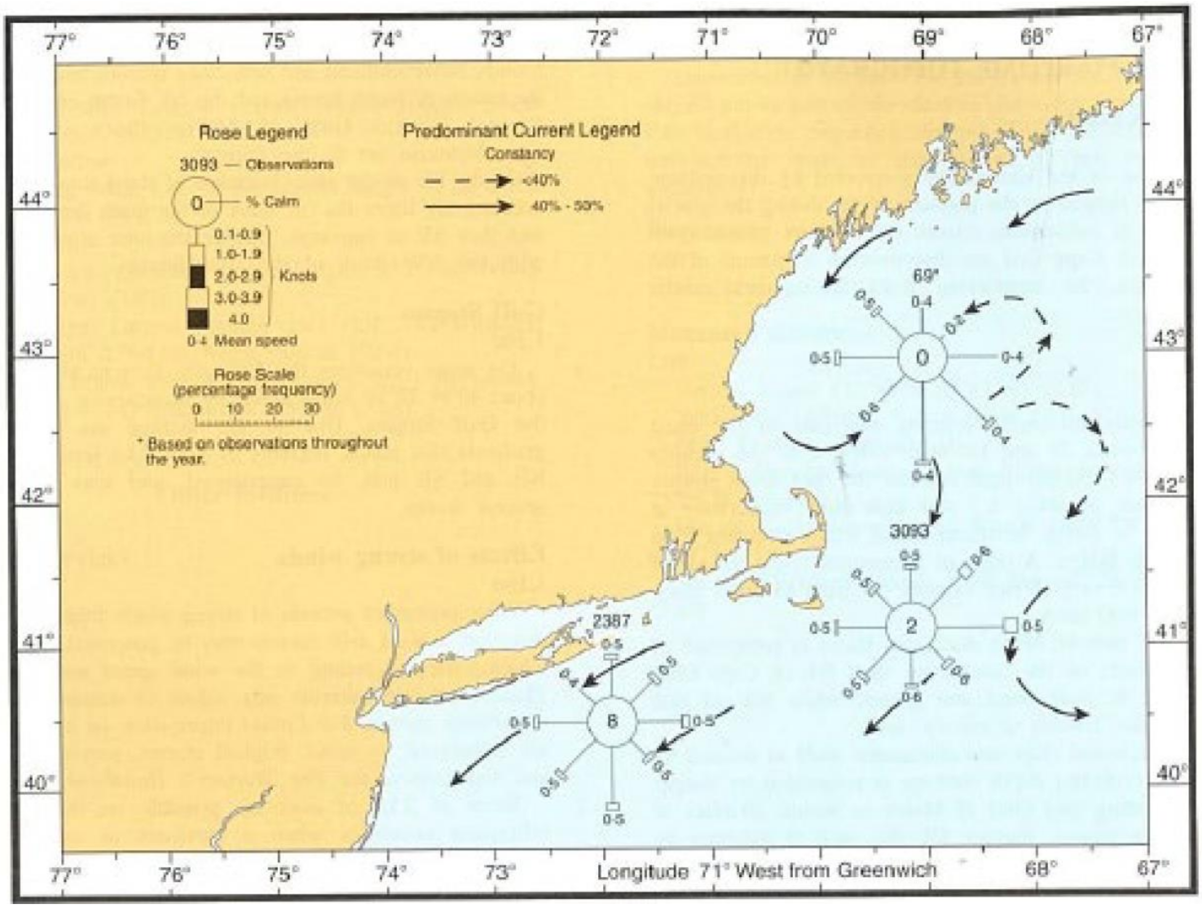
Source: Mid-Atlantic Regional Ocean Assessment. Oceanographic Setting and Processes (MAROA 2021)

FIGURE 4.1-11. PREDOMINANT CURRENT DIRECTION, CONSISTENCY, AND MEAN RATE DURING THE WINTER SEASON IN THE STUDY AREA



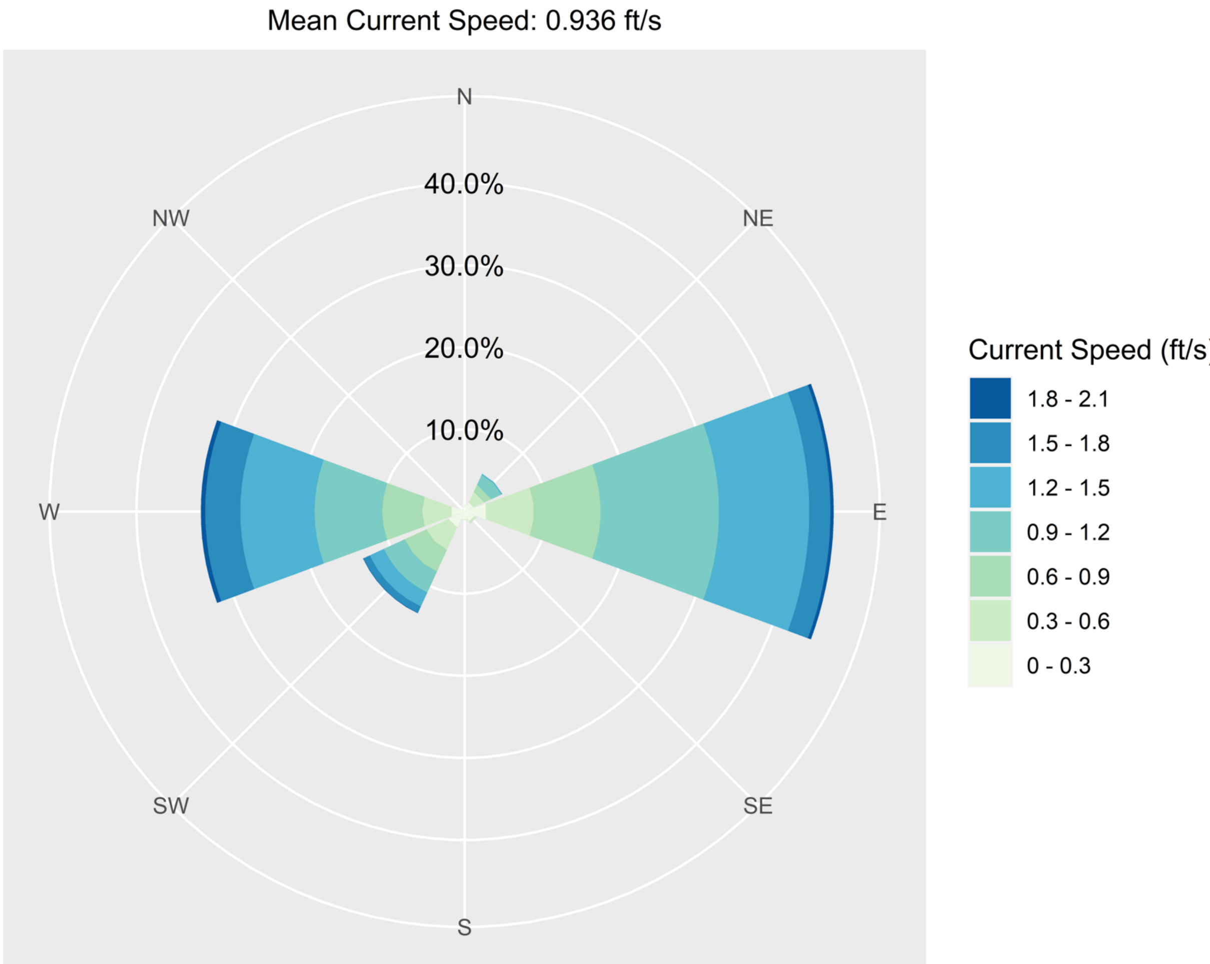
Source: UKHO 2009

FIGURE 4.1-12. PREDOMINANT CURRENT DIRECTION, CONSISTENCY, AND MEAN RATE DURING THE SUMMER SEASON AT THE STUDY AREA



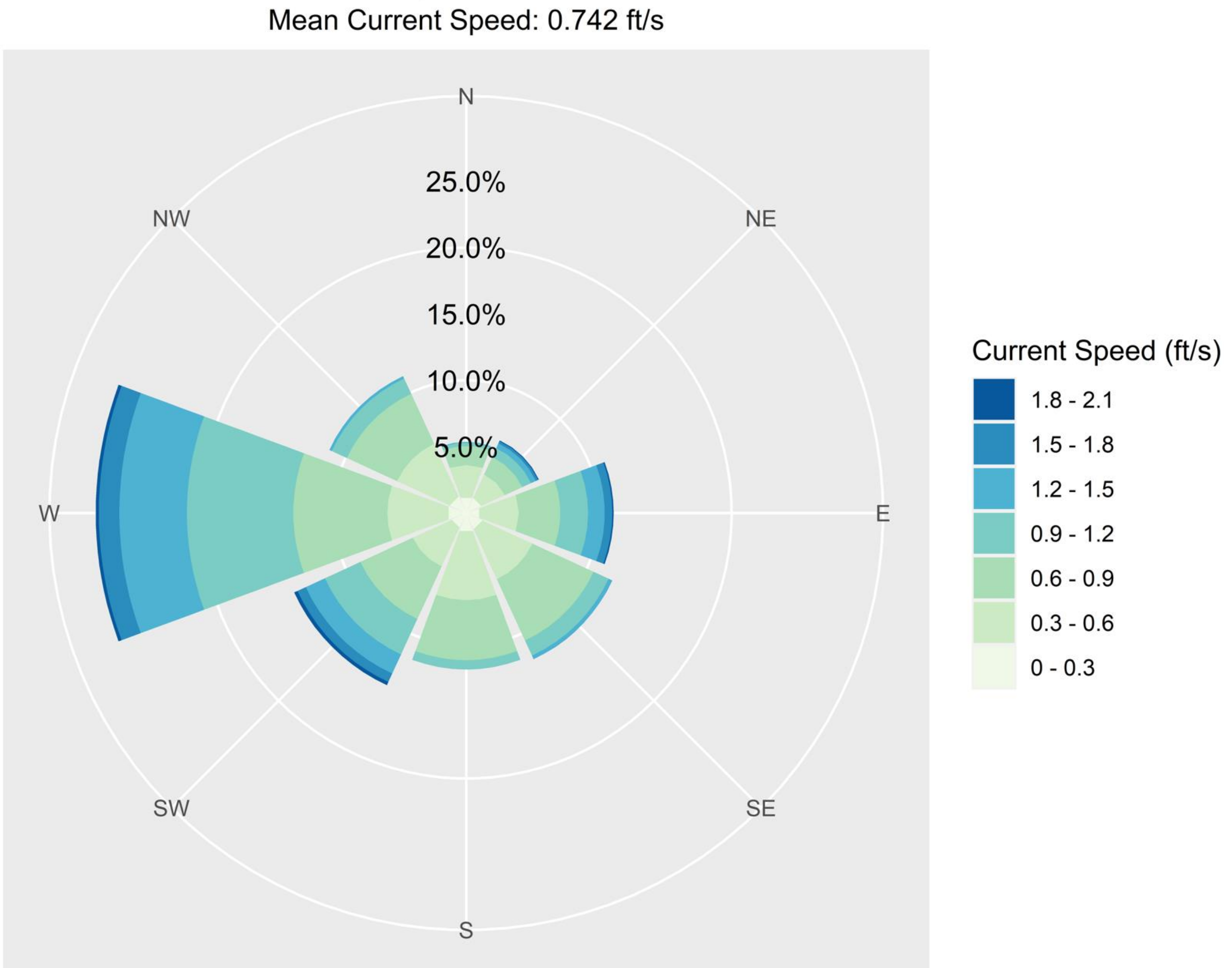
Source: UKHO 2009

FIGURE 4.1-13. CENTRAL LONG ISLAND SOUND (BUOY 44039) BUOY DEPTH-AVERAGED CURRENT ROSE



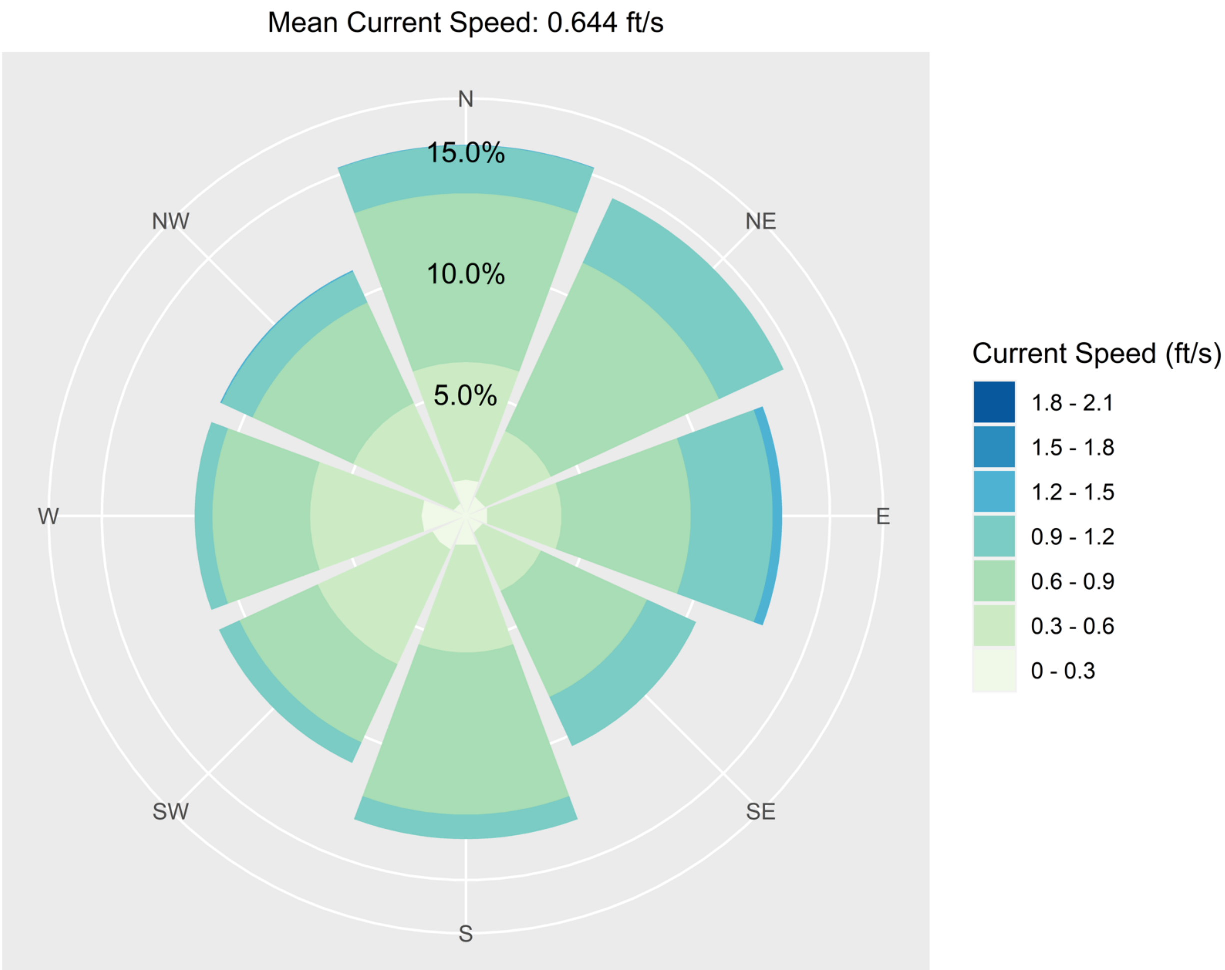
Source: O'Donnell 2021

FIGURE 4.1-14. MD-S BUOY DEPTH-AVERAGED CURRENT ROSE



Source: OSAMP 2010

FIGURE 4.1-15. MAYFLOWER WIND BUOY DEPTH-AVERAGED CURRENT ROSE



Source: Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

TABLE 4.1-5. MEAN CURRENT SPEED

			Average Current ft/s (m/s)											
Buoy	**Buoy Name**	**Timeframe**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
44039	Central Long Island Sound	December 2018-February 2019	0.9 (0.3)	0.9 (0.3)	---	---	---	---	---	---	---	---	---	1.0 (0.3)
MD-S		October 2009-October 2010	0.7 (0.2)	0.7 (0.2)	0.8 (0.2)	0.7 (0.2)	0.7 (0.2)	0.8 (0.2)	0.8 (0.2)	0.8 (0.2)	0.7 (0.2)	0.8 (0.2)	0.8 (0.2)	0.8 (0.2)
Mayflower Wind		September 2021	---	---	---	---	---	---	---	---	0.6 (0.2)	---	---	---

Note:

--- Signifies months not part of timeframe evaluated.

Source: O'Donnell 2021, OSAMP 2010, and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

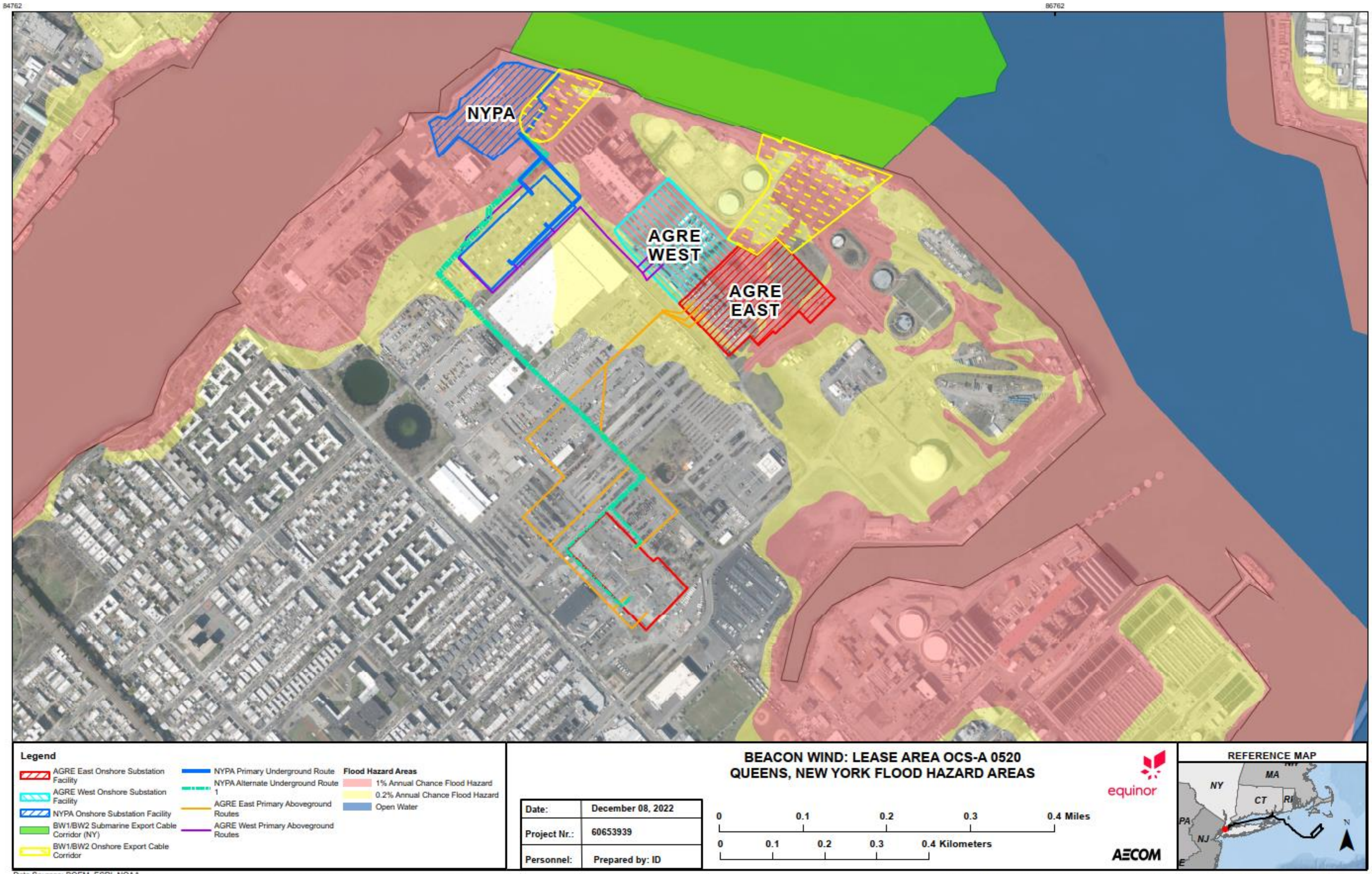
4.1.1.1.4 *Water Level*

Water levels around the Study Area fluctuate based predominately on tidal changes and extreme weather events, such as 100-year storms, tropical storms, and hurricanes. Based on a 2021 NOAA annual tide predictions for Wards Island, New York, located near Astoria, New York, the average tidal range is approximately 6 ft (1.8 m) throughout the year (NOAA 2021d). For the Niantic River near Waterford, Connecticut, the average tidal range is approximately 3 ft (0.9 m) throughout the year (NOAA 2021e). A flood map, based on Federal Emergency Management Agency (FEMA) flood statistics, of the submarine export cable landfall site options in Queens, New York can be found in **Figure 4.1-16** and for Waterford, Connecticut in Figure 4.1-17. This flooding is partially due to extreme weather events, such as tropical storms and hurricanes, as they have historically caused storm surges along coastal New England and New York. To understand frequency of such storms and their impact, Figure 4.1-18 depicts past hurricane tracks in the Study Area, while Figure 4.1-19 depicts a map of tropical cyclone wind exposures (NOAA 2021a) in the Study Area. Figure 4.1-18 is based on historical hurricane track data taken from NOAA and represents storms between 1851-2017, while Figure 4.1-19 is based on historical tropical wind data taken from NOAA and represents storms from 1900-2013 (NOAA 2021a).

Storm Events

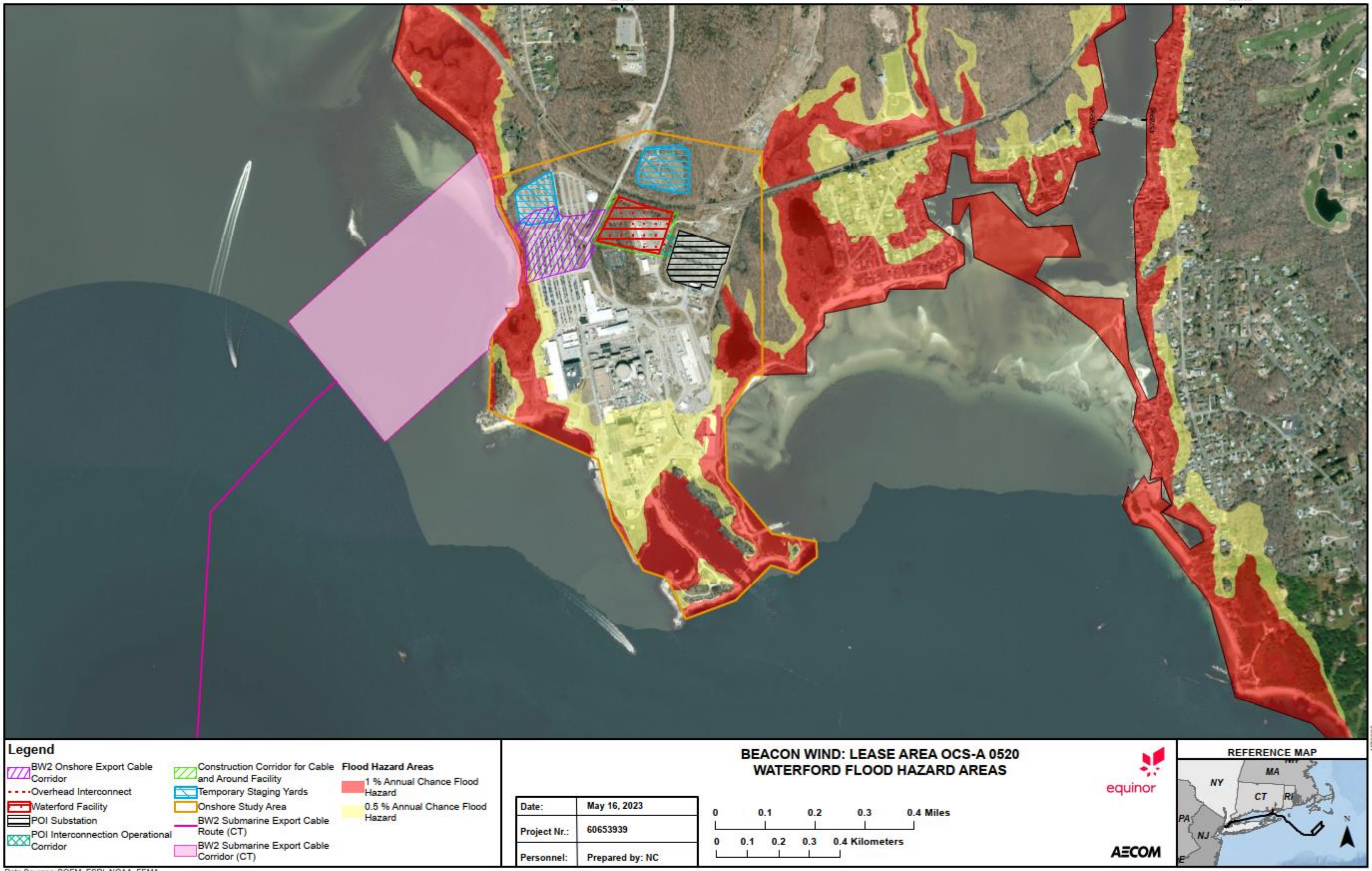
Large and erratic waves are created by the strong winds associated with tropical storms and hurricanes. Near the center of a storm, groups of large waves moving in different directions create very irregular wave heights and can combine to give exceptionally high waves. Waves travel radially outwards from the storm center as swell waves, with the highest swell moving ahead of the storm and roughly in the same direction as the storm. Storm surge may occur as a storm approaches a coastline, caused initially by the addition of the heavy swell and subsequently by the very high seas. This surge may cause severe flooding in low lying areas. The approach of a tropical storm is often indicated by long period swells whose height increases as the storm gets closer (UKHO 2009).

FIGURE 4.1-16. BEACON WIND: QUEENS, NEW YORK FLOOD HAZARD AREAS (BW1 AND BW2)



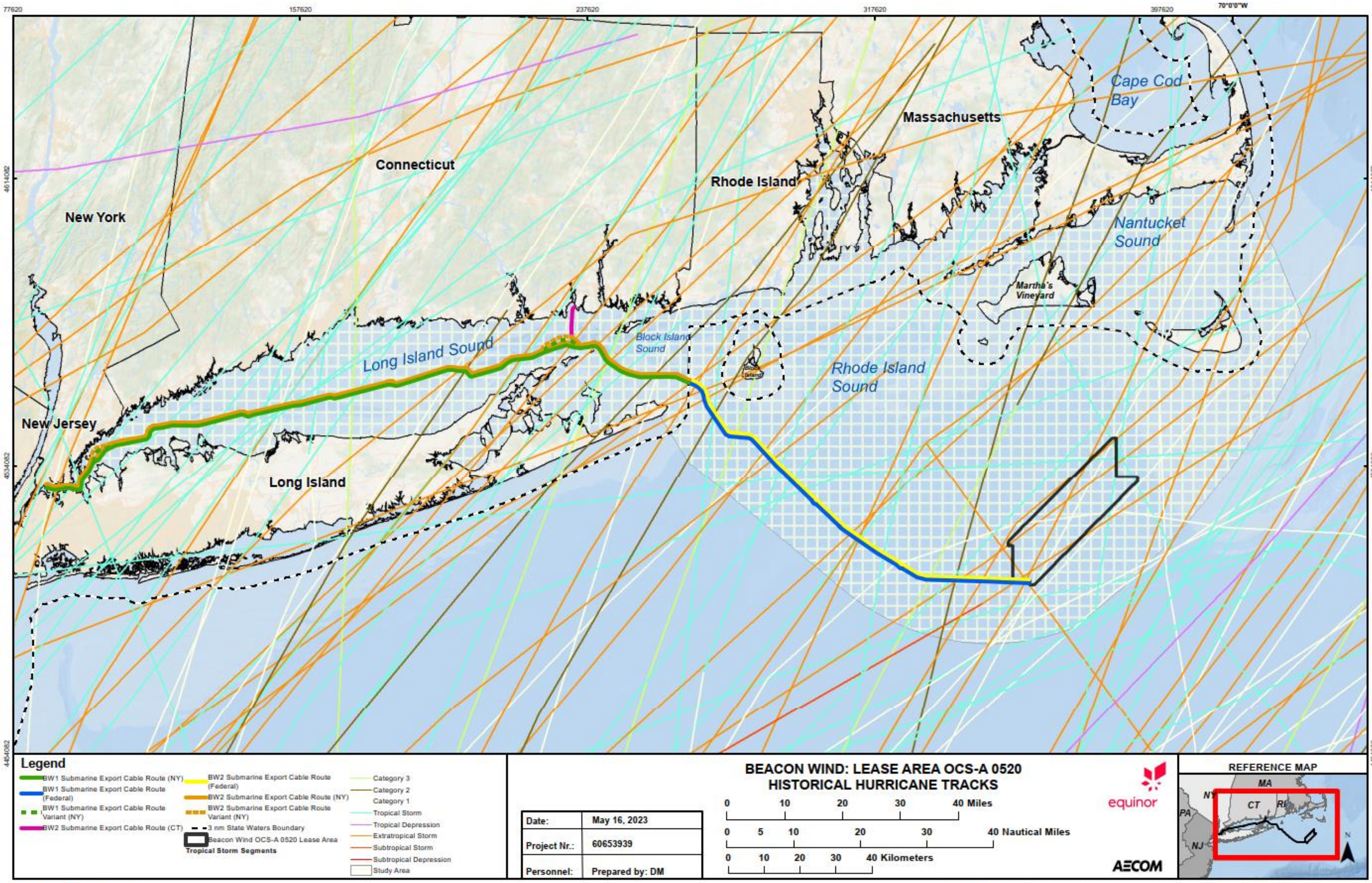
Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

FIGURE 4.1-17. BEACON WIND: WATERFORD, CONNECTICUT FLOOD HAZARD AREAS (BW2)



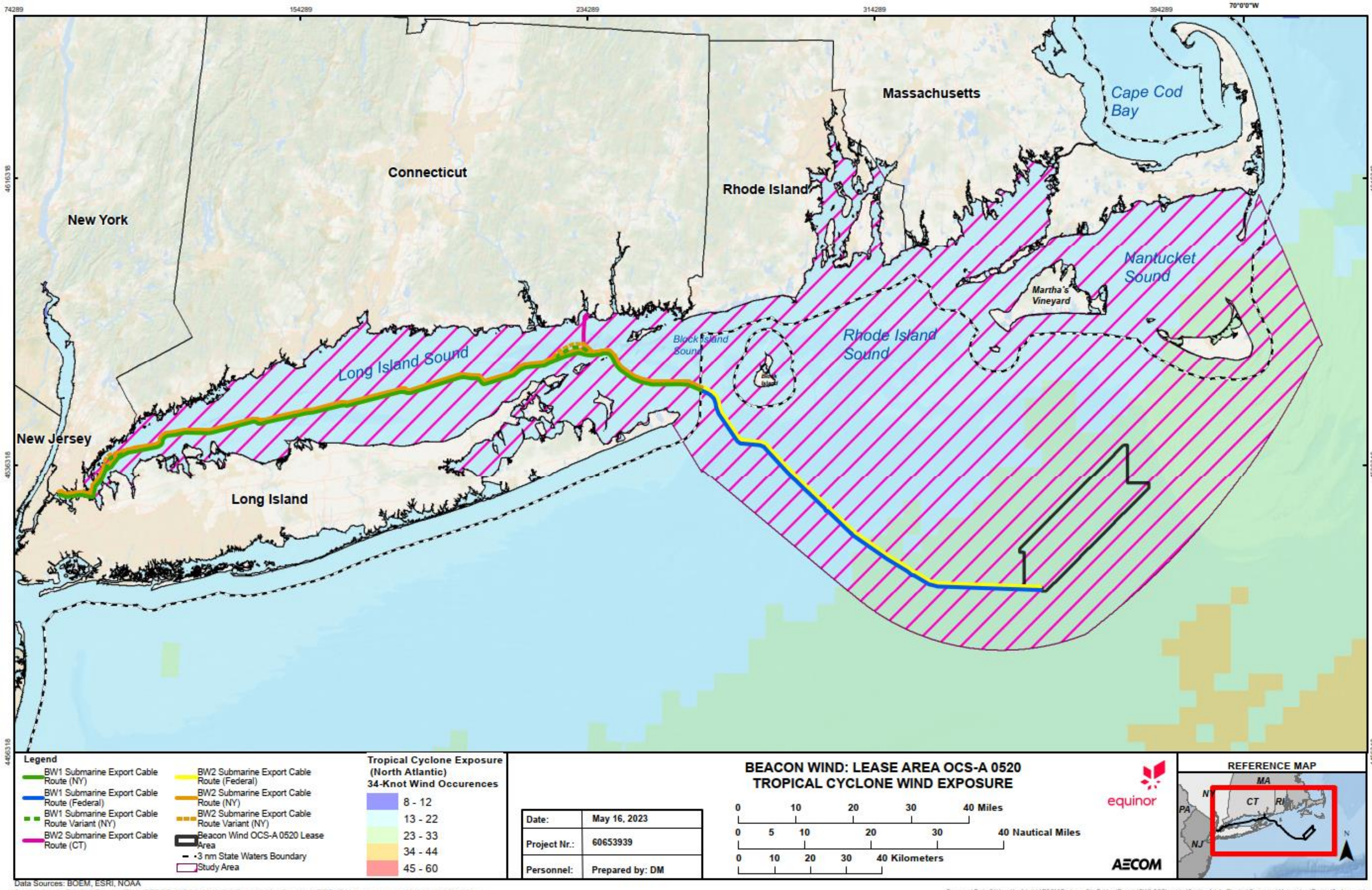
Data Sources: BOEM, ESRI, NOAA, FEMA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

FIGURE 4.1-18. BEACON WIND PROJECT AREA: HISTORICAL HURRICANE TRACKS



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

FIGURE 4.1-19. BEACON WIND PROJECT AREA: TROPICAL CYCLONE WIND EXPOSURE

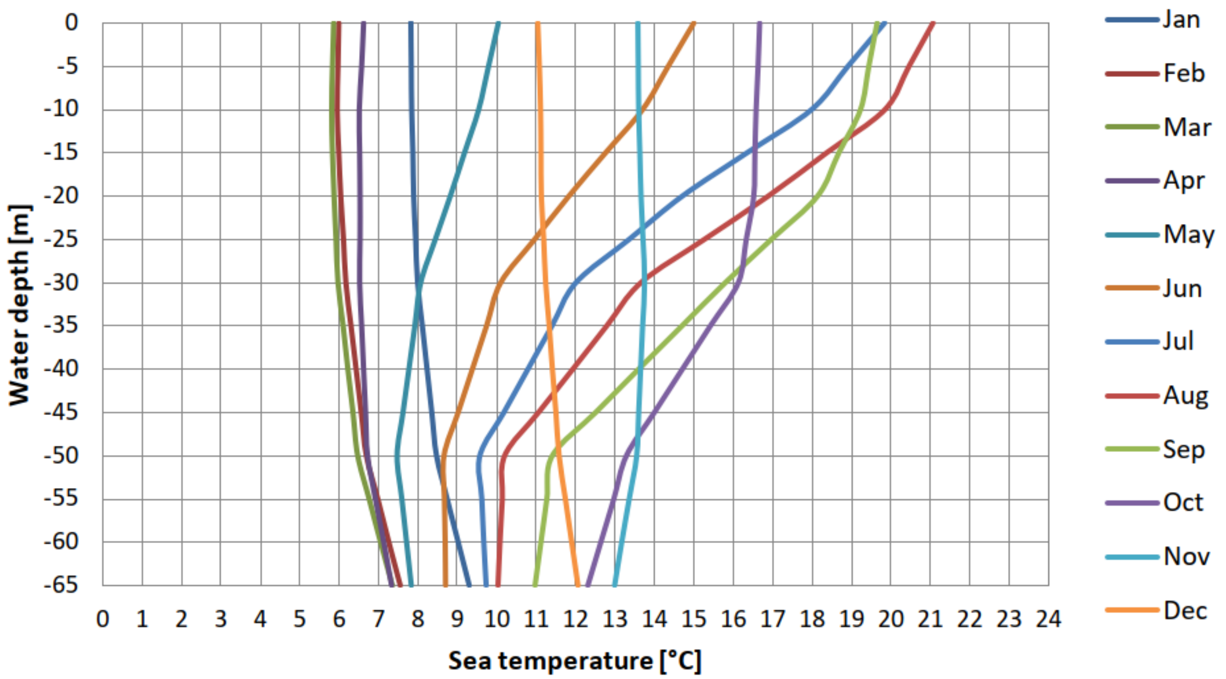


Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

4.1.1.1.5 *Sea Temperature and Salinity*

Sea temperature near the Lease Area was collected from the World Ocean Atlas (NOAA 2013). Sea temperatures were analyzed down to a depth of 213.3 ft (65 m) and ranged from approximately 43 to 70 degrees Fahrenheit (°F) (6 to 21 degrees Celsius [°C]) (**Figure 4.1-20**). The warmest months (July, August, and September) experienced water temperatures ranging from approximately 48 to 75 °F (9 to 21 °C), dependent on the water depths. The coldest months (February, March, and April), experienced water temperatures ranging from 43 to 45.5 °F (6 to 7.5 °C), dependent on water depth. Water near the surface is consistently warmer than deeper water during the spring and summer months whereas in winter months, the temperature difference between surface and deeper water is less and water can be colder at the surface. Surface waters experience the most variation in temperature, with bottom waters maintaining more consistent temperatures.

FIGURE 4.1-20. MONTHLY MEAN SEA TEMPERATURE (°C) NEAR LEASE AREA (NOAA 2013)



In addition, water quality data have been collected by the Northeast Fisheries Science Center (NEFSC) during seasonal multispecies bottom trawl surveys in the vicinity of the Lease Area. While these surveys primarily focus on fisheries, temperature and salinity profiles collected during the surveys help link fish distribution to physical oceanographic conditions. This program includes sampling locations from the Gulf of Maine to Cape Hatteras; therefore, only a sub-set of locations from this study pertinent to the Lease Area are summarized below. Trawl survey locations within a 5 mi (4 nm, 8 km) buffer around the Lease Area were considered to be relevant for consideration relative to water quality given that Project activities could affect water outside the Lease Area.

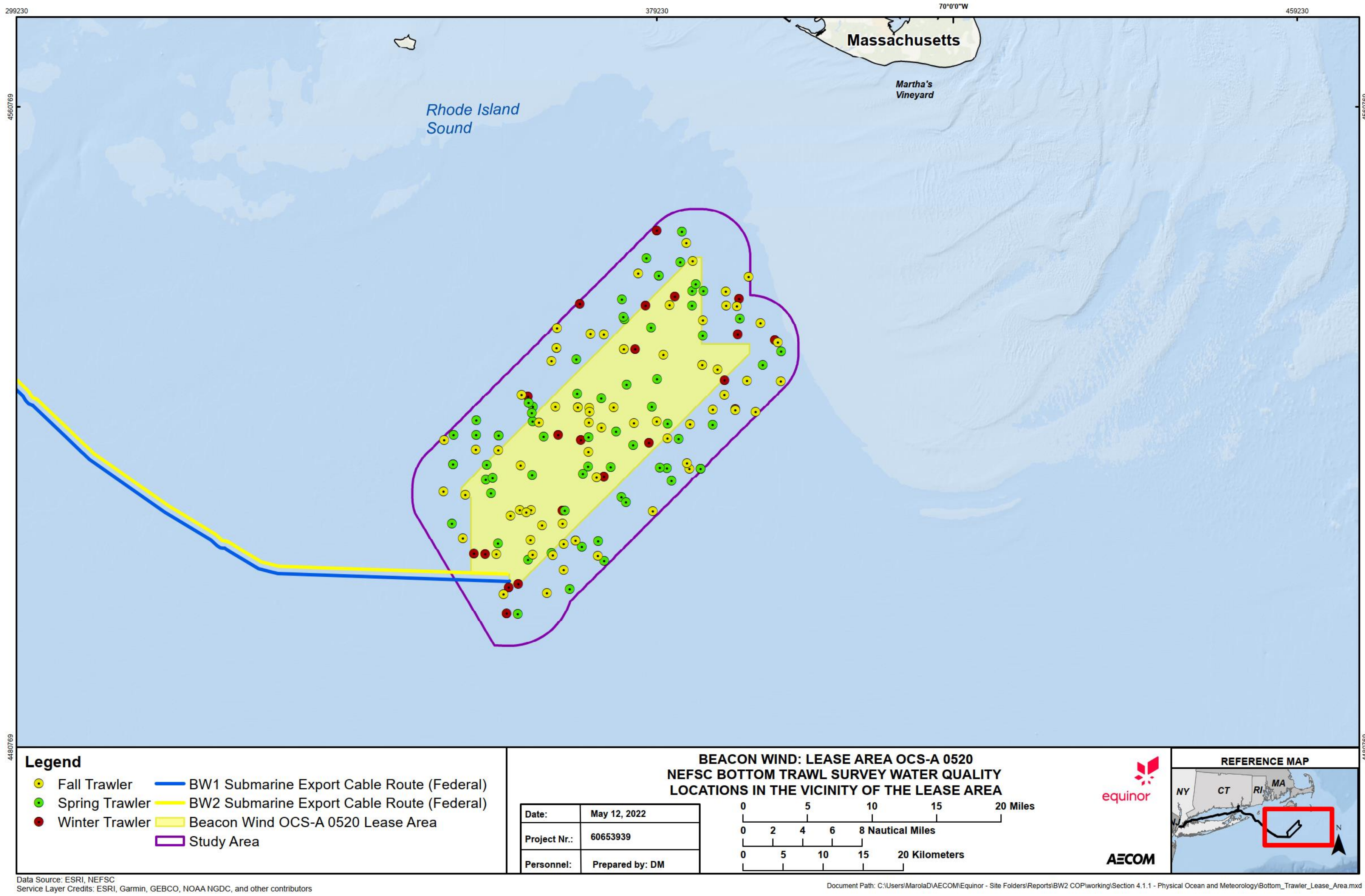
Water quality data collected between 1963 and 2019 were available for multiple offshore bottom trawls located in the general vicinity of the Lease Area (NEFSC 2021). Seasonal values for water temperature and salinity are summarized in **Table 4.1-6**, and **Figure 4.1-21** shows the sub-set of trawls conducted in the vicinity of the Lease Area.

Salinity and temperature were measured at the bottom and surface of the water column during surveys conducted in the spring, fall, and winter. Average water temperatures were lowest in the winter and highest in fall (trawls were not conducted in the summer). The greatest difference between bottom and surface water temperatures was in the fall (difference of 5.58 °F [3.1 °C]). Salinity varied from a low of 32.4 practical salinity unit (psu) to a maximum of 33.0 psu.

TABLE 4.1-6. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE AND SALINITY DATA FROM THE NEFSC MULTISPECIES BOTTOM TRAWL SURVEYS (1963-2020) IN THE VICINITY OF THE LEASE AREA

Season	Average Water Depth ft (m)	Layer	Average Water Temperature °F (°C)	Salinity (psu)
Spring (March – May; n=68)	170 (52)	Surface	41.0 ± 2.3 (5.0 ± 1.3)	32.5 ± 0.4
		Bottom	40.3 ± 2.0 (4.6 ± 1.1	32.6 ± 0.4
Fall (September – November; n=70)	167 (51)	Surface	61.7 ± 4.1 (16.5 ± 2.3)	32.7 ± 0.7
		Bottom	56.1 ± 3.4 (13.4 ± 1.9)	33.0 ± 0.5
Winter (December – February; n=25)	167 (51)	Surface	38.1 ± 2.3 (3.4 ± 1.3)	32.4 ± 0.4
		Bottom	38.3 ± 2.3 (3.5 ± 1.3)	32.5 ± 0.4

FIGURE 4.1-21. NEFSC BOTTOM TRAWL SURVEY WATER QUALITY SAMPLE LOCATIONS IN THE VICINITY OF THE LEASE AREA



For further evaluation, sea temperatures measured at depths ranging from 1.5 ft (0.5 m) to 6.6 ft (2 m) below the surface at NOAA NDBC buoys 44017, 44020, 44039, and Station BUZM3 were analyzed to evaluate sea temperature within the Study Area (**Table 4.1-7, Figure 4.1-22**). Data from these buoys illustrate that, like the Lease Area analysis, the maximum temperatures are measured during the summer months with lower temperatures in the winter months. Buoy 44017 has a monthly average temperature range of 40.5 to 73.2 °F (4.7 to 22.9 °C), Buoy 44020 has a monthly average temperature range of 35.7 to 74.5 °F (2.0 to 23.6 °C), Buoy 44039 was very similar to Buoy 44020 with a monthly average temperature range of 35.7 to 74.5 °F (2.1 to 23.6 °C), Buoy 44097 has a monthly average temperature range of 40.9 to 71.8 °F (4.5 to 22.1 °C), and Station BUZM3 has a monthly average temperature range of 37.2 to 67.6 °F (2.9 to 19.8 °C).

The Mayflower Wind buoy measured sea temperature at depths of 3.3 ft (1 m) to 6.6 ft (2 m). The 6.6 ft (2 m) measurements are included in **Table 4.1-7** and **Figure 4.1-22**. Monthly average temperature ranged from 40.9 to 71.8 °F (4.9 to 70.7 °C). Salinity data was also collected at this buoy at a water depth of 6.6 ft (2 m) and is summarized in **Table 4.1-8**. The average seasonal salinity ranged from 31.9 psu in the summer to 32.8 psu in the fall.

As with the Lease Area, water quality data have been collected by the NEFSC during seasonal multispecies bottom trawl surveys and data collected from the sub-set of locations in the vicinity of the submarine export cable routes between 1963 and 2019 (NEFSC 2021) were compiled. The subset of measurements is located between the tip of Long Island and the Lease Area. Seasonal values for water temperature and salinity are summarized in **Table 4.1-9**, and **Figure 4.1-23** shows the available data for trawls conducted in the vicinity of the submarine export cable routes.

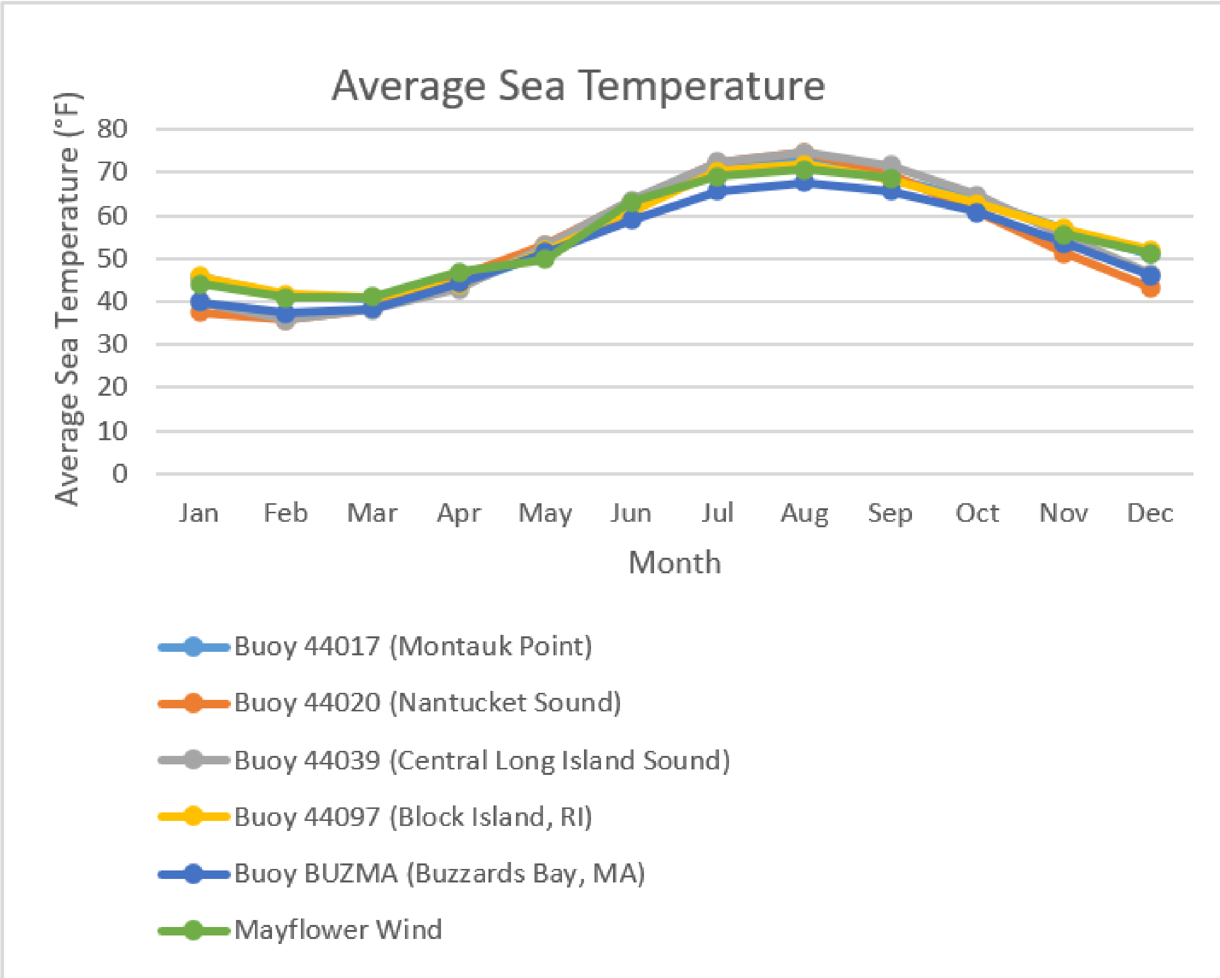
Salinity and temperature were measured at the bottom and surface of the water column during surveys conducted in the spring, fall, and winter. Average water temperatures were lowest in the winter and highest in fall (trawls were not conducted in the summer). The greatest difference between bottom and surface water temperatures was in the fall (difference of 9 °F [5 °C]). Salinity varied from a low of 32.0 psu to a maximum of 32.7 psu.

TABLE 4.1-7. AVERAGE SEA TEMPERATURE AT BUOYS IN THE STUDY AREA

Average Sea Temperature in °F (°C)															
Buoy	Buoy Name	Years	Measured Depth – Below Water Line ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area and Open Ocean															
44017	Montauk Point	2002-2008, 2010-2011, 2013-2020	4.9 (1.5)	45.5 (7.5)	41.2 (5.1)	40.5 (4.7)	43.8 (6.5)	51.4 (10.8)	61.7 (16.5)	71.6 (22.0)	73.2 (22.9)	68.9 (20.5)	63.4 (17.5)	56.7 (13.7)	51.0 (10.6)
44020	Nantucket Sound	2009-2020	6.6 (2.0)	37.5 (3.1)	35.7 (2.0)	38.3 (3.5)	45.6 (7.5)	53.3 (11.8)	63.0 (17.2)	72.3 (22.4)	74.5 (23.6)	69.6 (20.9)	61.0 (16.1)	51.2 (10.7)	43.3 (6.3)
44097	Block Island, Rhode Island	2009-2020	1.51 (0.46)	45.8 (7.7)	41.7 (5.4)	40.9 (4.9)	44.0 (6.7)	51.8 (11.0)	61.0 (16.1)	70.2 (21.2)	71.8 (22.1)	68.2 (20.1)	62.7 (17.1)	57.0 (13.9)	51.9 (11.1)
BUZM3	Buzzards Bay, Massachusetts	2000-2003, 2005-2010	[Varies – at or near Mean Lower Low Water]	39.9 (4.4)	37.2 (2.9)	38.3 (3.5)	44.2 (6.8)	51.3 (10.7)	59.0 (15.0)	65.6 (18.7)	67.6 (19.8)	65.8 (18.8)	60.7 (16.0)	53.5 (12.0)	46.1 (7.8)
Mayflower Wind		March 2020-July 2021	6.6 (2.0)	44.0 (6.7)	40.9 (4.9)	41.0 (5.0)	46.8 (8.2)	49.8 (9.9)	63.2 (17.3)	69.1 (20.6)	70.7 (21.5)	68.6 (20.3)	---	55.6 (13.1)	51.1 (10.6)
Long Island Sound															
44039	Central Long Island Sound	2004-2019	3.3 (1.0)	39.8 (4.3)	35.7 (2.1)	38.1 (3.4)	42.9 (6.1)	53.0 (11.7)	63.5 (17.5)	72.5 (22.5)	74.5 (23.6)	71.7 (22.1)	64.7 (18.2)	55.2 (12.9)	46.4 (8.0)

Note:
--- Signifies data was either unavailable or was outside of reasonable range and thus assumed to be inaccurate.
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/] and Mayflower Wind) (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-22. AVERAGE SEA TEMPERATURE (°F) AT BUOYS



Source: NOAA National Data Buoy Center [https://www.ndbc.noaa.gov/] and Mayflower Wind (NOAA IOOS NERACOOS) http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html

TABLE 4.1-8. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER SALINITY DATA FROM MAYFLOWER WIND BUOY 2020

Season	Mayflower Wind Buoy Data	
	Number of Samples	Average Salinity at 2 m Below Water Surface (psu)
Spring (March – May)	18,882	32.4 ± 0.7
Summer (June – August)	14,750	31.9 ± 1.8
Fall (September – November)	5,438	32.8 ± 0.3
Winter (December – February)	12,911	32.5 ± 0.1

TABLE 4.1-9. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE AND SALINITY DATA FROM THE NEFSC MULTISPECIES BOTTOM TRAWL SURVEYS (1963-2020) IN THE VICINITY OF THE SUBMARINE EXPORT CABLE ROUTES

Season	Average Water Depth ft (m)	Layer	Average Water Temperature °F (°C)	Salinity (psu)
Spring (March – May n=133)	157 (48)	Surface	40.6 ± 2.5 (4.8 ± 1.4)	32.0 ± 0.8
		Bottom	40.5 ± 2.0 (4.7 ± 1.1)	32.6 ± 0.4
Fall (September – November n=115)	157 (48)	Surface	63.5 ± 4.0 (17.5 ± 2.2)	32.4 ± 0.8
		Bottom	54.5 ± 5.0 (12.5 ± 2.8)	32.7 ± 0.5
Winter (December – February; n=34)	190 (58)	Surface	40.8 ± 2.3 (4.9 ± 1.3)	32.4 ± 0.7
		Bottom	41.5 ± 3.0 (5.3 ± 1.7)	32.7 ± 0.4

4.1.1.1.6 *Air Temperature*

Air temperatures in the Study Area were analyzed based on data from the NOAA NDBC buoys 44017, 44020, 44039, and Station BUZM3 (**Table 4.1-10**, **Figure 4.1-24**). As with average sea temperatures, monthly average air temperatures are highest during summer months and lower in the winter months for the buoys. Results at Buoy 44017 show a monthly average temperature range of 35.6 to 72.7 °F (2.0 to 22.6 °C), Buoy 44020 shows a monthly average temperature range of 33.5 to 71.8 °F (0.8 to 22.1 °C), Buoy 44039 shows a monthly average temperature range of 33.5 to 73.3 °F (0.8 to 23.0 °C), and Station BUZM3 shows a temperature range of 33.1 to 69.6 °F (0.6 to 20.9 °C). The Mayflower Wind buoy measured air temperature ranging from 37.0 to 71.5 °F (2.8 to 71.5 °C).

FIGURE 4.1-23. NEFSC BOTTOM TRAWL SURVEY WATER QUALITY SAMPLE LOCATIONS ALONG THE SUBMARINE EXPORT CABLE ROUTES

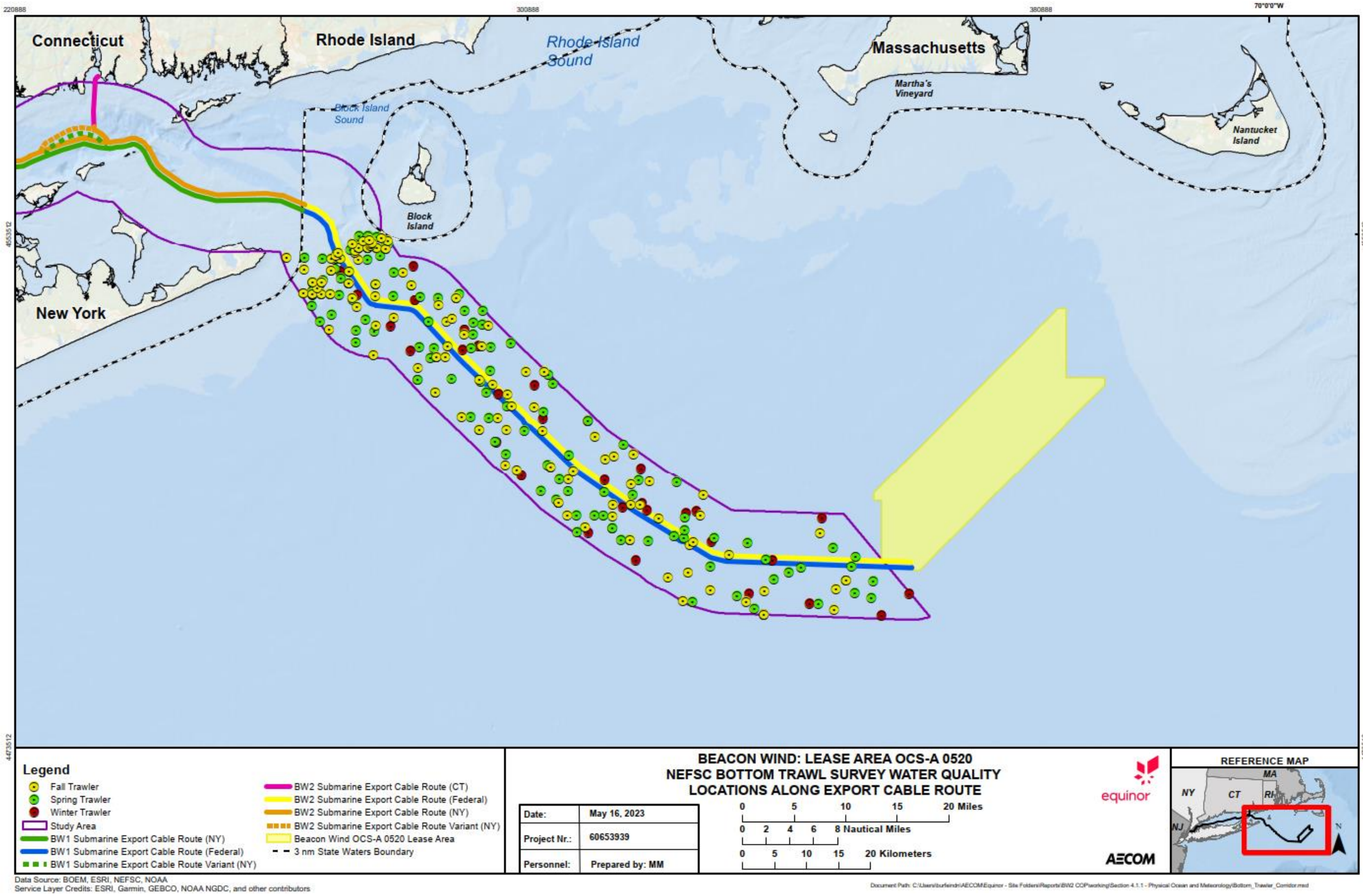
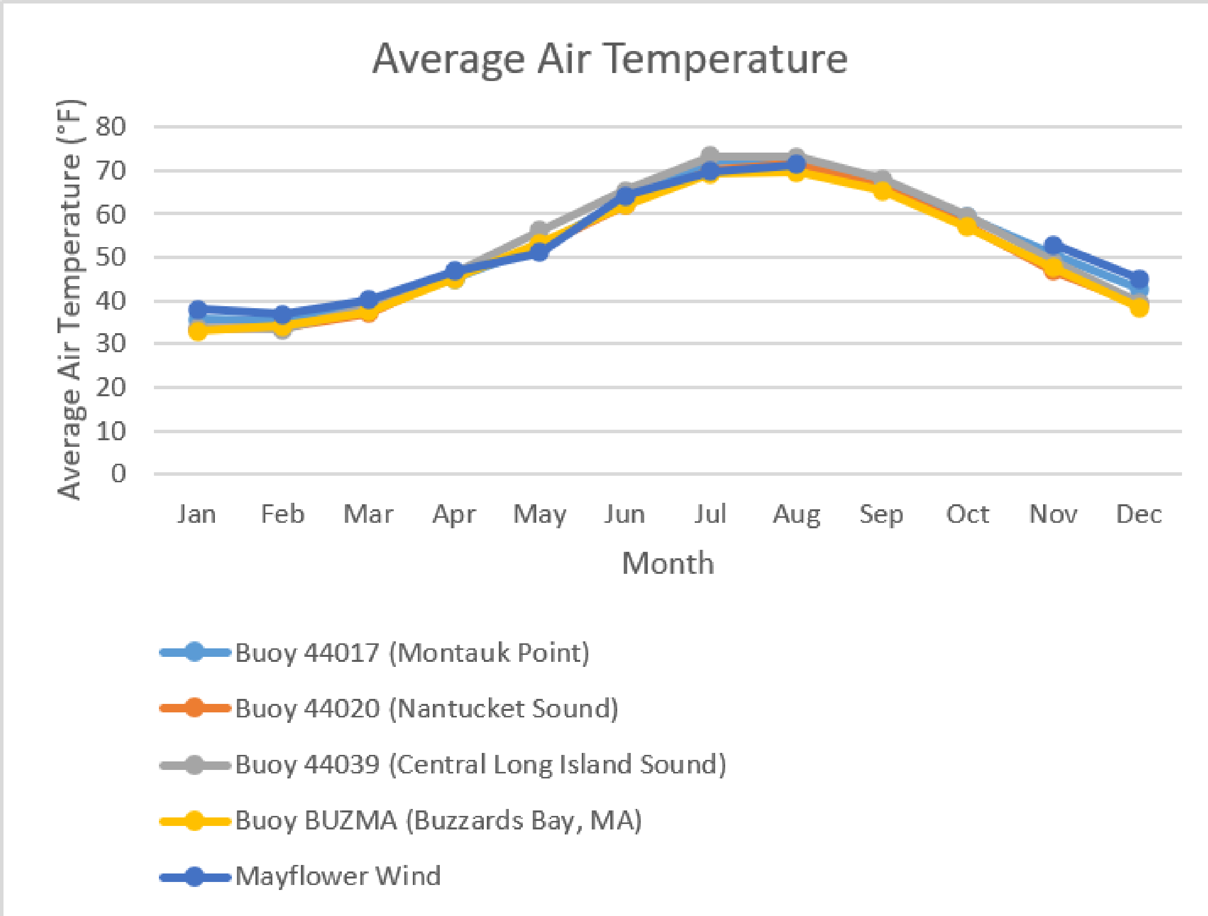


TABLE 4.1-10. AVERAGE AIR TEMPERATURE AT BUOYS IN THE STUDY AREA

			Average Air Temperature in °F (°C)												
Buoy	Buoy Name	Years	Measured Height – Above Sea Level ft (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lease Area and Open Ocean															
44017	Montauk Point	2002-2011, 2013-2020	12.1 (3.7)	35.7 (2.0)	35.6 (2.0)	38.6 (3.7)	45.0 (7.2)	52.6 (11.5)	63.0 (17.3)	72.0 (22.2)	72.7 (22.6)	67.3 (19.6)	59.4 (15.2)	50.7 (10.4)	42.7 (5.9)
44020	Nantucket Sound	2009-2020	11.2 (3.4)	33.5 (0.8)	34.0 (1.1)	37.1 (2.9)	45.8 (7.7)	52.7 (11.5)	62.0 (16.6)	70.0 (21.1)	71.8 (22.1)	66.3 (19.1)	57.3 (14.1)	46.9 (8.3)	39.2 (4.0)
BUZM3	Buzzards Bay, Massachusetts	2000-2020	81.4 (24.8)	33.1 (0.6)	34.2 (1.2)	37.5 (3.0)	45.2 (7.3)	53.3 (11.9)	62.1 (16.7)	69.2 (20.7)	69.6 (20.9)	65.3 (18.5)	56.9 (13.9)	47.6 (8.7)	38.6 (3.6)
Mayflower Wind		March 2020-July 2021	3.3 (1.0)	38.1 (3.4)	37.0 (2.8)	40.3 (4.6)	46.8 (8.2)	51.1 (10.6)	64.2 (17.9)	69.8 (21.0)	71.5 (21.9)	---	---	52.8 (11.6)	45.2 (7.3)
Long Island Sound															
44039	Central Long Island Sound	2004-2019	9.8 (3.0)	33.8 (1.0)	33.5 (0.8)	38.6 (3.7)	46.3 (8.0)	56.2 (13.4)	65.3 (18.5)	73.3 (23.0)	73.2 (22.9)	68.2 (20.1)	59.4 (15.3)	49.0 (9.5)	39.7 (4.3)

Note:
--- Signifies data was either unavailable or was outside of reasonable range and thus assumed to be inaccurate.
Source: NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/) and Mayflower Wind (NOAA IOOS NERACOOS) (http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html)

FIGURE 4.1-24. AVERAGE AIR TEMPERATURE (°F) AT BUOYS



Source: NOAA National Data Buoy Center [https://www.ndbc.noaa.gov/] and Mayflower Wind (NOAA IOOS NERACOOS) http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html

4.1.1.1.7 *Ice and Fog*

The New England winters are associated with cold air temperatures that brings with it the potential for icing of equipment above the water surface. Potential for icing exists as a result of a number of factors, including atmospheric 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). Merrill (2010) analyzed data from the Station BUZM3 to evaluate the potential for icing. Based on data from Buoy BUZM3, light accumulation of ice can occur on five or more days per month between December and February with more moderate ice accumulation occurring less than one day per month on average.

Merrill (2010) analyzed data from Station BUZM3 and the Martha's Vineyard Coastal Observatory (MVCO) to evaluate the potential for fog conditions. Based on eight years of data from Station BUZM3 and three years of data from MVCO, fog peaks in the summer months with frequency of events ranging from six to 11 days per month, lasting one or more hours. In the winter, frequency of fog decreases to three days per month. The fall and spring months typically experience fog between three and four days per month.

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 Study Area, is the potential for damage or disruption of the Project during BW1 and BW2. Therefore, the maximum design scenario would be an impact during BW1 and/or BW2 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, ice and fog, and therefore is 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 Study Area. The safety of the personnel, crew, and contractors are an absolute priority to Beacon Wind. 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. 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, the 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 Study 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. 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 and Connecticut 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. Wake effect is the phenomenon associated with turbulence caused by the currents changing direction and accelerating around the wind turbine foundation. The magnitude of this wake effect is in part dependent on the size of the foundation, the volume of water, and the current speed (BOEM 2020). Offshore facilities will compare plans to the International Electrotechnical Commission 614003-1 design code, which does not apply to offshore facilities in the

U.S. but will provide guidelines for building offshore facilities and incorporates considerations for tropical weather events.

As it relates to seawater temperatures, operations of the HVDC equipment on each of the two offshore substation facilities will require a cooling water intake system (CWIS) to remove heat from the HVDC equipment and the heating ventilation and air conditioning system. Ocean water will be drawn in from the water column, approximately 49-131 ft (15-40 m) below the water surface. Seawater circulating volumes will vary depending on the cooling demand, seawater temperature, and air temperature, and will not exceed 10.6 million gallons per day. Seawater volumes under normal operating conditions are regulated dependent on ambient conditions and cooling demand to use minimum amounts. The CWIS will discharge heated, treated seawater below the platform jacket approximately 66-112 ft (20-34 m) below the water surface. Discharged water temperature will be approximately 87.8°F (31°C) when the seawater inlet temperature is 68°F (20°C), though for much of the year the seawater will be cooler and the discharge temperature will accordingly be lower. Maximum discharged water temperature will not exceed 96.8°F (36°C), and this maximum temperature would correlate to a CWIS operating at a much smaller discharge volume than the maximum. The release of heated water will be localized to the area around the discharge points at the two offshore substation facilities and is expected to dissipate into the surrounding water column, resulting only in an increase in the temperature of the water in the immediate vicinity of the offshore substation facilities. Within a short distance from the CWIS, the temperature difference from surrounding seawater will drop to undetectable levels. No impingement of juvenile or adult fish is anticipated from operation of the CWIS.

The design, configuration, and operation of the offshore substation cooling systems will be permitted as part of an individual NPDES permit and additional details will be included in the permit application submitted to the EPA. Beacon Wind is actively working with EPA to understand any additional modeling and assessment that may be required for this system.

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 Project personnel will remain the top priority to Beacon Wind 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. 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 Beacon Wind anticipates will be needed for the Project, see **Section 3 Project Description**.

4.1.1.3 *Summary of Avoidance, Minimization, and Mitigation Measures*

In order to mitigate the potential impacts from physical oceanographic and meteorological conditions, Beacon Wind will require that 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 negligible 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. For the necessary offshore substation facility cooling activities, Beacon Wind will work to design an appropriate system and permit the activity with EPA.

4.1.2 Geological Conditions

This section describes the geological conditions within the Project Area, including both onshore and offshore conditions for BW1 and BW2. Additionally, this section describes 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 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 G**); and
- Marine Archaeological Resources Assessment (**Appendix U**).

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 federal, New York and Connecticut waters traversed by the submarine export cable routes (see **Figure 4.1-25**) and those onshore components including the onshore export and interconnection cable routes, the onshore substation facilities that include two locations under consideration in Queens, New York and one location in Waterford, Connecticut, and the POIs (see **Figure 4.1-26** and **Figure 4.1-27**). Two locations are under consideration in Queens, New York (NYPA and AGRE, which includes AGRE East and AGRE West) for the single proposed BW1 landfall and onshore substation facility. The Queens, New York onshore substation facility site that is not used (NYPA and AGRE) for BW1 will remain under consideration, in addition to the Waterford, Connecticut site, for the single proposed BW2 onshore substation facility.

In accordance with 30 CFR § 585.626, this section relies on several sources of data and information in assessing geologic conditions that may be present in the Project Area. These include publicly-available information including Marine Cadastre National Viewer (NOAA 2021b), USGS sediment data, Natural Resources Conservation Service (NRCS) soil data, journals, and studies. Additionally, Beacon Wind conducted geophysical and geotechnical campaigns across the Lease Area and along the submarine export cable routes as listed in **Table 4.1-11**. Beacon Wind 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 G Marine Site Investigation Report** .

FIGURE 4.1-25. OFFSHORE GEOLOGIC CONDITIONS STUDY AREA

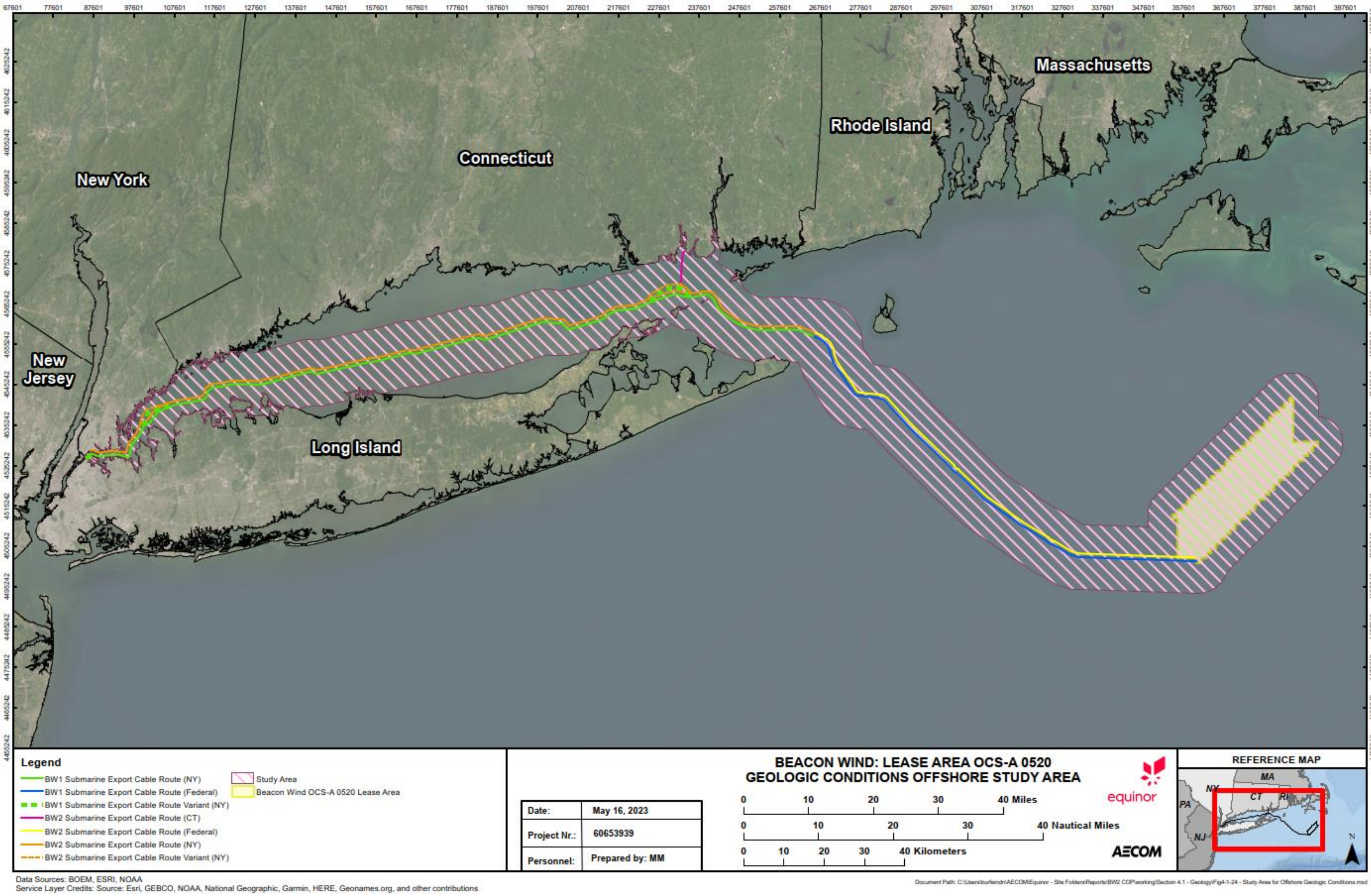


FIGURE 4.1-26. ONSHORE GEOLOGIC CONDITIONS STUDY AREA – QUEENS, NEW YORK

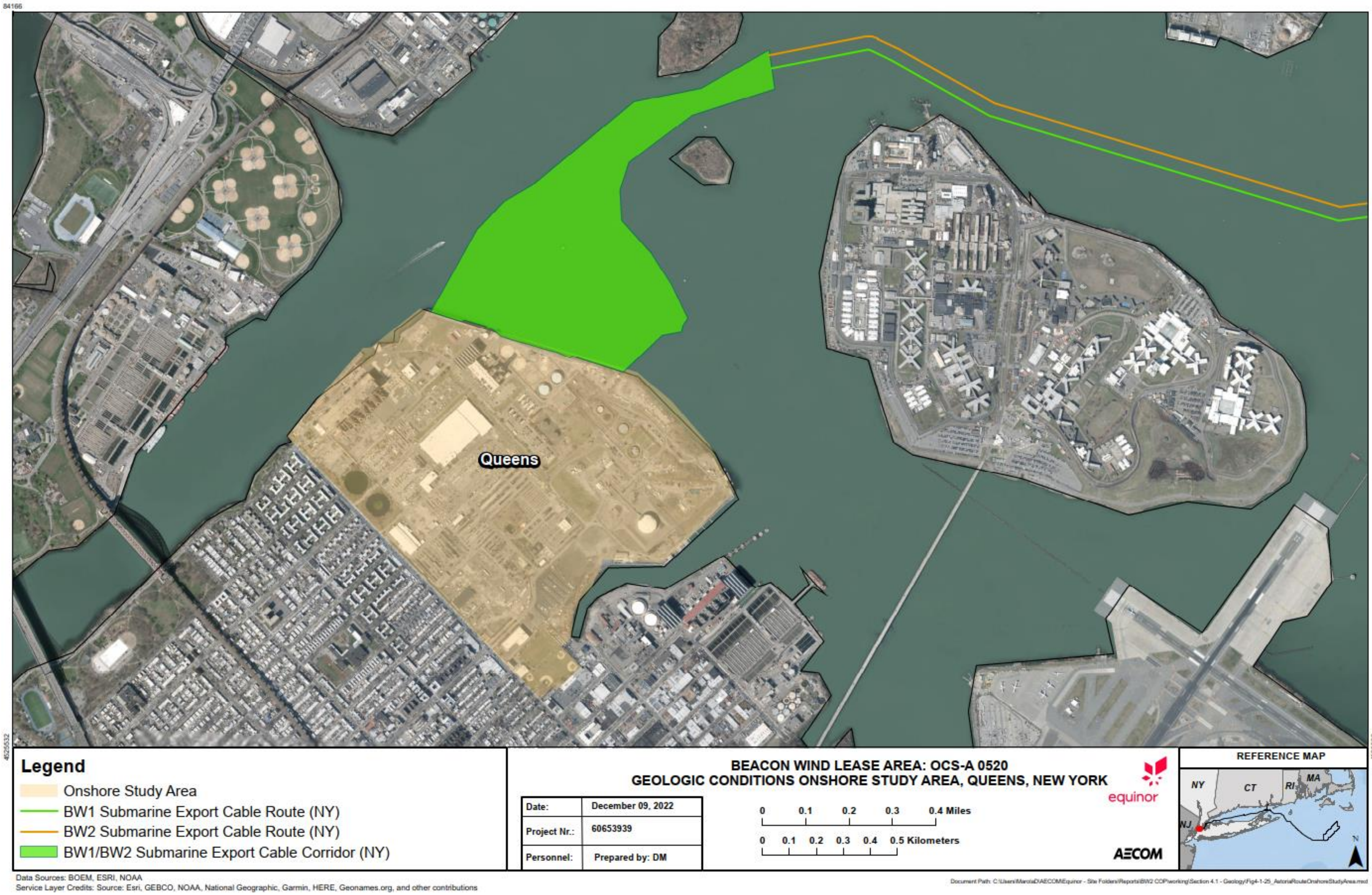


FIGURE 4.1-27. ONSHORE GEOLOGIC CONDITIONS STUDY AREA – WATERFORD, CONNECTICUT

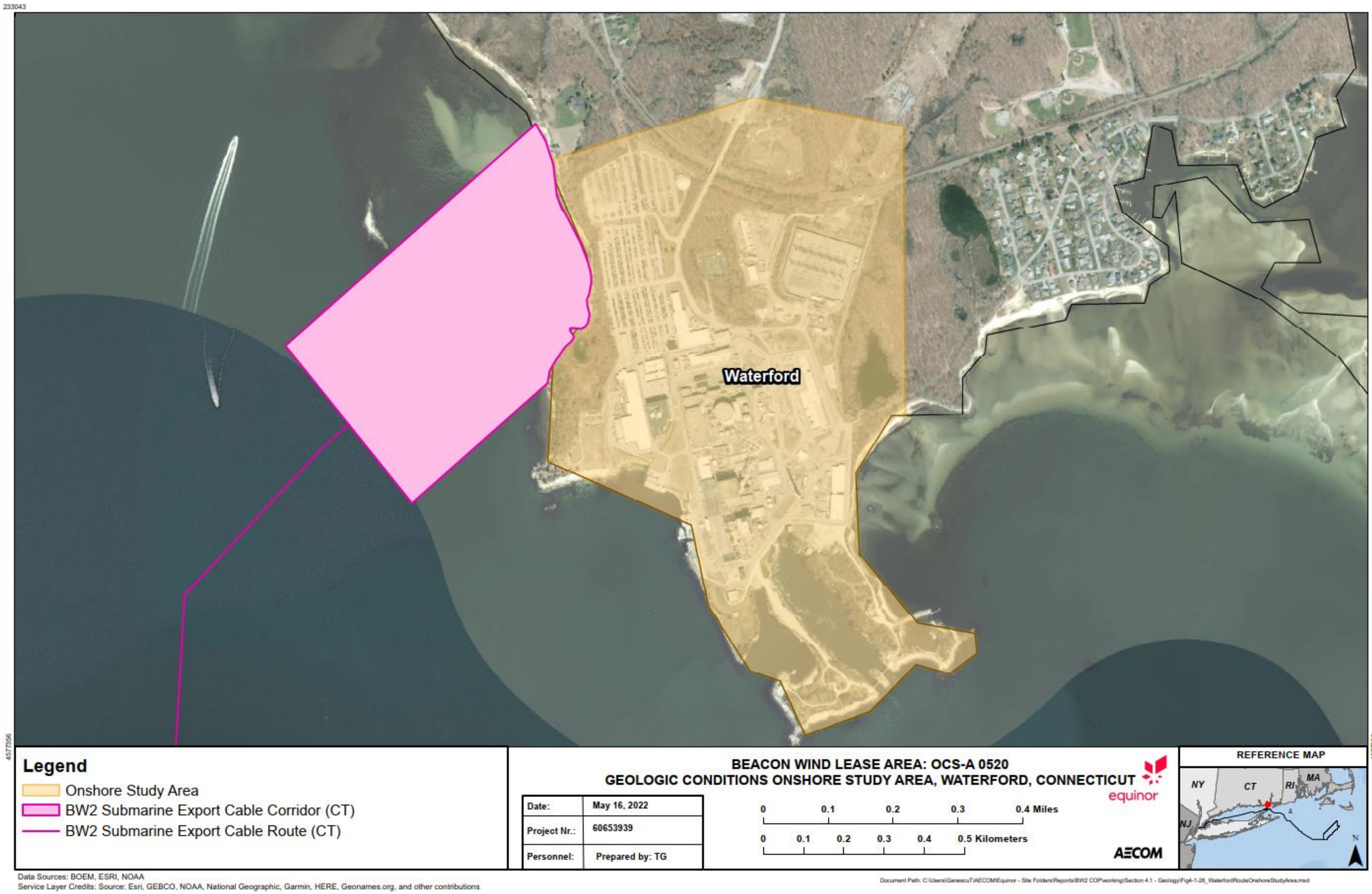


TABLE 4.1-11. COMPLETED GEOPHYSICAL AND GEOTECHNICAL CAMPAIGNS

Study	Scope	Dates	Timeline for Delivery to BOEM
2020 Geotechnical Investigation by Geoquip Marine	Five alternating sampling and cone penetration testing (CPTU) boreholes, 18 CPTU boreholes, six with adjacent shallow sampling boreholes in Lease Area	October 2020 – November 2020	Submitted October 2022
High Resolution Geophysical Survey by MMT	Conduct a high-resolution geophysical survey of the Lease Area and Submarine Export Cable Routes	August 2020 – August 2021 and December 2021 – February 2022	Submitted October 2022 – Lease Area Supplemental filing – Submarine Export Cable Corridors
Geotechnical and Benthic Survey by MMT	In Lease Area: benthic sampling suite at 157 wind turbine/offshore substation facility locations and sediment profile/plan view imaging (SPI/PV) only at 218 locations along interarray cable. Along the submarine export cable routes: sampling at 0.53-nm [1-km] intervals alternating A, B stations *"A" Stations* (1.07 nm [2 km] between stations): 19-ft (6-m) geotechnical vibracores 6-ft (1.8-m) geoenvironmental vibracores SPI/PV *"B" Stations* (1.07 nm [2 km] between stations): CPTs (19-ft [6-m] target depth) Benthic grabs SPI/PV Towed seafloor video	July 2021 – June 2022	Submitted October 2022 – Lease Area Supplemental filing - – Submarine Export Cable Corridors
2021/2022 Geotechnical Investigation by Geoquip Marine	CPTU boreholes at up to 140 locations, composite borings, seismic CPTs, and geophysical logging in Lease Area	July 2021 – June 2022	Supplemental filing

The results and interpretations of the geophysical and geotechnical datasets collected to date are detailed in **Appendix G Marine Site Investigation Report**, as detailed above. The data and interpretation information used to describe the submarine export cable routes within **Section 4.1.2** was collected from the surveys previously conducted for the Project. Additional surveys are ongoing to collect data and interpretation information. **Section 4.1.2** 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 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 foundations, submarine export cables, and interarray cables) and onshore components (including onshore export and interconnection cables, and onshore substation facilities). Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities.

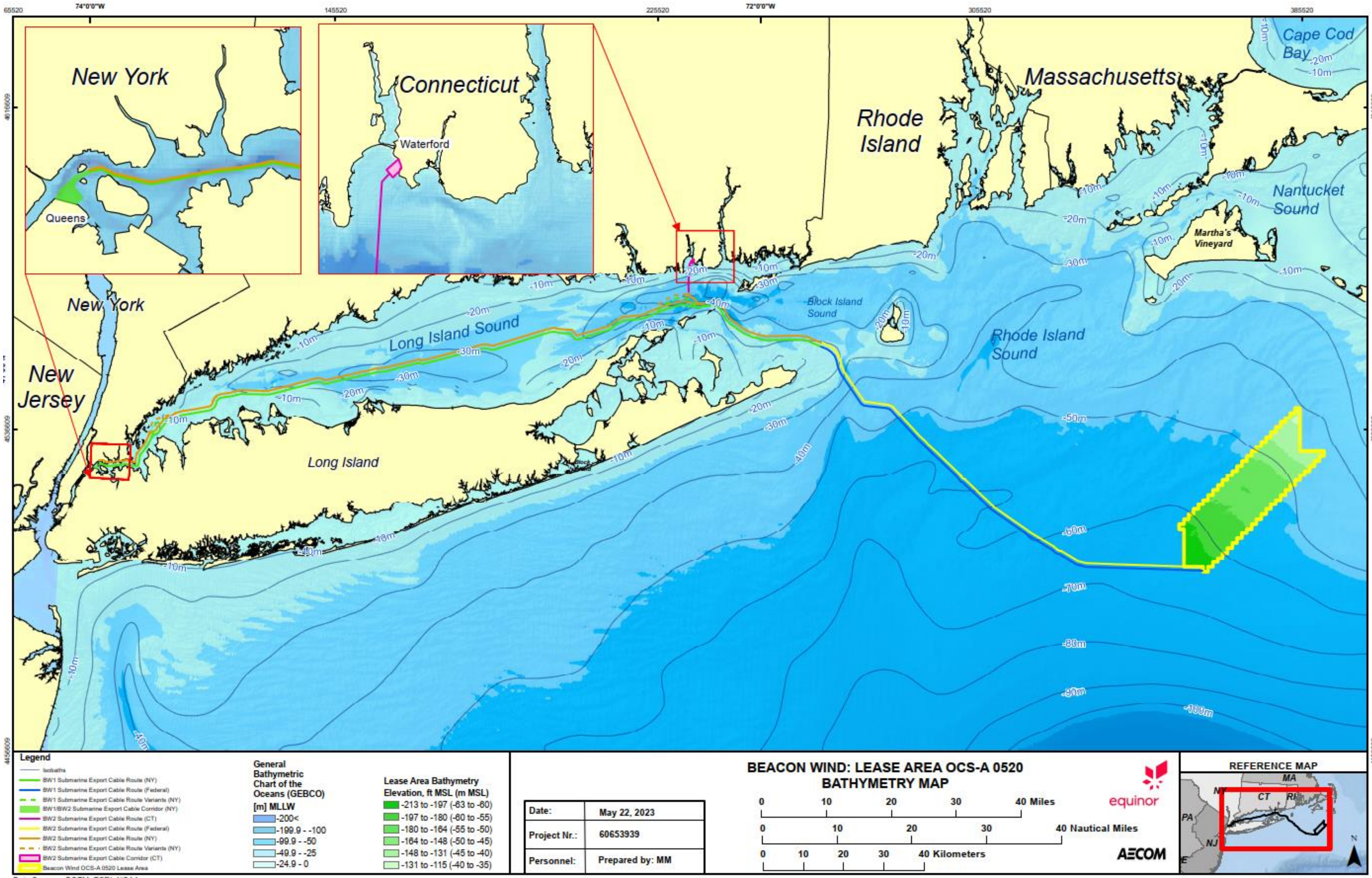
4.1.2.1.1 *Offshore Baseline Conditions*

Lease Area: The Lease Area is located in marine waters approximately 22 mi (19 nm, 35 km) southwest of Martha's Vineyard and Nantucket (**Figure 4.1-28**). The Lease Area lies within a portion of the northern Atlantic Ocean referred to as the Southern New England continental shelf subregion and is generally characterized as a region of low relief gently sloping seaward (Guida et al. 2017) (**Figure 4.1-29**). The sediments here were deposited by glaciers in the early-mid Pleistocene (approximately 130,000 years ago). The area is outside the mapped southern extent of the last glacial maximum during the late Pleistocene (BOEM 2018). Seismic profiles indicate that several buried channels exist at shallow depths below the seafloor in the vicinity of the Lease Area (BOEM 2018). Numerous shoals (i.e., Cox Ledge and Southwest Shoal) are also present in the vicinity of the Lease Area, acting as natural barriers that force waves to build and break prior to reaching coastlines (BOEM 2018). The northeastern half of the Lease Area is located at the western edge of a north-northwest trending glacial trough formed by a Late Pleistocene ice stream that was at least 900 ft (275 m) thick (Siegel et al. 2012).

Based on information from the high-resolution geophysical survey of the Lease Area, water depths in the Lease Area range from a shoal depth of 122 ft (37.2 m) in the northwest to 206 ft (62.9 m) in the southeast (Geoquip Marine 2021). Regionally, the seabed dips gently to the southwest at less than 0.1 degrees. The majority of the Lease Area consists of very gentle gradients. Gentle and moderate slopes are encountered along the edges of sorted bedforms (also called rippled scour depressions), while occasional steep and very steep gradients occur at edges of wrecks (see **Section 6.1 Marine Archaeological Resources** for discussion of wrecks in the Lease Area). Bedforms at the seabed surface include pitted seabed, ripples, and sorted bedforms, which indicate active reworking of seabed sediments by bottom currents. Additional details about conditions in the Lease Area is provided in **Appendix G Marine Site Investigation Report**.

Desktop sources identify surficial sediments within the Lease Area as shallow marine Holocene deposits consisting of predominantly medium to fine sand with some areas of very fine sand and silt (Poppe et al. 2014; USGS 2014) (**Figure 4.1-30**). The Project's sediment sampling in the Lease Area indicates a predominance of sand with some clay/silt layers in the northern and central portions of the Lease Area, whereas clay dominated sediments with sand are more prevalent in the southern portion of the Lease Area. Some organic material is present near channel deposits. The surficial sediments overlie Pleistocene fluvial and estuarine sediments deposited during glaciation. These deposits are thicker in the northeastern half of the Lease Area. Deeper stratigraphic units show signs of glacial deformation. The geologic units in the Lease Area are summarized in **Table 4.1-12** and depicted in **Figure 4.1-31**.

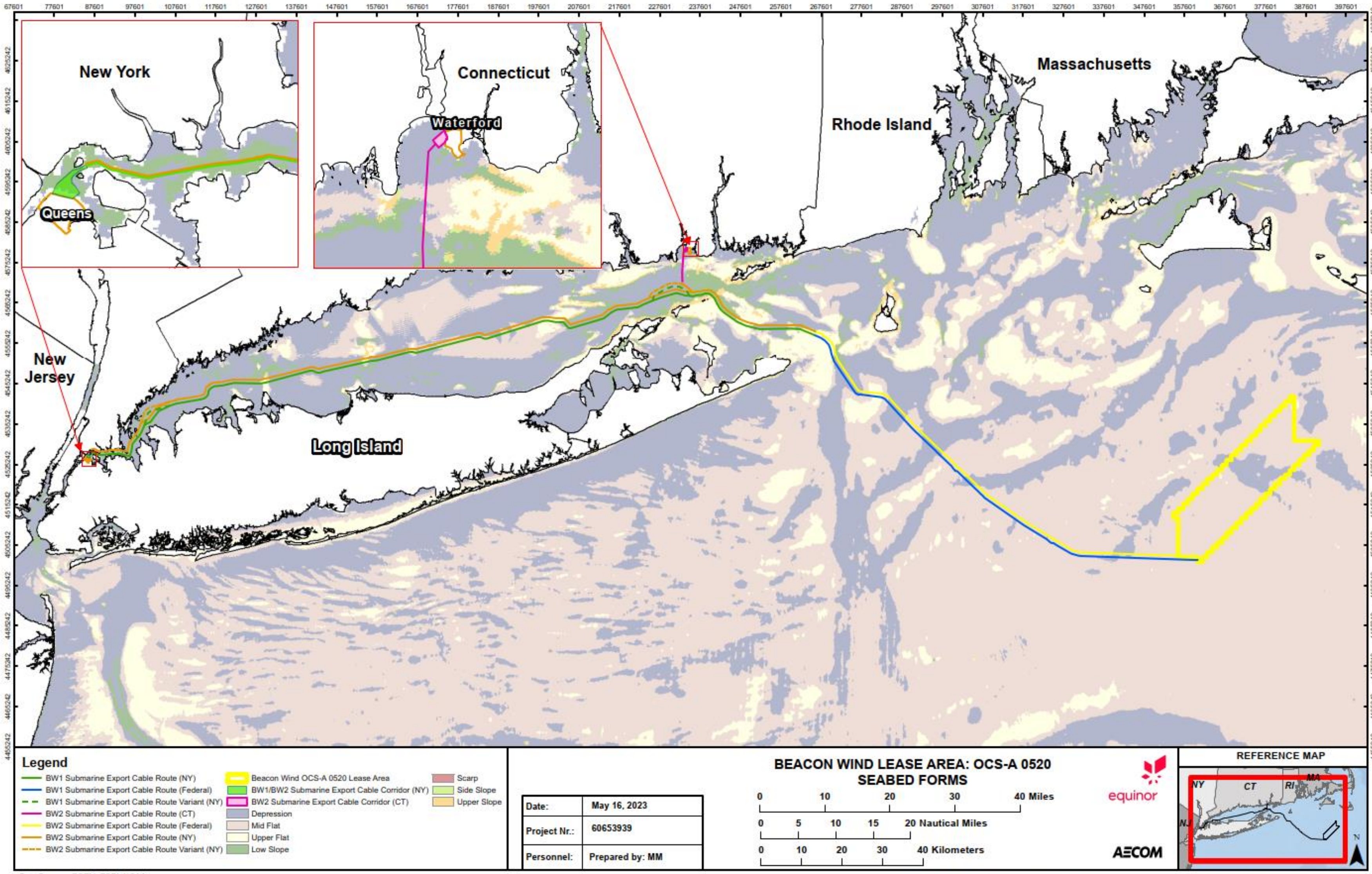
FIGURE 4.1-28. BATHYMETRY OF THE OFFSHORE PORTIONS OF THE PROJECT AREA



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

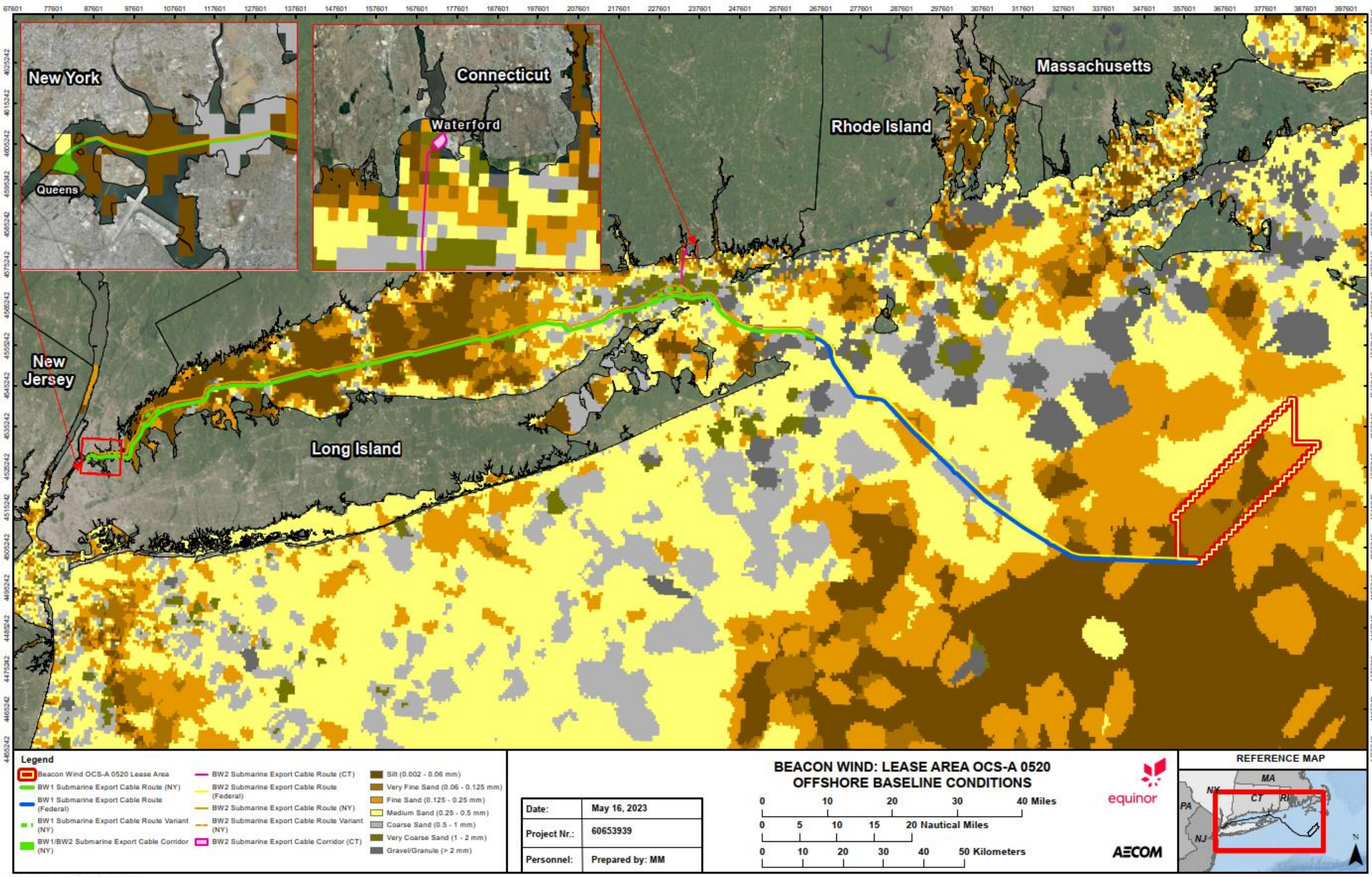
Document Path: C:\Users\MarolaD\AECOM\Equinor - Site Folders\Reports\BW2 COP\working\Section 4.1 - Geology\Fig4-1-27_BathymetryLeaseArea.mxd

FIGURE 4.1-29. NORTHEAST SEABED FORMS



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

FIGURE 4.1-30. SURFICIAL SEDIMENTS

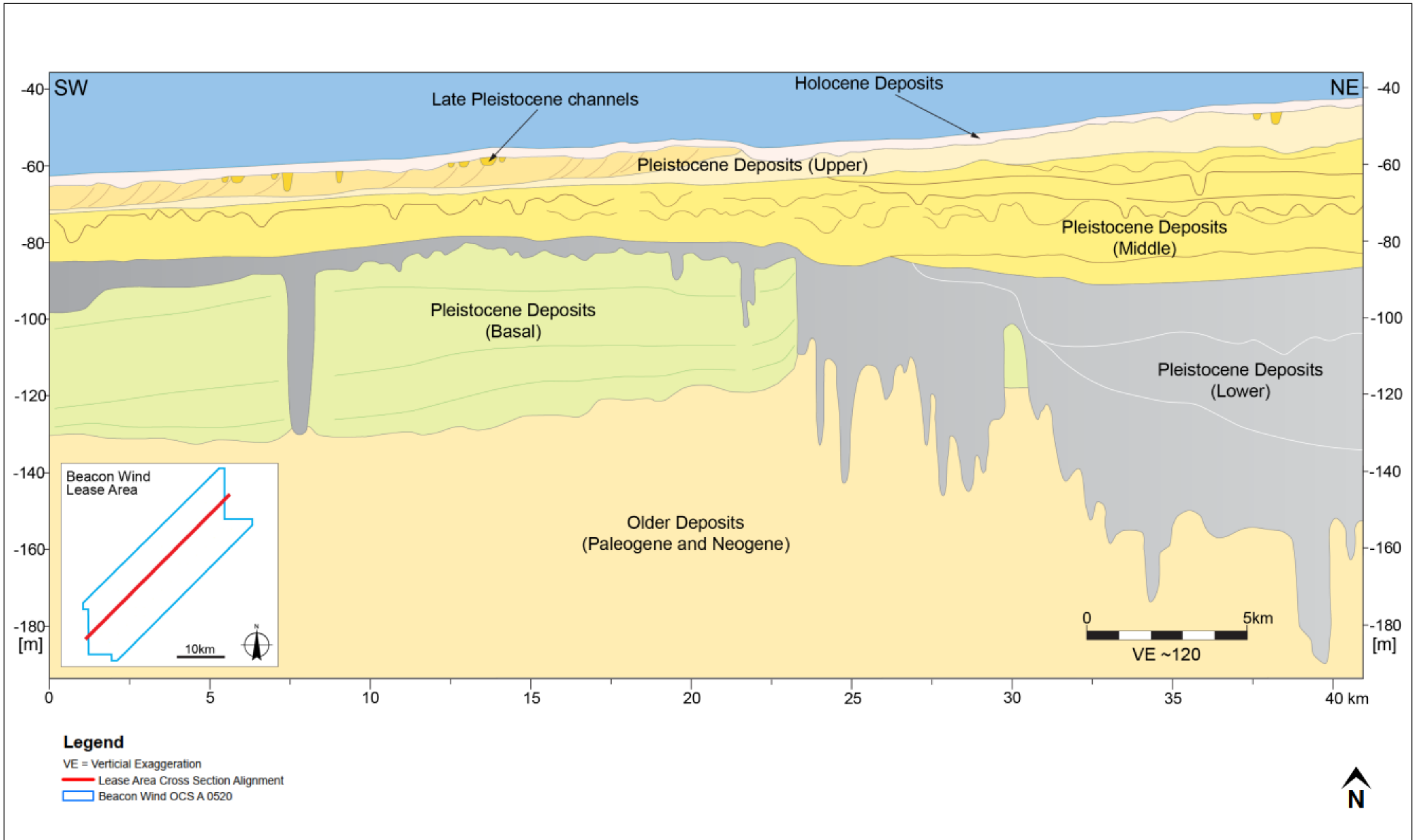


Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

TABLE 4.1-12. IDENTIFIED GEOLOGIC UNITS WITHIN THE LEASE AREA

Geological Unit	Interpreted Depositional Environment	Description	Composition	Depth range to unit base (m below seafloor [BSF])
Holocene Deposits	Marine	Soft, fine grained sediments; found throughout the Lease Area	Clays, silt, sand	0.3 - 7
Late Pleistocene Channels	Fluvial to marine	Erosive into Upper Pleistocene Deposits. Comprises of single channels and channel complexes found in the northeast and southwest of the Lease Area, respectively	Sand, clay, organics	0.8 - 10.6
Pleistocene Deposits (Upper)	Shallow marine	Progradational deposits (clinoforms) extend across the southwest half of the Lease Area, whereas shallow marine deposits associated with a sea level high stand characterize the northeast part	Sand, silty sand, clayey sand	0.5 - 16
Pleistocene Deposits (Middle)	Transgressive and outwash deposits	Stacked sequences of erosive, channelized and transgressive deposits reflecting frequent relative sea level fluctuations and varying energy regimes. The unit is present across entire Lease Area	Mostly sand, silt, some clay	7 - 54
Pleistocene Deposits (Lower)	Glacial outwash plain	Glacial deposits potentially comprising reworked sediments. Erosive into Basal Pleistocene Deposits. Varying degrees of internal deformation are observed. The unit is present across the Lease Area but thickens substantially in the northeast	Sand, silt, clay, gravel	32 - 163
Pleistocene Deposits (Basal)	Marine	Middle shelf, marine sands deposited in a stable, low energy environment. Unit is present in central and southwest part of the Lease Area	Sand, silt, clay, glauconite	48 - 96
Older Deposits	Coastal plain and marine	Inferred marine and/or fluvial deposits related to cyclic sea level changes	Not sampled	Base not seen

FIGURE 4.1-31. GEOLOGIC CROSS-SECTION OF LEASE AREA BASED ON BEACON WIND GEOTECHNICAL CAMPAIGN DATA



Geologic Cross-Section of Lease Area Based on Beacon Wind Geotechnical Campaign Data

BW1 and BW2 Submarine Export Cable Routes in Federal Waters: The BW1 and BW2 submarine export cable routes would be located within federal waters from the Lease Area to the entrance to Block Island Sound. The submarine export cable routes exit the southern boundary of the Lease Area generally to the west, then extends northwesterly to Block Island Sound. Like the Lease Area, this portion of the submarine export cable routes lie within the Southern New England continental shelf subregion of the northern Atlantic Ocean, which is generally characterized as a region of low relief gently sloping seaward (Guida et al. 2017). Surface sediments near the Lease Area are believed to be from glacial activity in the early-mid Pleistocene (approximately 130,000 years ago) (BOEM 2018). Near Block Island Sound, surface sediments transition to Late Pleistocene fluvial deposits, which were reworked by the Holocene transgression (i.e., movement of shoreline toward higher ground due to sea level rise) (Garrison and McMaster 1966).

Water depths range from 98 ft (30 m) deep near Block Island Sound and generally increase with distance from land to as deep as 229 ft (70 m) near the Lease Area (NOAA 2021b). Block channel is a deep channel with a depth of approximately 200 ft (61 m). The channel is flanked on the east by shallower areas known as Southwest Ledge, a discontinuous ridge that extends southwest from Block Island toward Montauk Point (NOAA 2021b).

The Nature Conservancy (TNC) mapped seabed topography as measured by a combination of seabed position and slope (TNC 2010). Seabed position describes the topography of the area surrounding a particular location, and slope is the steepness of the seafloor at that location. The Nature Conservancy used the following slope categories in its analysis:

- Level Flat = 0 – 0.015 degrees;
- Flat = 0.015 – 0.05 degrees;
- Gentle Slope = 0.05 - 0.8 degrees;
- Slope = 0.8 – 8.0 degrees; and
- Steep Slope (including canyons) = greater than 8.0 degrees.

Seabed forms along the submarine cable route in federal waters are primarily Mid Flats and Upper Flats dissected by Depressions (**Figure 4.1-29**) (TNC 2010). Mid Flats are a combination of lower middle to upper middle landscape position and Flat slope. Upper Flats are a combination of high or very high landscape position and Level Flat or Flat slope. Depressions are a combination of low or very low landscape position and Level Flat or Flat slope. Near Block Island Sound, the seabed forms are more diverse and include Depressions, Upper Flats, Low Slopes, Upper Slopes, and Mid Flats. Low Slopes are a combination of low or very low landscape position and Gentle Slope or Slope. Upper Slopes are a combination of high or very high landscape position and Gentle Slope or Slope.

Surficial sediments within the submarine cable corridor in federal water are predominantly silt and fine sand near the Lease Area and medium sand with patches of coarse and fine sand as the corridor continues northwest to Block Island Sound (NOAA 2021b). There is a notable band of coarse sand and gravel/granule sediment extending between the tip of Long Island and Block Island (NOAA 2021b).

Additional details about conditions and the stratigraphy underlying the submarine export cable routes in federal waters will be provided in a supplemental COP filing to the **Appendix G Marine Site Investigation Report**. Results of the offshore geophysical survey, which will include information about the

BW1 and BW2 Submarine Export Cable Routes in New York Waters: The BW1 and BW2 submarine export cable routes traversing to the landfalls at Queens, New York would be located within New York State waters from Block Island Sound, through Long Island Sound to the landfall in Queens, New York. Block Island Sound connects to Long Island Sound through The Race (**Figure 4.1-32**). The submarine export cable routes enters New York State waters in Block Island Sound, continues northwestward through The Race to Long Island Sound, then generally westward to the East River and landfall in Queens, New York.

Western Block Island Sound is characterized by irregular topography that includes six major depressions and shallow ridges and knolls generally oriented to the southeast. The deepest depression is located near Fishers Island, extending between 210 and 330 ft (64 to 100 m) deep. The bedrock and overlying sediments in Block Island Sound were extensively eroded during the late Tertiary and early Pleistocene, carving valleys that coalesced and drained southward (McMaster and Ashraf 1973; Needell et al. 1983; Needell and Lewis 1984).

Western Block Island Sound includes six major depressions with water depths extending to 210 and 330 ft (64 to 100 m). Seabed forms in Block Island Sound include Upper Flats, Depressions, Mid Flats, Low Slopes, and Upper Slopes. Surficial sediments along the cable corridor in Block Island Sound include fine sand, medium sand, and bands of coarse sand and gravel/granule at areas of water exchange with Long Island Sound at The Race and with the Atlantic Ocean between the tip of Long Island and Block Island.

Long Island Sound is divided into five regions consisting of the Eastern, Central, and Western Basins; the Eastern Narrows; and the Western Narrows **(Figure 4.1-32**). Long Island Sound was formed through a combination of glaciation, ice retreat, and marine submergence. The Eastern Basin of Long Island Sound is characterized by gentle slopes and greater depths than the other two basins. Water depths generally range from 114 to 197 ft (35 to 60 m) in most areas of the Eastern Basin. The deepest portion of the Eastern Basin is located at the narrowest eastern end leading to The Race, an area where strong currents exchange ocean water within deep channels that connect to Block Island Sound. The Race reaches a depth of approximately 300 ft (91 m). Flow westward from the Eastern Basin to the Central Basin is attenuated by Mattituck Sill, a shallow submarine ridge, with depths averaging 69 ft (21 m) (Gottschall et al. 2000). Seabed forms in the Eastern Basin are predominantly Depressions; with Low Slopes, and Upper Slopes near The Race; and Upper Flats, Upper Slopes, Low Slopes, and Mid Flats along the Mattituck Sill. Surficial sediments along the cable corridor in the Eastern Basin include fine to very coarse sand and gravel/granule.

The Central Basin of Long Island Sound is the largest and widest portion of Long Island Sound and is bound by the Mattituck Sill on the east and the Stratford Shoal on the west. It is characterized by gentle slopes leading into a flatter bottom, generally 100 ft (30 m) in depth. The deepest area of the Central Basin is approximately 147 ft (45 m) deep and approximately 5.3 mi (4.6 nm, 8.5 km) north of Mt. Sinai Harbor, Long Island. Seabed forms in the Central Basin are predominantly Depressions and Mid Flats, with some areas of Upper Flat. Surficial sediments along the cable corridor in the Central Basin are predominantly silt, very fine sand, and sand; the corridor also includes areas of medium to very coarse sand near the Mattituck Sill.

The Stratford Shoal extends generally from Stratford, Connecticut, south to Port Jefferson, Long Island, and shallow areas restrict water flow between the Central Basin and the Western Basin. The Stratford Shoal is characterized by shallow areas separated by two deeper east-west channels: one approximately 4 mi (3.5 nm, 6.4 km) south of Connecticut and one approximately 2 mi (1.7 nm, 3 km) north of Long Island. Seabed forms in the Stratford Shoal are predominantly Upper Flat and Upper Slope, with Low Slopes where channels cut through the shoal. Surficial sediments along the Stratford Shoal transition from coarse material (gravel/granule) to fine sand with distance from the shoal.

The Western Basin of the Long Island Sound is characterized by gentle bathymetric slopes extending from the northern and southern shores toward the basin's center. A deeper natural channel runs east-west along the main axis of Long Island Sound with water depths ranging from around 115 ft (35 m) mid basin and increasing westward toward the Norwalk Shoal, up to maximum of approximately 200 ft (61 m) at the Norwalk Shoal southern channel **(Figure 4.1-32**). Seabed forms in the Western Basin are predominantly Depressions and Mid Flats. Surficial sediments along the cable corridor in the Western Basin are predominantly silt but the corridor also includes very fine sand, and fine sand.

The Norwalk Shoal extends from Norwalk, Connecticut south to Eatons Neck on Long Island. Similar to the Stratford Shoal, the Norwalk Shoal has two deeper areas that are separated by shallow shoals that restrict flow between the Western Basin and the Eastern Narrows. Seabed forms at the Norwalk Shoal include Upper Flats, Upper Slopes, and Low Slopes where the channels cut through the shoal. Surficial sediments along the Norwalk Shoal transition from very coarse to fine sand with distance from the shoal.

The Narrows is the westernmost portion of Long Island Sound, extending between the mouth of the East River in the west and the Norwalk Shoal in the east. The Hempstead Sill, a shoal extending from Matinecock Point on Long Island to the New York/Connecticut boundary in the north, divides the Narrows into the Eastern Narrows and Western Narrows. The Eastern Narrows are nearly level and depths range from 32 to 66 ft (10 to 20 m). In the Western Narrows, depths range from 32 to 108 ft (10 to 33 m), and reefs and islands are common features (Gottschall et al. 2000 and NOAA 2021b).

Seabed forms in the Eastern Narrows are predominantly Depression, with some Low Slopes. Surficial sediments along the cable corridor in the Eastern Narrows are predominantly silt but also include areas with very fine sand, fine sand, medium sand, coarse sand and very coarse sand. Seabed forms in the Western Narrows are predominantly Depression with some Low Slopes. Surficial sediments along the cable corridor in the Western Narrows include silt and very fine sand.

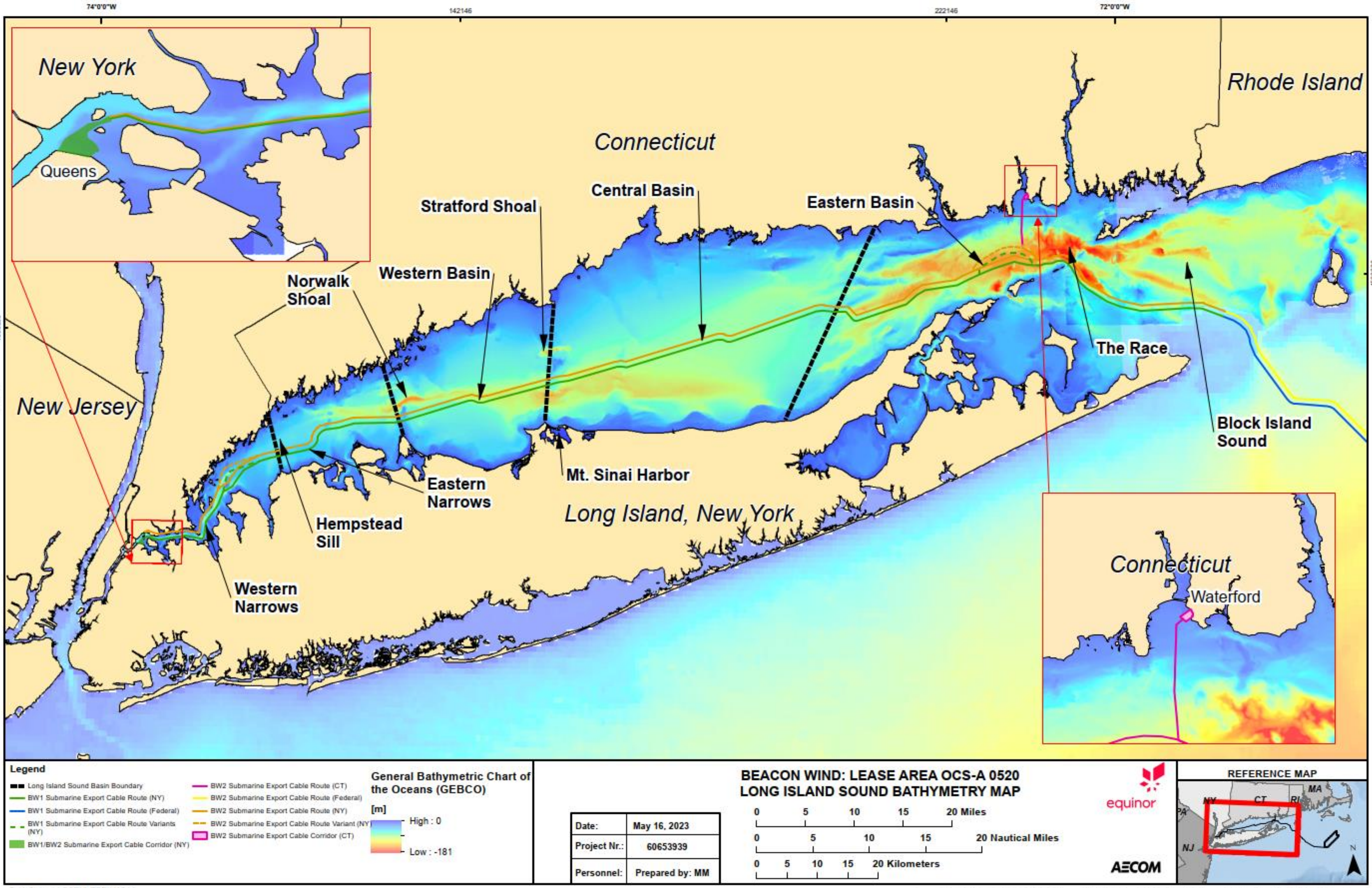
The BW1 and BW2 submarine export cable routes continue through New York State waters into the East River to Queens, New York. The East River Navigation Channel project depth is 35 ft (10.6 m); depths outside the navigation channel range from 2 to 108 ft (0.6 to 33 m). Seabed forms include depressions and low slope. Surficial sediments include silt, very fine sand, and sand.

Additional details about conditions and the stratigraphy underlying the submarine export cable routes in New York State waters will be provided in a supplemental COP filing to the **Appendix G Marine Site Investigation Report**.

BW2 Submarine Export Cable Route in Connecticut Waters. In addition to the submarine export cable routes to Queens, New York described above, Beacon Wind is also assessing a landfall option for BW2 in Waterford, Connecticut. For the Waterford, Connecticut landfall alignment, the submarine export cable route would exit from the Lease Area and travel northwest into the Eastern Basin of Long Island Sound. About 5 nm (9 km) west of The Race, the BW2 submarine export cable route would separate from the BW1 submarine export cable route and turn north to transit through Connecticut

State waters to Niantic Bay and landfall at Waterford, Connecticut. Water depths at the Connecticut State waters boundary are around 150 feet (46 m) and gradually decrease towards shore **(Figure 4.1-29**). Seabed forms along this route through Connecticut waters are predominantly Depressions with Mid Flats and Low Slopes (**Figure 4.1-30**). Sediments range from coarse to very fine sand, generally becoming finer with increasing proximity to shore (**Figure 4.1-31**). Additional details about conditions and the stratigraphy underlying the submarine export cable route in Connecticut State waters will be provided in a supplemental COP filing to the **Appendix G Marine Site Investigation Report**.

FIGURE 4.1-32. BATHYMETRY OF LONG ISLAND SOUND



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

Document Path: C:\Users\burfeindn\AECOM\Equinor - Site Folders\Reports\BW2 COP\working\Section 4.1 - Geology\Fig4-1-31_LIS_Bathymetry.mxd

4.1.2.1.2 *Onshore Baseline Conditions – Queens, New York*

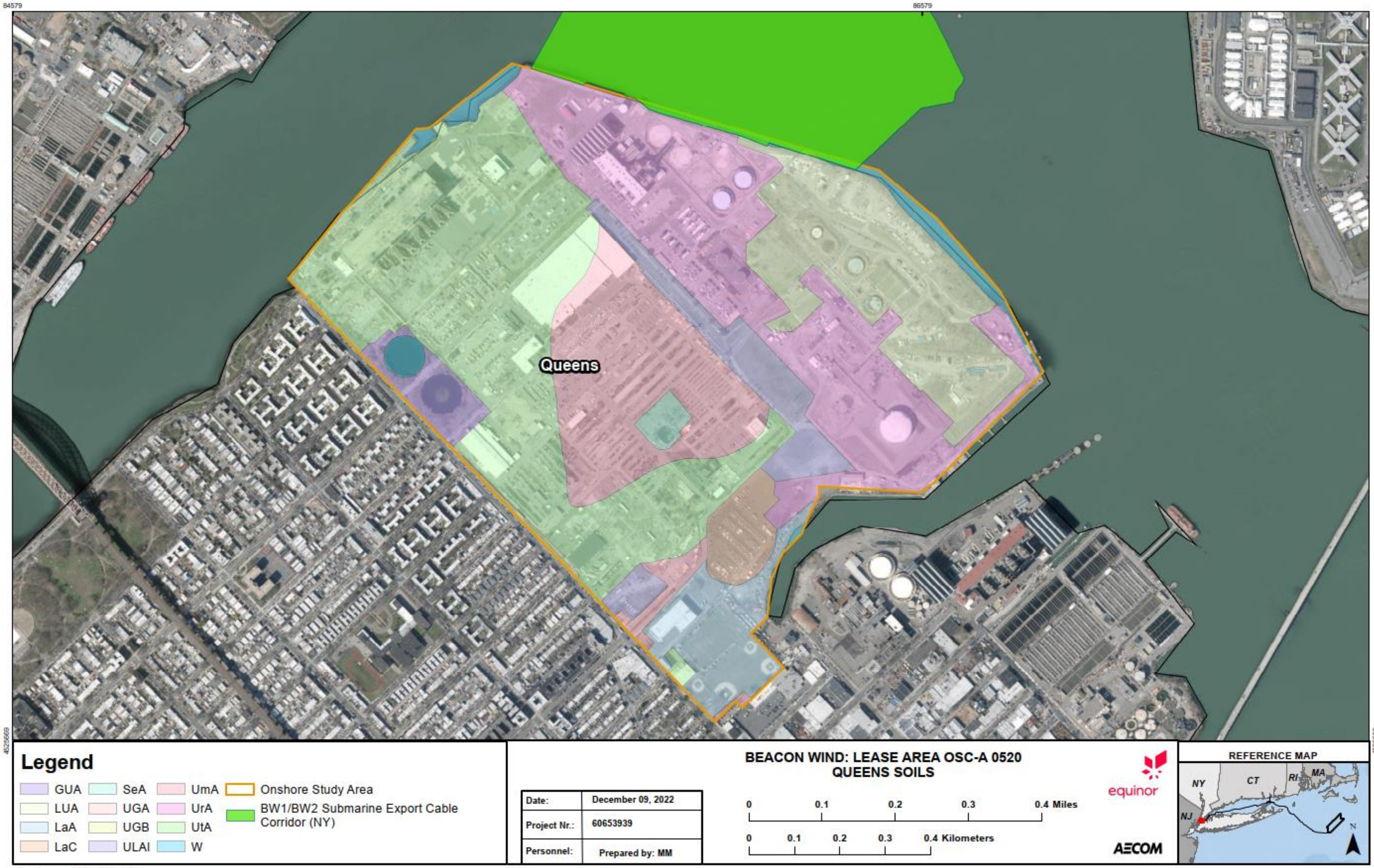
Onshore portions of the Project Area at Queens, New York are located in the Long Island Coastal Lowlands Section of New York's Atlantic Coastal Plain Physiographic Province. The natural surficial geology of the Long Island Coastal Lowlands Section consists of Pleistocene sandy till; sandy loamy till; moraine gravel, sand, and silt; and outwash gravel, sand, and silt as well as saline and estuarine marsh deposits underlain by unconsolidated Quaternary glacial and alluvial deposits and/or Harrison/Ravenswood gneiss (Bryce et al. 2010; NRCS Training Center 2021; USGS 2021). However, in the onshore portions of the Project Area itself, the natural soils have been either removed or covered with fill and construction material.

Based on the U.S. Department of Agriculture Natural Resources Conservation Service soil survey data (NRCS 2021), the Project Area for the onshore facilities at Queens, New York comprises primarily Urban land soils (see **Figure 4.1-33**). Individual soil units that occur in the Project Area are described in **Table 4.1-13**. Surficial soils in this area are underlain by Wisconsinan glacial deposits with variable thicknesses generally ranging from about 50 to 100 ft (15 to 30 m) (Soren 1978).

TABLE 4.1-13. ONSHORE PORTIONS OF PROJECT AREA SOILS, QUEENS, NEW YORK

Soil Unit	Map ID	Slopes (percent)	Typical Profile of Dominant Components
Greenbelt-Urban Land complex	GUA	0 to 3	loam over sandy loam cemented material over gravelly sandy loam
Laguardia-Urban land complex	LUA	0 to 3	cobbly-artifactual coarse sandy loam over very cobbly-artifactual coarse sandy loam cemented material over gravelly sandy loam
Laguardia artifactual coarse sandy loam	LaA LaC	0 to 3 8 to 15	cobbly-artifactual coarse sandy loam over very cobbly-artifactual coarse sandy loam
Secaucus artifactual fine sandy loam	SeA	0 to 3	gravelly- to very gravelly artifactual fine sandy loam over extremely cobbly-artifactual fine sandy loam
Urban land-Laguardia complex	ULAI	0 to 3	cemented material over gravelly sandy loam cobbly-artifactual coarse sandy loam over very cobbly-artifactual coarse sandy loam
Urban land, tidal marsh substratum	UmA	0 to 3	cemented material over very gravelly sand
Urban land, reclaimed substratum	UrA	0 to 3	cemented material over gravelly sandy loam
Urban land, till substratum	UtA	0 to 3	cemented material over gravelly sandy loam
Water	W	Not applicable	not applicable
Source: NRCS 2021			

FIGURE 4.1-33. QUEENS, NEW YORK SOILS



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributions

ONSHORE BASELINE CONDITIONS – WATERFORD, CONNECTICUT

Onshore portions of the Project Area at Waterford, Connecticut are located in the New England Upland section of the New England Physiographic Province. All the surficial sediments in Connecticut were deposited during the Quaternary Period (Stone et al. 2005). At least twice in the late Pleistocene, continental ice sheets swept across Connecticut. Two surficial geologic units are present in the Waterford onshore Study Area. Niantic deposits from a sediment-dammed Wisconsinan glacial meltwater lake occur in the westernmost part of the onshore Study Area. The surficial geology over the rest of the onshore Study Area consists of thin (generally less than 12 to 15 ft [4 to 5 m] thick) till deposits from late Wisconsinan, Illinoian glaciation (Stone et al. 2005). The till is comprised of poorly sorted, nonlayered sediments ranging from poorly sorted compact silty and clayey till to less compact sandy and gravelly till. It locally includes layers of loose till and lenses of sand and gravel (Goldsmith 1974). This till unit is discontinuous on slopes or in areas of moderate local relief where bedrock outcrops are numerous and where bedrock surface topography controls local relief of land surface (Stone et al. 2005).

Stone et al. (2005) map the bedrock in this area as undivided schists and gneisses consisting of mostly light gray to medium-gray metamorphic rocks of Proterozoic to Devonian age. Locally, the Westerly Granite (a gneiss) has historically been mined in this area.

Based on the U.S. Department of Agriculture Natural Resources Conservation Service soil survey data (NRCS 2022), the Project Area for the onshore facility at Waterford, Connecticut is comprised of twenty-two soil types but primarily consisting of urban land with smaller areas of well drained soils (see **Figure 4.1-34**). Individual soil units that occur in the Project Area are described in **Table 4.1-14**.

TABLE 4.1-14. ONSHORE PORTIONS OF PROJECT AREA SOILS, WATERFORD, CONNECTICUT

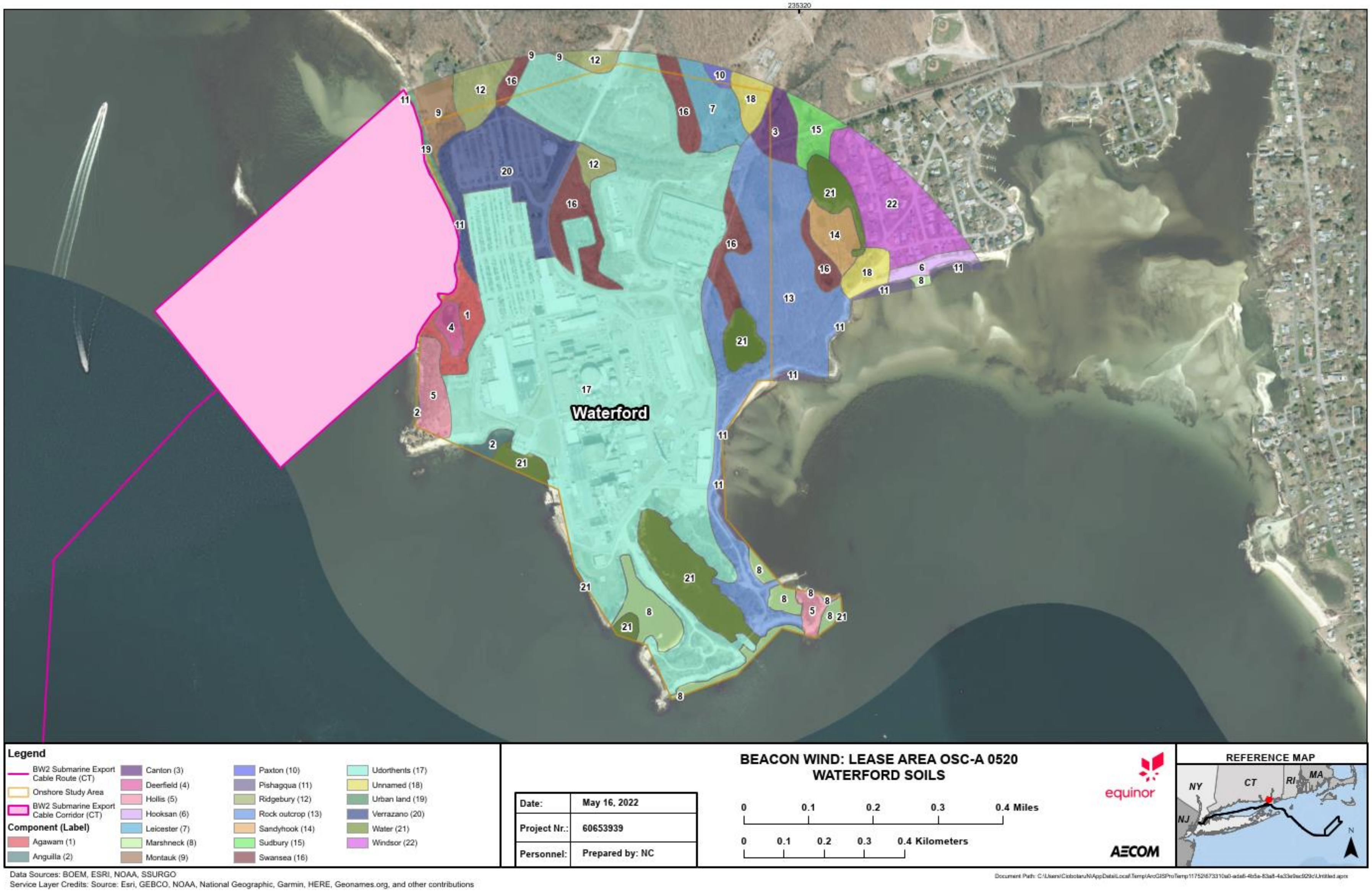
Soil Series	Map ID	Description
Agawam	1	Very deep, well drained soils formed in sandy, water deposited materials. Level to steep soils on outwash plains and high stream terraces.
Anguilla	2	Very deep, subaqueous soils permanently submerged beneath 4 through 59 in (10 through 150 cm) of tidal estuarine water in mainland coves and submerged mainland beaches within coastal lagoons and open bays.
Canton	3	Very deep, well drained soils formed in a loamy mantle underlain by sandy till. Nearly level to very steep moraines, hills, and ridges.
Deerfield	4	Very deep, moderately well drained soils formed in glaciofluvial deposits. Nearly level to strongly sloping soils on terraces, deltas, and outwash plains.
Hollis	5	Well drained and somewhat excessively drained soils formed in a thin mantle of till. Shallow to bedrock. Nearly level to very steep upland soils on bedrock-controlled hills and ridges.

Soil Series	Map ID	Description
Hooksan	6	Very deep, excessively drained fine sand, sand, or coarse sand on rolling topography with beach grass and brush cover.
Leicester	7	Very deep, poorly drained soils formed in coarse-loamy till. Nearly level or gently sloping soils in drainageways and low-lying positions on hills.
Marshneck	8	Very deep, subaqueous soils permanently submerged beneath up to 98 in (250 cm) of tidal estuarine water on flood tidal delta slopes and shoals in coastal lagoons and bays. Formed in coarse loamy marine and estuarine sediments transported by flood tidal currents and estuarine silts settling in low energy areas.
Montauk	9	Very deep, well drained soils formed in lodgment or flow till derived primarily from granitic materials with lesser amounts of gneiss and schist. On upland hills and moraines.
Paxton	10	Very deep well drained loamy soils formed in lodgment till. Nearly level to steep soils on hills, drumlins, till plains, and ground moraines.
Pishagqua	11	Very deep, subaqueous soils permanently submerged in lagoon bottoms and lagoon channels in coastal lagoons and bays. Formed beneath 20 to 197 in (50 to 500 cm) or more of tidal estuarine water in fine-silty marine or estuarine deposits.
Ridgebury	12	Very deep, somewhat poorly and poorly drained soils formed in lodgment till derived mainly from granite, gneiss and/or schist. Nearly level to gently sloping soils in depressions in uplands. Also occur in drainageways in uplands, in toe-slope positions of hills, drumlins, and ground moraines, and in till plains.
Rock outcrop	13	Bedrock
Sandyhook	14	Very deep, very poorly drained soils formed in thick sandy marine deposits along the Atlantic coast. Subject to daily tide flooding. Slopes from 0 to 8 percent.
Sudbury	15	Very deep, moderately well and somewhat poorly drained soils on outwash plains. Nearly level through strongly sloping soils in slight depressions and on terraces and foot slopes in areas of outwash or glaciofluvial deposits.
Swansea	16	Very poorly drained organic soils. Formed in 16 to 51 in (40 to 130 cm) of highly decomposed organic material over sandy mineral. In depressions or on flat level areas on uplands and outwash plains.

Soil Series	Map ID	Description
Udorthents	17	Primarily moderately coarse textured soil material and a few small areas of medium textured material. In areas that have been cut to a depth of 2 ft (0.61 m) or more or are on areas with more than 2 ft 0.61 m) of fill.
Unnamed	18	No information available
Urban Land	19	Soils in areas of high population density in the largely built environment.
Verrazano	20	Very deep well drained soils formed in loamy human-transported materials over sandy material and occurs on human-altered landscapes in and near major urbanized areas of the Northeast. The loamy mantle is typically a deliberate addition of topsoil to improve lawns and grassed areas.
Water	21	Not applicable
Windsor	22	Very deep, excessively drained soils formed in sandy outwash or eolian deposits. Nearly level to very steep soils on glaciofluvial landforms.

Source: NRCS 2022

FIGURE 4.1-34. WATERFORD, CONNECTICUT YORK SOILS



4.1.2.2 *Impacts Analysis for Construction, Operations, and Decommissioning*

The potential impacts during 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 BW1 and BW2. The maximum design scenario, as described in **Table 4.1-18**, 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 for BW1 and BW2. The parameters provided in **Table 4.1-15** represent the maximum design scenario associated with full build-out of the Lease Area to incorporate a total of up to 157 structures within the Lease Area (made up of up to 155 wind turbines and two offshore substation facilities) with one submarine export cable route for BW1 to Queens, New York and one submarine export cable route for BW2 to Queens, New York or Waterford, Connecticut and two onshore substation facilities.

TABLE 4.1-15. SUMMARY OF MAXIMUM DESIGN SCENARIO PARAMETERS FOR GEOLOGICAL CONDITIONS

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	Representative of the maximum number of structures.

Submarine export cables	Based on full build-out of the Project (BW1 and BW2):
	• BW1 to Queens, New York (202 nm [375 m]).
	• BW2:
	  ○ To Queens, New York (202 nm [375 km]) or
	  ○ To Waterford, Connecticut (113 nm [209 km]).
		Representative of the maximum length of new submarine export cables to be installed.

Interarray cables	Based on full build-out of the Project (BW1 and BW2): BW1: 162 nm (300 km). BW2: 162 nm (300 km).	Representative of the maximum length of interarray cables to be installed.
Foundation horizontal disturbance	Jacket (Piled or Suction Bucket)	Representative of the foundations that would result in the maximum horizontal area of sediment disturbance during installation.
Foundation installation method vertical depth disturbance	Piled Jacket	Representative of the foundation installation method that would result in the maximum vertical depth of sediment disturbance during installation.
Project-related vessels	Based on full build-out of the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), 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.

Parameter	Maximum Design Scenario	Rationale
Submarine export cable landfalls offshore	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York (HDD casing pipe and goalposts in a 60 ft by 7 ft [18 m by 2 m] area). • BW2: o To Queens, New York (HDD casing pipe and goalposts in a 60 x 7 ft [18 x 2 m] area offshore) or o To Waterford, Connecticut (HDD casing pipe and goalposts in a 60 x 7 ft [18 m x 2 m] area offshore.	Representative of the maximum area to be utilized to facilitate the export cable landfalls offshore.
Submarine export cable landfalls onshore	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York (HDD work area in a 246 ft by 246 ft [75 m by 75 m] area). • BW2: o To Queens, New York (HDD work area in a 246 ft x 246 ft [75 m x 75 m] area) or o To Waterford, Connecticut (HDD work area in a 328 ft x 164 ft [100 m x 50 m] area).	Representative of the maximum area to be utilized to facilitate the export cable landfalls onshore.
Onshore export and interconnection cables	Based on full build-out of Project (BW1 and BW2): • BW1 to Queens, New York (0.93 mi [1.5 km]) • BW2: o To Queens, New York (0.93 mi [1.5 km]) or o To Waterford, Connecticut (0.55 mi [0.89 km]).	Representative of the maximum length, width, and area of onshore export and interconnection cables to be installed.
Onshore substation facilities	Based on full build-out of the Project (BW1 and BW2): • BW1 Queens, New York (up to a 16-ac [6.5-ha] area). • BW2: o Queens, New York (up to a 16 ac [6.5 ha]) or o Waterford, Connecticut (up to a 16 ac [6.5 ha]).	Representative of the maximum area to be utilized to facilitate the construction of the onshore substation facilities.
Staging and construction areas, including port facilities, work compounds, and lay-down areas	Based on full build-out of the Project (BW1 and BW2). Maximum number of work compounds and lay-down areas required. Some ground disturbing activities may be anticipated at Queens, New York with grading and minor tree clearing at Waterford, Connecticut. 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 and Maintenance		
Project-related vessels	Based on full build-out of the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), submarine export cables , and associated interarray cables. Based on maximum number of vessels and movements for servicing and inspection.	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, substation facilities, and 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 Project Area. Installation of the Project is not anticipated to result in broad scale impacts to the geological setting in the area.

The Project has included appropriate foundation and cable installation methodologies that account for the geological conditions of the Project Area. 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, 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 landfalls, onshore export and interconnection cables, and onshore substation facilities 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 Beacon Wind will comply with applicable permitting standards to limit environmental impacts from Project-related activities.

Results of the offshore geophysical surveys were used to address geologic hazards in the Lease Area and along the submarine export cable routes. Potential hazards and risks are presented for each part of the Project Area in **Table 4.1-16** and **Table 4.1-17** below. Additional details about identified geohazards are provided in **Appendix G Marine Site Investigation Report**.

TABLE 4.1-16. POTENTIAL GEOLOGIC HAZARDS IN THE LEASE AREA AND MITIGATION STRATEGIES

Hazard	Description and Potential Impact	Mitigation Strategies
Lease Area		
Shallow Faults	None observed within Lease Area	No mitigation required
Shallow Gas, pockmarks	Seismic amplitude variations typically associated with channel lag deposits are identified in several areas across the Lease Area. They are interpreted to be associated with soft clays and possibly organic-rich material which may contain small amounts of biogenic gas. Shallow gas could result in disturbance of shallow soils reducing foundation capacity and stiffness and can pose a risk to the operations in the field.	Addressed for geotechnical drilling operations in Equinor shallow gas assessment and initial Desktop Study.
Gas hydrates	None observed within Lease Area	No mitigation required

Hazard	Description and Potential Impact	Mitigation Strategies
Lease Area		
Slump blocks or slump sediments	None observed within Lease Area	No mitigation required
Slumps or slides, potentially unstable slopes, creep, karst topography	None observed within Lease Area	No mitigation required
Ice scour of seabed sediments	None observed within Lease Area	No mitigation required
Glaciotectonics in Quaternary sediments	Local internal deformation of seismic unit U110 which is interpreted to contain glacial sediments.	To be considered in the geotechnical design of the foundations.
Scour, erosion features	Scour is observed around debris and shipwrecks. Scour can lead to exposure and/or burial of structures.	Scour modelling and protection studies as input to foundation design
Boulders at surface	No boulders were identified at the seabed within the Lease Area	No mitigation required
Buried boulders	Boulders were identified as low probability in the Desktop Study. There is a possibility of subsurface boulders in seismic units U090, U100, and U110, but they are difficult to identify from seismic data. However, geotechnical soil investigations did not encounter subsurface boulders. The presence of boulders may hinder installation of deep foundations such as monopiles and jackets with pin piles.	To be considered in the geotechnical design of the foundations and during installation phase.
Seabed obstructions and manmade features	Numerous contacts were identified on side scan sonar and magnetometer data, classified as either active or derelict fishing equipment; four wrecks were identified within the Lease Area. No known existing infrastructure is present in the Lease Area. The presence of seabed obstructions could hinder installation operations. Debris can be dragged and result in local features.	Assessment carried out for the inter-array cables and on a location-by-location basis prior to foundation installation. A pre-installation survey and preparation works may be required in critical locations. MARA determines cultural significance of wrecks.
Unexploded Ordnance (UXO)	Clearance for each WTG location is required for geotechnical operations. Unintentional disturbance and/or detonation of UXO can pose a major safety risk to individuals and assets.	Refined during engineering phase. In some areas, installations may require specific UXO survey and clearance certificates.

Hazard	Description and Potential Impact	Mitigation Strategies
Lease Area		
Seismic activity	Earthquake activity is considered very low (Desktop Study).	Impact assessed during design phase.
Seabed subsidence	None observed within Lease Area	No mitigation required
Liquefaction and seabed subsidence	Loose granular soils may liquefy under cyclic loading (seismic or wave loading) reducing foundation bearing capacity. Liquefaction can lead to a dramatic reduction of foundation resistance and stiffness, as wells as increased loading of the foundation.	Assessed during the geotechnical design and foundation engineering stages.
Seabed mobility	Ripples are observed.	Low impact, no mitigation required.
Ridges, bedforms, seabed scars/drag marks	The Lease Area seabed is characterized by gentle gradients (1-5 degree). Pitted sands, ripples, and sorted bedforms are observed; trawl scars are common. Trawling could damage inter-array cables if cables are not buried to sufficient depth.	Detailed review during inter-array cable CBRA, design and installation stages.
Bedrock, rock outcrop, reefs	None observed within Lease Area	No mitigation required
Unusual soils	Glauconite sands were identified in Seismic Unit U130. Published data on this type of material and its engineering properties is limited. The particles in these soils tend to break down during a process such as pile driving, which could lead to changes in soil properties and soil behavior.	Targeted investigation and laboratory testing strategy to acquire the necessary data to assess this risk is ongoing. Assess the effect of glauconite sands on foundation installation such as pile driving and follow avoidance strategy if necessary.
Organic soils	Possible organic soils (e.g., peat) associated with shallow paleochannels. Organics can present a layer of low soil strength.	Assessment during CBRA and design phase.

TABLE 4.1-17. POTENTIAL GEOLOGIC HAZARDS ALONG THE SUBMARINE EXPORT CABLE ROUTES AND MITIGATION STRATEGIES

Hazard	Description and Potential Impact	Mitigation Strategies
Submarine Export Cable Routes		
Shallow Faults	None observed	No mitigation required
Shallow Gas, pockmarks	Shallow gas is observed in several areas along the submarine export cable routes. Gas or fluid seepage is not observed.	Risk is considered low, no mitigation.
Gas hydrates	None observed	No mitigation required
Slump blocks or slump sediments	None observed	No mitigation required
Slumps or slides, potentially unstable slopes, creep, karst topography	Potentially unstable steep slopes in The Race.	Assessment in CBRA study.
Sludge/contaminated soils	Contaminated soils recovered from vibrocores in East River. Could result in the disturbance of contaminants exceeding thresholds during cable installation	Will be assessed in the sediment transport analysis. Installation tools and methodology to reduce disturbance will be selected based on modelling results and real time installation monitoring
Ice scour of seabed sediments	None observed	No mitigation required
Glaciotectonics in Quaternary sediments	None observed	No mitigation required
Till, glacial sediments	Glacial till is interpreted to be present in several areas along the Submarine Export cable Route. Till can represent a harder layer and might lead to cable installation challenges.	Assessment in CBRA and cable installation studies.
Surface live bottoms, buried channel and scour features	Former fluvial drainage pathways interpreted as Holocene and Pleistocene paleochannels are observed in several areas along the submarine export cable routes.	Channel fill and presence documented in survey and geotechnical reports. MARA significance to be determined.
Boulders at surface	Boulders are observed in several areas along the submarine export cable routes.	Assessment in CBRA study. Will either be removed or relocated if boulders are in the path of the cable installation
Buried boulders	Potential glacial origin infers possibility of subsurface boulders,	Dependent on depth and impact on cable route. Need for removal

Hazard	Description and Potential Impact	Mitigation Strategies
Submarine Export Cable Routes		
	but they are difficult to identify from seismic data.	or relocation part of the assessment in CBRA study.
Seabed obstructions and manmade features	Areas affected by pre-existing seabed intervention (e.g., mooring areas, dredged channels).	Assessment in CBRA study.
Crossings, existing infrastructure	Infrastructure on the seabed or trenched below it (e.g., cables, pipelines).	Crossing designs and methodology will be coordinated with asset owners.
Unexploded Ordnance (UXO)	Unintentional disturbance and/or detonation of UXO can pose a major safety risk to individuals and assets.	UXO mitigation strategy will be refined during engineering phase. An additional survey can be carried out if required.
Seismic activity	Risk of earthquakes is considered low.	Impact assessed during design phase.
Seabed subsidence	None observed	No mitigation required
Liquefaction and seabed subsidence	Loose granular soils may liquefy under cyclic loading (seismic or wave loading) leading to trench instability.	Assessed in CBRA and cable installation studies.
Scour and sand waves	Sand waves are observed along the submarine export cable route. Mobile seabed can cause exposure and/or increased burial of cables. Scour is locally observed around debris and isolated objects.	Assessment in CBRA and seabed mobility modelling studies.
Ridges, bedforms, seabed scars/drag marks	Incisions in the seafloor may be caused by bottom fishing activity.	Burial depth will be assessed in CBRA study and will inform the need for 6 ft (2m) burial for proper protection from trawling equipment
Currents and hydrodynamic effects	Strong currents in The Race and East River can lead to challenging conditions during cable installation.	Assessment in cable installation study.
Bedrock, rock outcrop, reefs	Crystalline bedrock is not observed.	Assessment in CBRA study.
Unusual soils	Very soft/low strength sediments (clay) causing increased sinkage of cables during installation that can lead to elevated thermal resistivity values and hot spots.	Assessment in CBRA study and during cable design phase. Will assess deeper burial for sufficient protection from anchor strikes or trawling equipment snags.
Thermal resistivity understanding	Soils with increased thermal resistivity values can lead to cable hot spots (e.g., organic-rich soils).	Thermal resistivity has been measured and will be mitigated through cable design.

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 geological conditions, including foundations and interarray and export cables, is described in **Section 3.5.1 Offshore O&M**, 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/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, as described in **Section 4.1.2.2.1**. 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 Beacon Wind anticipates will be needed for the Project, please see **Section 3 Project Description**.

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, Beacon Wind 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 will be sited in previously disturbed areas and areas already dominated by industrial uses, existing roadways, and/or rights-of-way to the extent practicable;
- The Project will utilize an existing O&M Base and will not require construction of a new O&M Base in the State of New York, therefore avoiding additional potential impacts to geological conditions as a result of new construction; 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, Beacon Wind will commit to the following avoidance, minimization, and mitigation measures to mitigate the impacts described in **Section 4.1.1.2.2.**

- The ongoing monitoring of assets that have the potential to be impacted by geological conditions, including foundations and interarray and export cables, to confirm that scour and cable protection measures are working sufficiently, and cables are buried.

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 describes potential natural and anthropogenic hazards present 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 within this COP that are related to natural and anthropogenic hazards include:

- Geologic Conditions (**Section 4.1.2**);
- Marine Archaeological Resources (**Section 6.1**);
- Marine Transportation and Navigation (**Section 8.7**);
- Commercial and Recreational Fishing (**Section 8.8**);
- Marine Energy and Infrastructure (**Section 8.10**);
- Marine Site Investigation Report (**Appendix G**);
- Marine Archaeological Resources Assessment (**Appendix U**); and
- Navigation Safety Risk Assessment (**Appendix BB**).

Data Relied Upon and Studies Completed

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.** Surveys to collect site-specific information and efforts to interpret the survey data (including the identification of specific locations of hazards identified during the surveys) are detailed within **Appendix G Marine Site Investigation Report**. Details regarding marine archaeological resources are detailed within **Appendix U Marine Archaeological Resources Assessment**.

4.1.3.1 *Affected Environment*

The affected environment is defined as the coastal and offshore areas within the Lease Area and along the submarine export cable routes 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. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities.

Existing natural and anthropogenic hazardous conditions in the Project Area are identified and discussed in detail in **Appendix G Marine Site Investigation Report**. Shipwrecks occur through the Project Area and are addressed in **Section 6.1 Marine Archaeological Resources**. Navigation channels and shipping lanes are discussed in **Section 8.7 Marine Transportation and Navigation** and **Appendix BB Navigation Safety Risk Assessment**. Commercial and recreational fishing are covered in **Section 8.8 Commercial and Recreational Fishing**. These topics include potential for hazard to Project facilities and are discussed in detail in **Section 4.1.3.1**. This section further details Beacon Wind's effort to survey and identify MEC, also termed UXOs, in the Project Area.

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, are the potential for damage or disruption of the Project during BW1 and BW2. The maximum design scenario, as described in **Table 4.1-18**, 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 cables burial/landfalls and interarray cable burial. The parameters provided in **Table 4.1-18** represent the maximum potential impact from full build-out of the Lease Area and incorporates a total of 157 structures within the Lease Area (made up of up to 155 wind turbines and two offshore substation facilities) with a submarine export cable route to Queens, New York for BW1 and a submarine export cable route to Queens, New York or Waterford, Connecticut for BW2.

TABLE 4.1-18. 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 the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	Representative of the maximum number of structures.
Submarine export cables	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York (202 nm [375 km]). • BW2: – To Queens, New York (202 nm [375 km]) or – To Waterford, Connecticut (113 nm [209 km]).	Representative of the maximum length of new submarine export cables to be installed.

Parameter	Maximum Design Scenario	Rationale
Interarray cables	Based on full build-out of the Project (BW1 and BW2): BW1: 162 nm (300 km). BW2: 162 nm (300 km).	Representative of the maximum length of interarray cables to be installed.
Foundation horizontal disturbance	Jacket (Piled or Suction Bucket)	Representative of the foundations that would result in the maximum horizontal area of sediment disturbance during installation.
Foundation installation method vertical depth disturbance	Piled Jacket	Representative of the foundation installation method that would result in the maximum vertical depth of sediment disturbance during installation.
Project-related vessels	Based on full build-out of the Project (BW1 and BW2) which corresponds to the maximum number of structures (155 wind turbines, two offshore substation facilities), submarine export cables, 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 and Maintenance		
Project-related vessels	Based on full build-out of the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines, two offshore substation facilities), submarine export cables, 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 substation facilities, 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 Project 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 Project Area, the following primary natural and anthropogenic hazards have been identified and/or may be present, including, but not limited to:

- Identified MEC/UXO, wrecks, debris, pipelines, 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 sediments or sands, which may increase the risk of unstable seabed;
- Sand waves, reefs, or boulders may present uneven seafloor conditions;
- Buried channels may represent natural hazards due to variability in geotechnical conditions; and
- Navigation channels and other federal-authorized areas will require deeper burial of the 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 is 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 MEC/UXO, wrecks, debris, and cable assets may require avoidance buffers and/or crossing agreements. Assessments for MEC/UXO hazards and risks have been performed by Beacon Wind to produce an MEC/UXO risk mitigation strategy, which is under development and will be conducted in coordination with BOEM and other appropriate agencies. The MEC/UXO risk mitigation strategy will be refined and finalized prior to construction and, if necessary, specific MEC/UXO surveys will be performed. The MEC/UXO surveys, if required, would typically be performed two years prior to the beginning of installation activities. If MEC/UXO is identified within any portion of the Project Area, appropriate mitigation measures will be taken, including recommended avoidance and removal, if necessary. In addition, industry standard precautions will be taken during construction operations, which include accurate positioning on submerged Project equipment, to decrease the likelihood of contact with any MEC/UXO. Those assessments completed to date by Beacon Wind have been detailed within a MEC/UXO Assessment Report and Project ALARP Strategy Report, which have been provided within **Appendix G Marine Site Investigation Report**.

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 so 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 submarine export cable routes, the asset owners will be engaged to promote 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**. Beacon Wind has maintained communication with the fishing industry in order to decrease the impacts to the industry caused by the Project. Beacon Wind continues to address concerns from various interests, including fishing communities, maritime groups, and recreational boating groups. Beacon Wind has engaged in communications with these groups through various forums such as informational meetings, press releases, website promotion, and information gathering sessions to gain information for the Project Area. In addition, Beacon Wind successfully utilized scout boats during survey activities to identify fixed fishing gear and coordinate with fishing vessels active in the area to better identify and avoid issues with fishing gear. As discussed in **Section 3.3.1.7 Cable Protection**, Beacon Wind will determine, through the Cable Burial Risk Assessment, the appropriate target burial depth for submarine 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 sediments and shallow gas, which may increase the risk of unstable seabed. The presence of soft sediments has been detected during geotechnical surveys in the Lease Area; additional analysis is necessary to determine presence of soft sediments along the submarine export cable routes. The areas of soft sediment have been mapped and will be accounted for in the Project's geotechnical design basis. Glauconite sands were detected in deeper sediments within the Lease Area. The presence of glauconite, if sufficient in concentration, may affect the geotechnical behavior of an otherwise sandy unit. Sand waves or boulders may present uneven seafloor conditions, which will be taken into consideration during foundation design. Survey findings did not indicate evidence or the presence of detectable gas in the subsurface.

Buried channels may contain submerged marine archaeological resources. Buried paleochannel features were identified within the Lease Area and may be present along portions of the submarine export cable routes. The existence of these paleo-landscape features represents 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 **Appendix G Marine Site Investigation Report** and the FDR/FIR respectively.

Navigation channels and other federal-managed areas may require deeper burial of the submarine export cables. If necessary and subject to discussions with USACE and other stakeholders, Beacon Wind may bury some sections of the submarine export cable routes deeper in order to avoid any future issues with maintenance of these areas. Beacon Wind will continue to consult with USACE on this matter.

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**

Offshore O&M, and generally includes regular surveys of foundations as well as the submarine export and interarray cable routes to confirm the cables have not become exposed or that the cable protection measures have not lost their integrity. An operations and maintenance 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 Project Area, the following primary natural and anthropogenic hazards have been identified and/or may be present, including, but not limited to:

- Sand waves and other mobile seabeds may result in exposure or over burial of buried submarine cables.

During operation of the Project, sand waves and other mobile sediments (such as those in erosional areas in The Race or on slopes at shoals) pose a risk that cables will be exposed, or scour protection could be impacted during operation of the Project. Further studies may be needed to identify specific locations of mobile seabed along the submarine export cable routes. 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. Beacon Wind will implement necessary measures to promote proper cable burial and protection that accounts for mobile seabed in this area such as direct embedment of the submarine export cable and adequate cable protection (where necessary), as well as plan for the possibility of sand wave removal during any future repairs to the cables. **Appendix EE Potential Scour Analysis** provides information on identified sand wave locations along the submarine export cable routes and mobility rate assessments.

4.1.3.2.3 *Decommissioning*

Impacts during decommissioning are expected to be similar or less than those experienced during construction, as described in **Section 4.1.3.2.1**. 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 Beacon Wind anticipates will be needed for the Project, please see **Section 3 Project Description**.

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 drive 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. 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, Beacon Wind 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;
- The MEC/UXO risk mitigation strategy will be refined and finalized prior to construction and, if necessary, specific MEC/UXO surveys will be performed, which (if required) would typically be performed two years prior to the beginning of installation activities;
- 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 sand wave 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 LNM and active engagement with applicable stakeholders to promote awareness of the positions of Project-related assets to avoid any collision or interference.

4.1.3.3.2 *Operations and Maintenance*

During operations, Beacon Wind 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 promote 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 4.1.3.3.1** and **Section 4.1.3.3.2**. 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.

4.1.4 References

TABLE 4.1-19. SUMMARY OF DATA SOURCES

Source	Includes	Available at	Metadata Link
BOEM	Lease Area	https://www.boem.gov/BOEM-Renewable-Energy-Geodatabase.zip	N/A

Source	Includes	Available at	Metadata Link
BOEM	State Territorial Waters Boundary	https://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-andData/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
FEMA	Flood Hazard Zones	https://www.fema.gov/flood-maps/national-flood-hazard-layer	N/A
NOAA	Tropical Cyclone Storm Segments	ftp://ftp.coast.noaa.gov/pub/MSP/TropicalCycloneWindExposure.zip	https://www.fisheries.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://www.fisheries.noaa.gov/inport/item/54196
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coa stal/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, and onshore substation facilities. Potential impacts to water quality resulting from construction, operations, and decommissioning of the Project are discussed. Proposed Project-specific measures adopted by Beacon Wind are also described that are intended to avoid, minimize, and/or mitigate potential impacts to water quality.

Other resources and 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**);
- Wetlands Delineation Reports (**Appendix N**);
- Benthic Resource and Finfish, Invertebrates, and Essential Fish Habitat (**Section 5.5**);
- Benthic Resources Characterization Reports – Lease Area and Submarine Export Cables and Mapbooks (**Appendix S**);
- Essential Fish Habitat Technical Report (**Appendix T**);
- Potential Scour Analysis (**Appendix EE**); and
- Sediment Transport Analysis (**Appendix I**).

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the offshore waters and coastal areas that may be directly and/or indirectly impacted by the offshore components, including the foundations, wind turbines, and offshore substation facilities, the onshore components, including the onshore export and interconnection cable routes and the onshore substation facilities, and the staging and construction areas associated with the construction, operations, and decommissioning of the Project (see **Figure 4.2-1, Figure 4.2-2**, and **Figure 4.2-3**). The Study Area includes a 0.25 mi (0.4 km) buffer around the onshore components, including the landfalls, onshore export and interconnection cables, and onshore substation facilities located in Queens, New York and Waterford, Connecticut and a 5 mi (8 km) buffer around the Lease Area and the submarine export cable routes.

This section relies upon publicly-available resources for marine, groundwater, and surface waters. The Project developed **Appendix I Sediment Transport Analysis** 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. Data required to complete this analysis included meteorological data, flows and velocities, and seabed sediment characterizations.

Water quality data for this section were identified from the following sources:

- National Oceanic and Atmospheric Administration (NOAA) NDBC buoys 44097 and 44039;
- Northeast Fisheries Science Center Multispecies Bottom Trawl Surveys;
- Environmental Protection Agency (EPA) National Coastal Condition Assessment;
- New York City Department of Environmental Protection (NYCDEP) Harbor Water Quality Survey;
- New York State Water Quality Standards (NYS WQS); and
- Connecticut Water Quality Standards (CT WQS).

FIGURE 4.2-1. LEASE AREA AND SUBMARINE EXPORT CABLE WATER QUALITY STUDY AREA

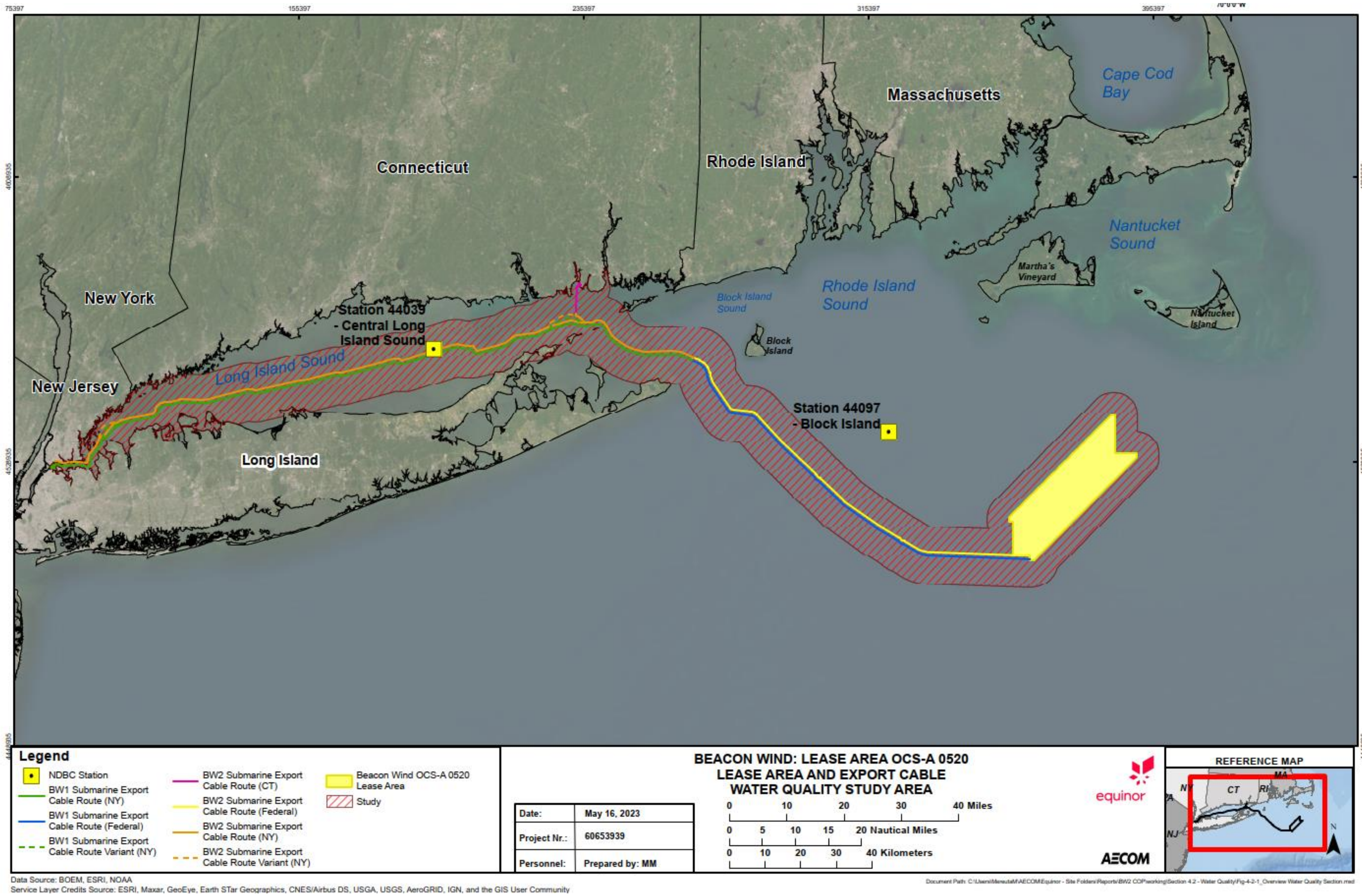
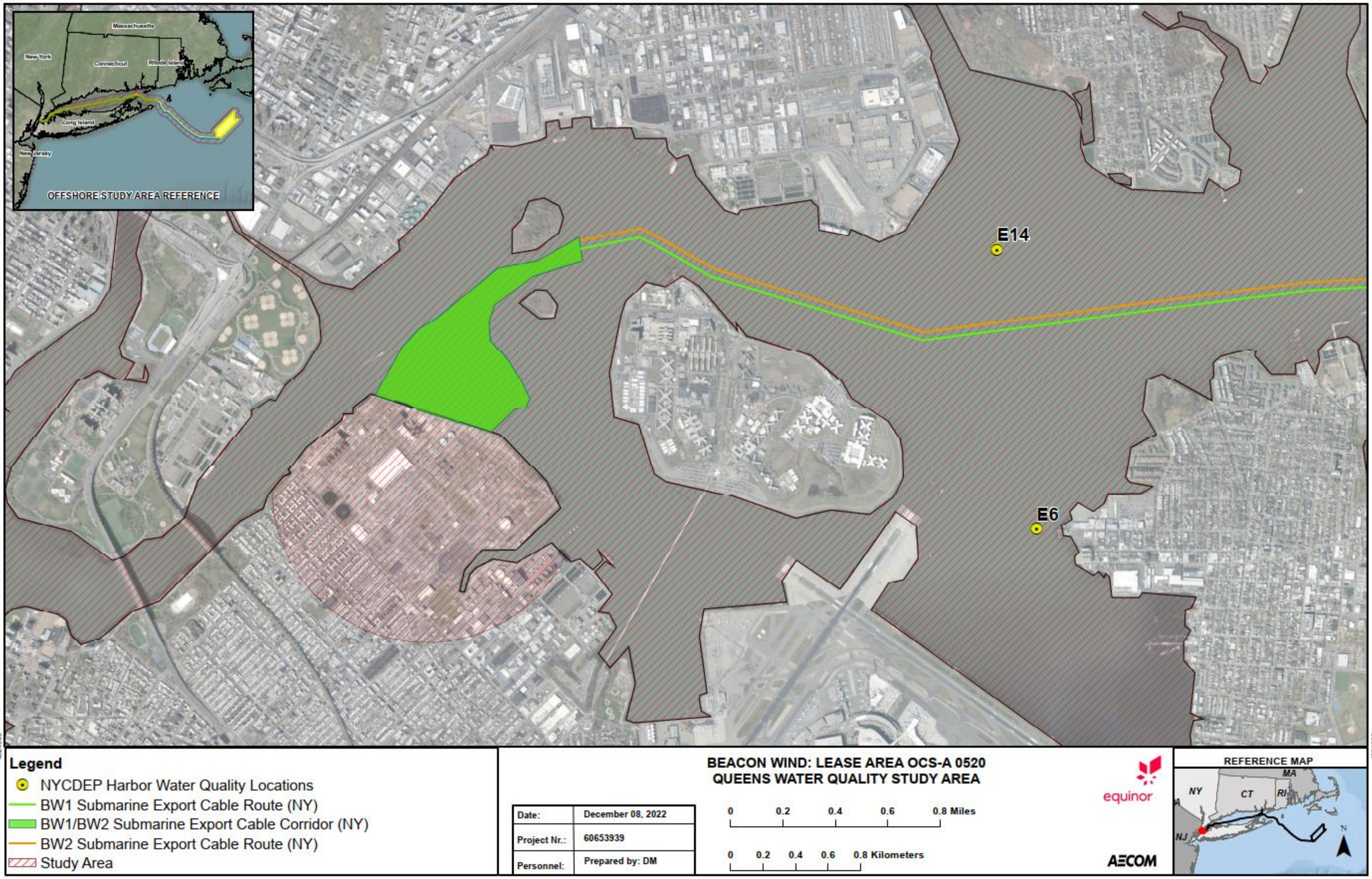
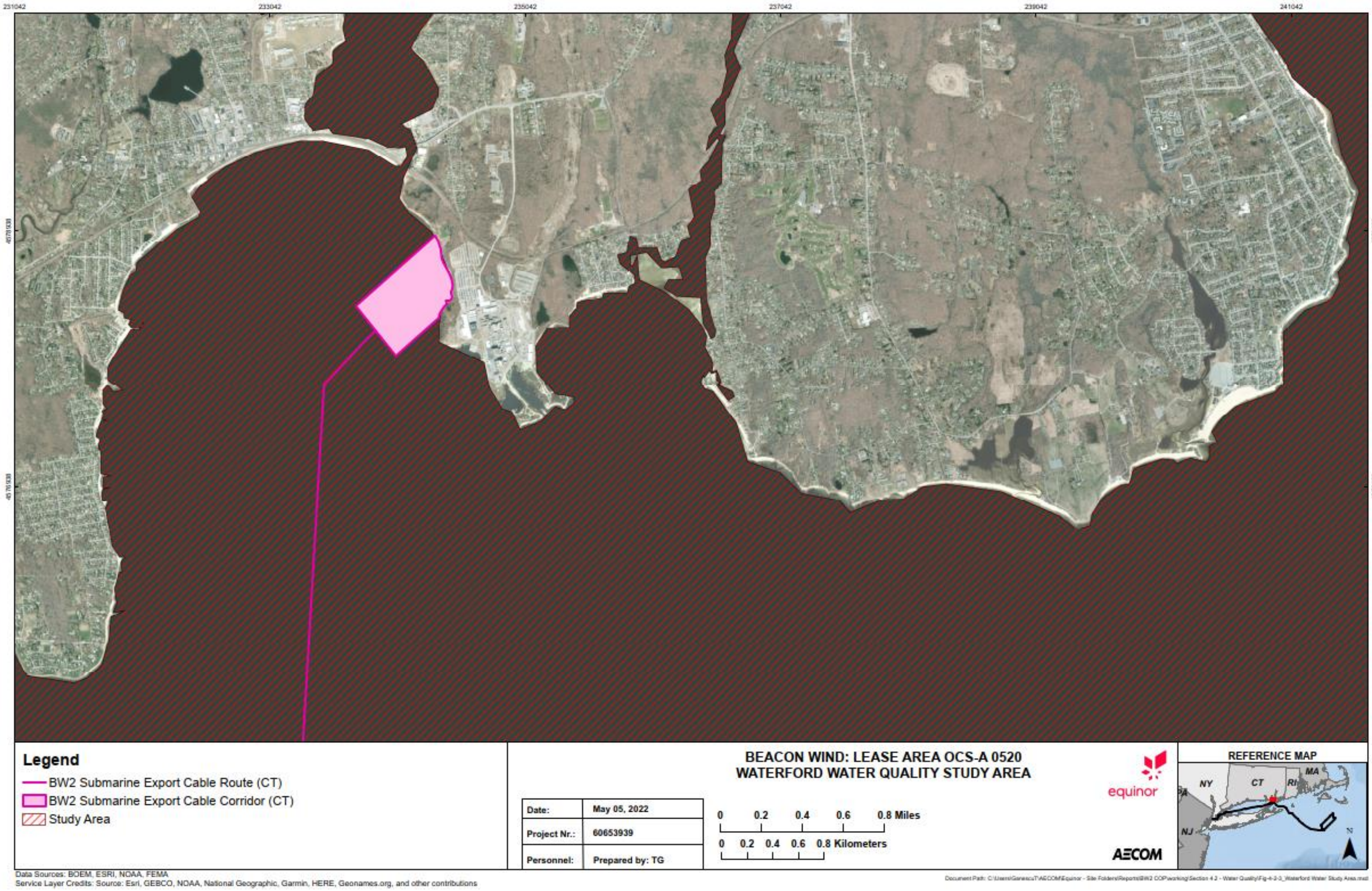


FIGURE 4.2-2. WATER QUALITY STUDY AREA – QUEENS, NEW YORK



Data Source: BOEM, ESRI, NOAA
Service Layer Credits Source: ESRI, Maxar, GeoEye, Earth STar Geographics, CNES/Airbus DS, USGA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4.2-3. WATER QUALITY STUDY AREA – WATERFORD, CONNECTICUT



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. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities.

Water temperature, salinity, dissolved oxygen (DO), chlorophyll *a*, turbidity, and nutrient levels are key parameters for characterizing ocean water quality. Some of these parameters are accepted proxies for ecosystem health (e.g., DO, nutrient levels), while other parameters such as temperature and salinity delineate coastal habitats from marine habitats (BOEM 2021).

Factors such as constituents contributed from both natural and anthropogenic sources can cause changes to water quality, which can be detrimental to marine life and ecosystems. Natural constituents can be delivered into water systems via freshwater drainage, transport of offsite marine waters, and influx from sediments. Anthropogenic sources of pollutants often include those from direct discharges, runoff, dumping, seabed activities, and spills. Other water quality parameters can also be affected by human activities as well as in response 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 *Regional Setting for Marine Water Quality*

The affected environment for water quality for the offshore portion of the Project (Lease Area and submarine export cable routes) is a subset of the regional setting and includes coastal waters in nearshore areas where bottom depth is less than 98.4 ft (30 m) and deeper offshore marine waters within the Lease Area. The 98.4 ft (30 m) isobath delineates the ecologically distinct nearshore and offshore systems (FGDC 2012). The Project Lease Area is located within offshore marine waters and the submarine export cables are located within both offshore and coastal marine waters. For the Project, one submarine export cable transits from the Lease Area through Block Island Sound and approaches Long Island through the eastern entrance to Long Island Sound, with a terminal landfall location at the Astoria power complex in Queens, New York. This route will be used for BW1 and is under consideration for BW2. A second route under consideration for BW2 follows the same route from the Lease Area between Block Island and Long Island and then due west of The Race it extends to the north to a landfall site in Waterford, Connecticut.

Temperature is an important factor for water quality. Northeastern coastal waters are experiencing a long-term warming trend; average temperatures from 1980 to 2005 are 0.9 to 1.8 °F (0.5 to 1.3 °C) warmer than average temperatures from 1890 to 1905 (BOEM 2021). Increased coastal development on Long Island has and continues to cause increased nutrient loading, particularly for coastal communities, of which the majority is due to groundwater contamination by septic systems (NYDEC 2014). Other sources of constituents that contribute to declining water quality include industry, boating activities, and agriculture.

4.2.1.2 *Marine Water Quality in the Lease Area*

The Lease Area represents a subset of the regional offshore setting described above. Water originating in the Atlantic Ocean is the dominant source of water in the Lease Area. In general, sources of contamination within these offshore waters are limited to constituents from ship discharges, including bilge and ballast water and sanitary waste (EPA 2012).

Physical factors such as depth, turbidity, temperature, and DO are important toward understanding water quality Water depths within the Lease Area range from approximately 120 to 200 ft (approximately 37 to 61 m) mean lower low water (MLLW). Offshore water temperatures vary with depth and season due to seasonal thermoclines and DO concentrations in temperate climates generally decrease with depth and change seasonally with temperature (see **Section 4.1.1 Physical Oceanography and Meteorology** for additional discussion of water temperature). Dissolved oxygen levels are typically highest in winter when the water is cooler and lower in the summer and fall (Ullman and Codiga 2010). Water quality data collected in the vicinity of the Lease Area as part of a 2006 survey of ecological conditions within the Mid-Atlantic Bight showed average DO levels of 9.1 milligrams per liter (mg/L) for near-surface samples and 9.4 mg/L for near-bottom samples (Balthis, et al. 2009). These results are representative of well-oxygenated waters that are suitable to support aquatic life. Ullman and Codiga (2010) determined that turbidity in the vicinity of the Lease Area ranged from 0.25 to 0.5 nephelometric turbidity units (NTU) in September, March, and June, but in December increased to a range of 0.75 to 1.25 NTU.

BOEM (2021) reported temperature, salinity, and chlorophyll *a* data from the Lease Area vicinity. Water temperatures were determined to be highest in the fall (63.5 °F [17.5 °C] at the surface and 54.9 °F [12.7 °C] at the bottom; data were not reported for the summer months) and lower in the spring (43.3 °F [6.3 °C] at the surface and 44.9°F [7.2 °C] at the bottom) and winter (41.7 °F [5.4 °C] at the surface and 45.5 °F [7.5 °C] at the bottom). Salinity levels in the vicinity of the Lease Area were seasonally consistent in the surface samples (32.9 psu in spring, fall, and winter) and slightly more variable in bottom samples (ranging from 33.4 to 33.8 psu). Chlorophyll *a* levels ranged from a low of 0.4 micrograms per liter (µg/L) in the summer to a high of 2.4 µg/L in the winter. The EPA considers levels of chlorophyll *a* under 5 µg/L to represent natural background concentrations (EPA 2015a). Water temperature and salinity data for the Lease Area and submarine export cable routes are discussed further in **Section 4.1.1 Physical Oceanography and Meteorology**. Long-term offshore water quality data for nutrient and chlorophyll *a* data compiled on the Marine Cadastre website are discussed below.

4.2.1.2.1 *Nutrients in the Lease Area*

Sources of nutrients to offshore systems vary and include seasonal upwelling from winter storm events and, to a lesser degree, vessel-related waste, such as food, grey water, and sewage.

Nitrogen and Phosphorus in the Lease Area

The Marine Cadastre website, which was developed through a partnership between BOEM and NOAA, uses satellite-based modeling and long-term composite of data from 2000 to 2014 by Bio-ORACLE to show nitrate (NO_3, an inorganic form of nitrogen typically used by plants for growth) concentrations along on the continental shelf and U.S. coastline (Marine Cadastre 2021). **Figure 4.2-4** illustrates the mean surface concentration of nitrate in the vicinity of the Lease Area and through Long Island Sound. Offshore mean annual surface nitrate concentrations in the Lease Area are less than or equal to 1.227 micromoles per liter (µmol/L) as shown in **Figure 4.2-4**. In general, there is an increase in mean annual nitrate concentrations in surface waters from the offshore Lease Area into Long Island Sound (Ramboll 2021).

Marine Cadastre uses the same data sources and protocols for modeling offshore surface phosphate (PO_4^{3-}, inorganic form of phosphorus) concentrations (Maine Cadastre 2021). In the Lease Area, mean annual phosphate concentrations are less than or equal to 0.180 µmol/L as shown in **Figure 4.2-5**. Phosphate concentrations are generally low and uniform from the offshore Lease Area and along most of the submarine export cable routes, then increases near the Queens, New York interconnect location (Ramboll 2021).

4.2.1.2.2 *Chlorophyll in the Lease Area*

Marine Cadastre uses data from 2007 to 2016 provided by the National Aeronautics and Space Administration Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group to model annual chlorophyll *a* concentrations. As shown in **Figure 4.2-6**, annual mean chlorophyll *a* concentrations in the Lease Area are 1.01 to 3.0 milligrams per cubic meter (mg/m^3). In general, chlorophyll *a* concentrations increase from the offshore Lease Area along the submarine export cable routes to the interconnect location in Queens, New York (Ramboll 2021).

FIGURE 4.2-4. MEAN NITRATE CONCENTRATIONS 2000 TO 2014

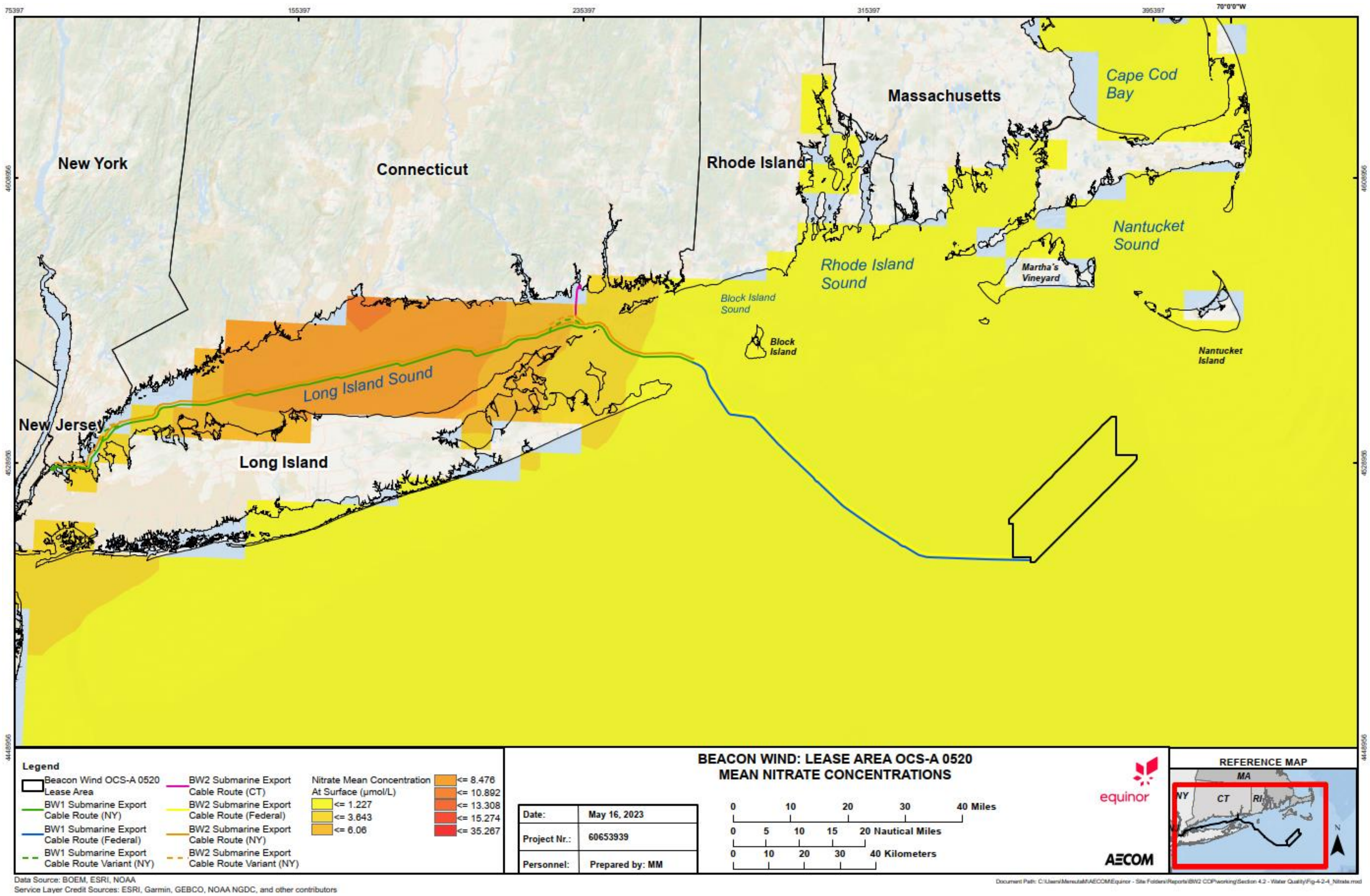
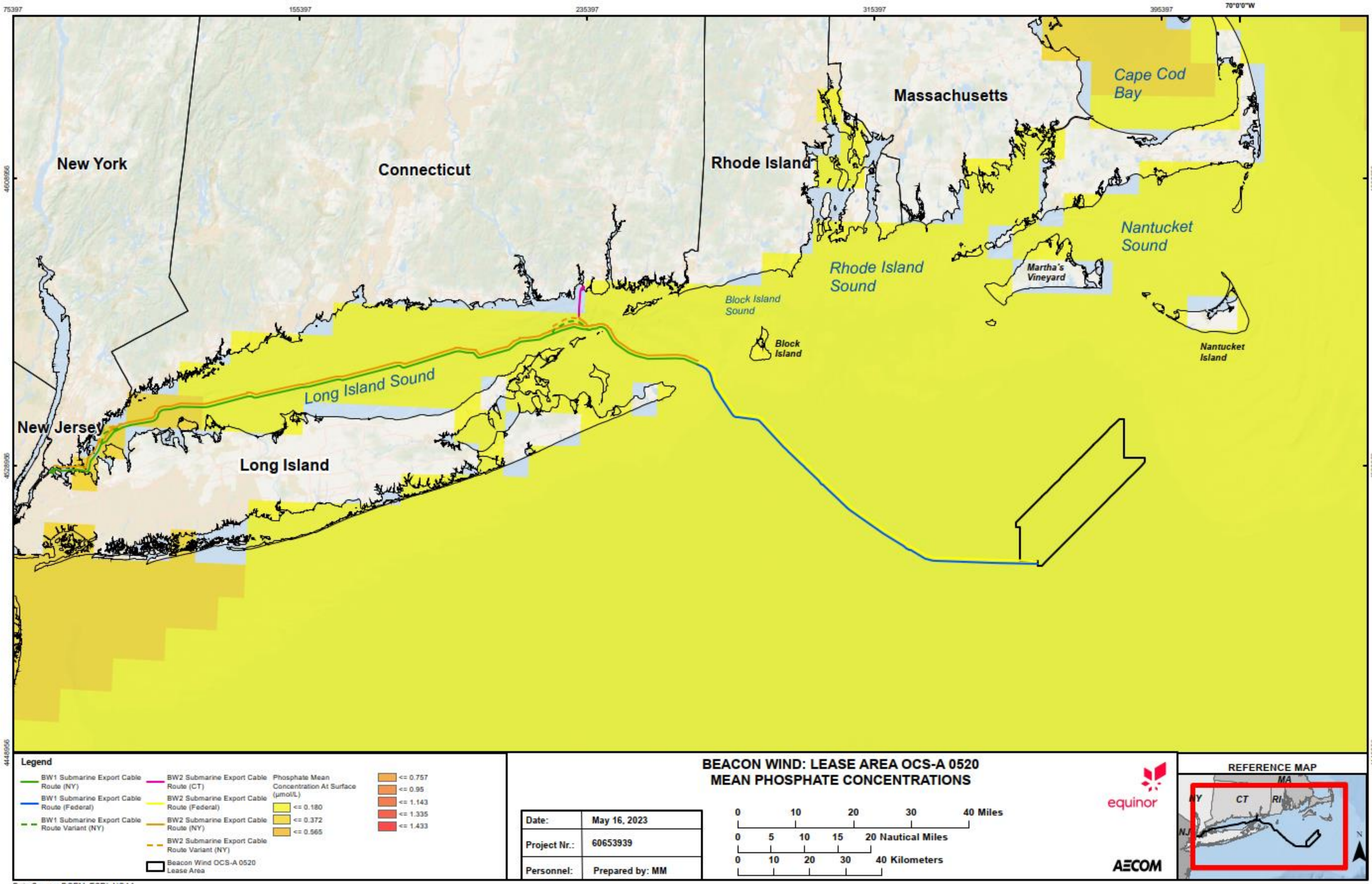
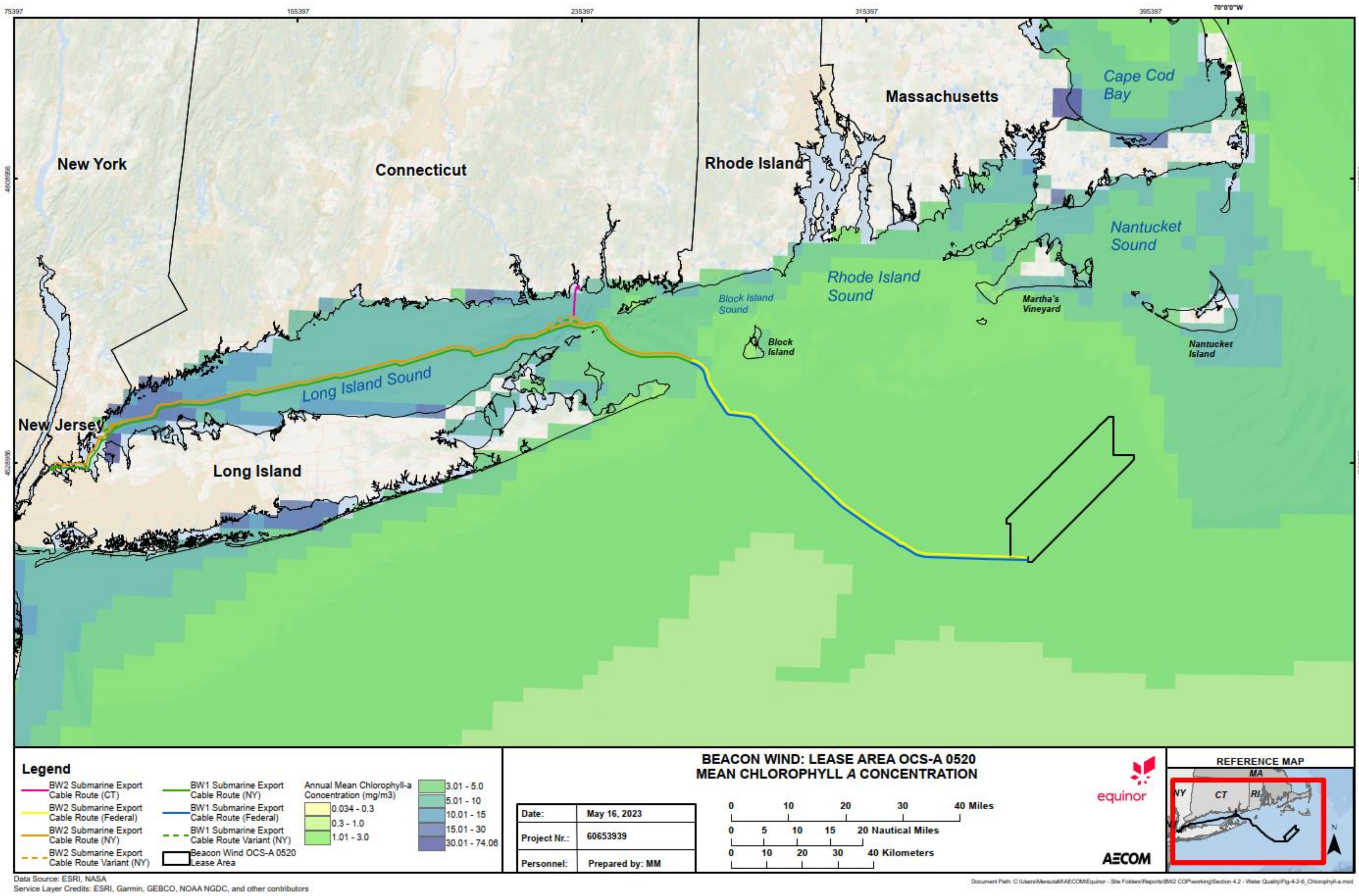


FIGURE 4.2-5. MEAN PHOSPHATE CONCENTRATIONS 2000 TO 2014



Data Source: BOEM, ESRI, NOAA
Service Layer Credit Sources: ESRI, Garmin, GEBCO, NOAA NGDC, and other contributors

FIGURE 4.2-6. MEAN CHLOROPHYLL *A* CONCENTRATIONS 2007 TO 2016



4.2.1.3 *Marine Water Quality along the Nearshore Submarine Export Cable Routes*

As shown in **Figure 4.2-1**, a submarine export cable route passes between Block Island and Long Island and extends to the west through the length of Long Island Sound to a landfall site in Queens, New York. This route will be used for BW1 and is under consideration for BW2. A second route under consideration for BW2 follows the same route from the Lease Area between Block Island and Long Island and then extends to the north to a landfall site in Waterford, Connecticut. Water depths along the routes in Long Island Sound range from approximately 49 to 131 ft (15 to 40 m). Water temperature and salinity data for Long Island Sound is presented in **Section 4.1.1 Physical Oceanography and Meteorology**.

In 1987, Congress designated Long Island Sound as an Estuary of National Significance. It is surrounded by some of the most densely populated areas of the nation where 23 million people live within 50 mi (80 km) of its shores. The watershed of the Long Island Sound drains an area of more than 10,240,000 ac (4,144,000 ha), and it encompasses virtually the entire State of Connecticut, portions of Massachusetts, New Hampshire, and Vermont, with a small area at the source of the Connecticut River in Canada.

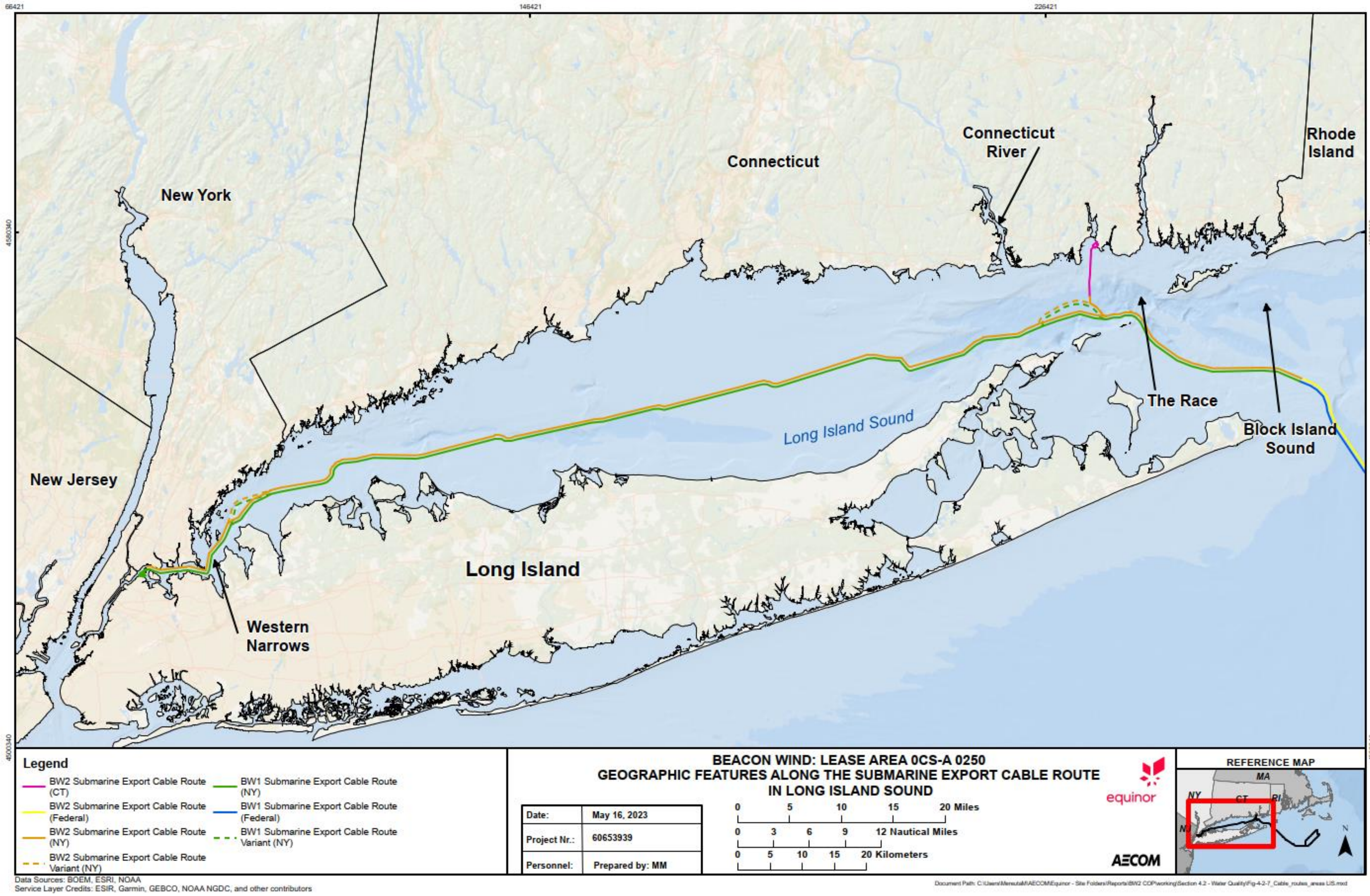
Unlike a typical estuary, the Long Island Sound has no major direct source of fresh water at its head. Instead, the Long Island Sound has two marine inlets. Lower salinity waters enter the western end of Long Island Sound from the Upper Bay of New York Harbor through two tidal straits, the East River and the Harlem River. These rivers comprise the Western Narrows (**Figure 4.2-7**) and are adjacent to one of the highest population density areas and greatest percent of impervious surface areas in the U.S. (USACE and PANYNJ 2016). Higher salinity waters of the Atlantic Ocean enter at its eastern end, through Block Island Sound and The Race (**Figure 4.2-7**). The largest source of fresh water is the Connecticut River, discharging into the eastern end of Long Island Sound, which contributes about 70 percent of the more than six trillion gallons of fresh water discharged to the Long Island Sound by major tributaries each year. These unusual characteristics contribute to the Long Island Sound’s complex circulation and mixing patterns.

Stormwater runoff from the Western Narrows contribute large amounts of non-point source pollution. There are 14 major wastewater treatment facilities in New York City that discharge to the Western Narrows and New York Harbor (HEP 2011). Sediment loads to the East River are high due to overland runoff, poor land management practices, tributary channel erosion, and shoreline modification (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 areas (USACE and PANYNJ 2016).

Concentrations of contaminants, bacteria, nutrients, and metals have been decreasing due to the implementation and enforcement of regulations under the CWA promulgated over 45 years ago (HEP 2012). Despite improvements in water quality, legacy chemicals in the sediments, including mercury, polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), 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).

Water quality generally improves with distance from shore as oceanic circulation and tidal flushing disperses, dilutes, and biodegrades contaminants from New York City. 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 waters. Areas with poor water quality are generally close to large population densities and/or industrial activity (EPA 2012).

FIGURE 4.2-7. GEOGRAPHIC FEATURES ALONG THE SUBMARINE EXPORT CABLE ROUTES IN LONG ISLAND SOUND



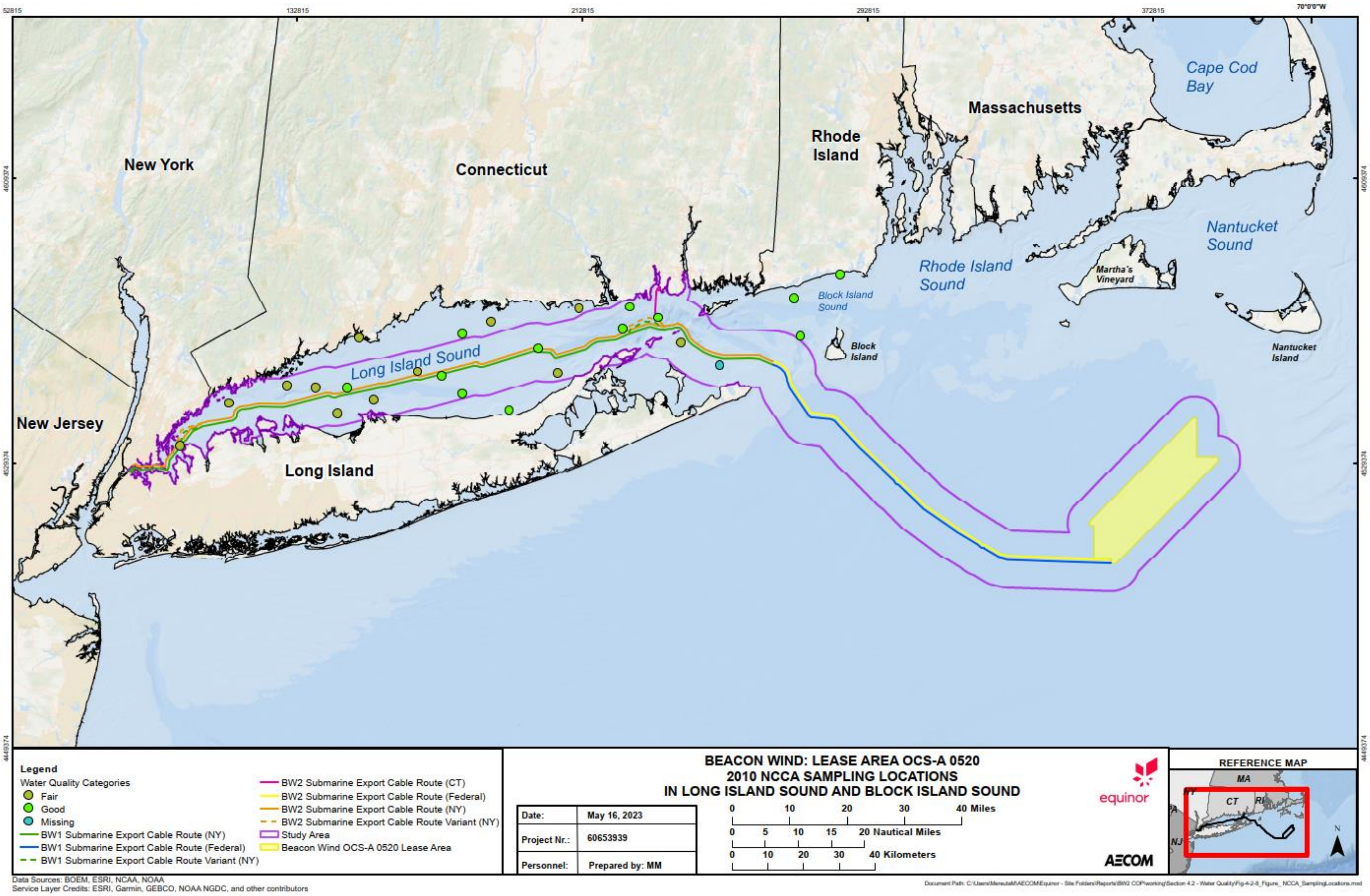
The condition of coastal water was assessed by the EPA in the 2010 National Coastal Condition Assessment (NCCA) (EPA 2015a). Water quality data from the 2010 NCCA are available for 24 stations within Long Island Sound and Block Island Sound with sample locations shown in **Figure 4.2-8**. It is recognized that some of these locations fall outside the Study Area identified in **Figure 4.2-1**; however, they are discussed below as they are expected to be generally representative of coastal conditions near the submarine export cable routes.

Analytes measured in this assessment included chlorophyll *a*, dissolved inorganic nitrogen (DIN; the sum of nitrate, nitrite, and ammonium), dissolved inorganic phosphorus (DIP), DO at the bottom of the water column, and light transmissivity. These water quality parameters were used to determine an overall Water Quality Index (WQI) for each sample characterized as “good”, “fair”, or “poor.” As indicated in **Figure 4.2-8**, the samples within Long Island Sound and Block Island Sound were categorized as having “good” or “fair” water quality; no samples were categorized as having “poor” water quality.

Water temperature and salinity data for the Lease Area and submarine export cable routes are discussed in **Section 4.1.1 Physical Oceanography and Meteorology**. Long-term offshore water quality data from the publicly accessible NEFSC and NOAA NDBC databases are summarized below. These sources had sampling locations in the vicinity of the submarine export cable routes and individual data were available for download.

Individual water quality parameters measured as part of the NCCA and other programs are also discussed below. This discussion includes data from the Marine Cadastre website as well as from various studies conducted within Long Island Sound.

FIGURE 4.2-8. 2010 NCCA SAMPLING STATIONS IN LONG ISLAND SOUND AND BLOCK ISLAND SOUND



4.2.1.3.1 *Dissolved Oxygen along the Nearshore Submarine Export Cable Routes*

The amount of DO in the water determines the amount of oxygen that is available for marine life to use. Dissolved oxygen levels are strongly influenced by temperature with colder water typically maintaining higher DO concentrations than warmer water. Minimal data is available for the open ocean environment of the Lease area; however, there is extensive research available for the Long Island Sound. Dissolved oxygen levels can also be influenced by biological factors such as respiration, photosynthesis, and bacterial decomposition. Concentrations below 2 mg/L can lead to hypoxia, which is detrimental to most aquatic organisms. Dissolved oxygen levels above 5 mg/L are generally accepted as being protective of aquatic life.

Hypoxia within Long Island Sound has been the subject of water quality monitoring for decades (LISS 2021b). In 1989 more than 320,000 ac (129,500 ha), equivalent to approximately 40 percent of the Long Islands Sound's bottom waters, had DO levels less than 3 mg/L.[3] and in 1987 anoxia, the absence of any oxygen, was recorded in a portion of the Western Narrows between the East River and Western Long Island Sound. Water quality monitoring conducted as part of the Long Island Sound Study (LISS) has shown a reduction in hypoxic conditions since 1987 with 40,320 ac (16,317 ha) of the Long Island Sound's bottom waters experiencing DO levels less than 3 mg/L in 2019. Hypoxia occurs most frequently in the westernmost areas of Long Island Sound where the bottom waters have routinely experienced hypoxia nearly every year since regular monitoring began in 1994 (LISS 2021b).

The Interstate Environmental Commission (IEC), as part of the Long Island Sound Monitoring program, has surveyed water quality at 22 stations in Western Long Island Sound over 12 weeks in the summer since 1991. Monitoring in 2020 reported the lowest bottom water DO level of 1.1 mg/L in late July in a station near the Execution Rocks lighthouse. Dissolved oxygen levels in bottom waters were below 3 mg/L in at least one station in nine of the 12 weeks and a station in Manhasset Bay frequently had the lowest DO levels. Seventeen of the 22 stations exhibited hypoxia in bottom waters during mid-August (Interstate Environmental Commission [IEC] 2020).

Given the levels of hypoxia in the bottom waters in Western Long Island Sound, it has been hypothesized that bioaccumulation of mercury and methylmercury into plankton would be greater in this portion of the Sound compared to Eastern Long Island Sound, which experiences more water circulation and higher levels of DO. Redox conditions can lead to the appearance of H_2S and alterations in the cycles of heavy metals, in particular leading to the formation of MeHg. If lower DO levels and higher temperatures enhance methylation in the sediment and water column, then an increased flux of methylmercury would be expected into the water column in the summer. Work by Gosnell et al. (2017) found that, although sampling in Western Long Island Sound showed slightly higher concentrations of methylmercury in the water column, the concentrations of methylmercury in phytoplankton and zooplankton were higher in Eastern Long Island Sound. Dissolved organic carbon levels were higher in Western Long Island Sound and the authors indicated that the methylmercury may have been bound to the organic carbon and less available for uptake into algae. There was also no measured increase in methylmercury in the water column during the warmer summer months. This study occurred during 2014, which did not have a lengthy period of hypoxia in the Western Long Island Sound. As noted above, the frequency and extent of hypoxia in the Long Island Sound has decreased over time, so the observations made in 2014 may be applicable to current conditions. When anoxic sediments are disturbed and suspended in the water column, it is possible that constituents bound to

[3] As defined by the Long Island Sound Study (LISS), hypoxia exists when DO drops below a concentration of 3 mg/L.

sediment particles can be oxidized and their bioavailability may be increased as a consequence (National Research Council [NRC] 2003).

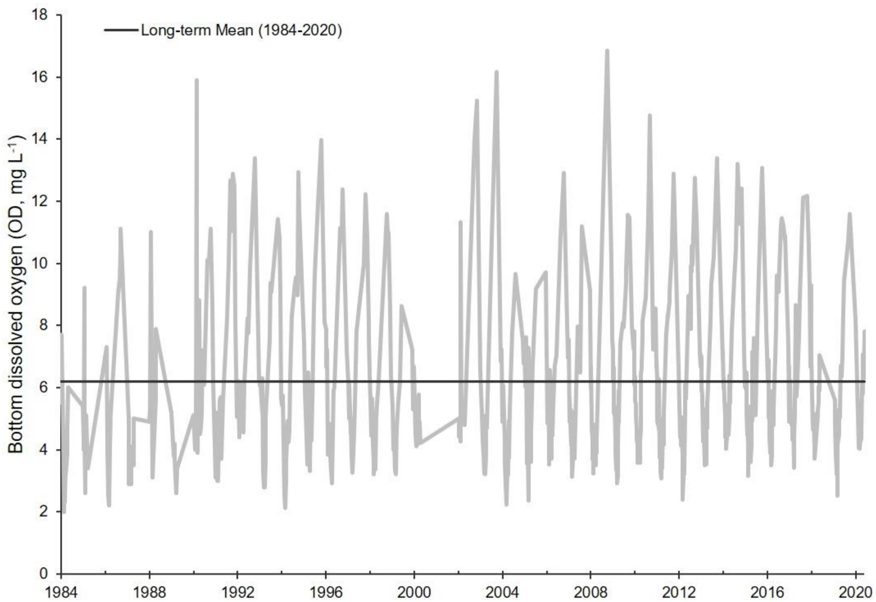
In 2000, most estuaries sampled by EPA as part of the NCCA in Long Island Sound had high (greater than 5 mg/L) or moderate (2 to 5 mg/L) DO concentrations, which represents nearly 100 percent of the estuaries assessed (EPA 2004). Of the 22 DO samples from Long Island Sound and Block Island Sound evaluated in the 2010 NCCA, 16 had DO levels above 5 mg/L and the remaining samples had DO levels above 3 mg/L (EPA 2015a).

It is unlikely that the coastal waters near the Waterford, Connecticut BW2 location experience low DO concentrations, based on relatively shallow bathymetry (32.8 to 65.6 ft; 10 to 20 m) and exposure to winds which would likely prevent prolonged stratification and declines in DO at depth. Monitoring conducted by CTDEEP as part of the Long Island Sound Water Quality Monitoring Program between 1998 and 2021 shows that bottom DO concentrations measured at stations to the east and west of the submarine export cable route to Waterford, Connecticut average approximately 6.5 mg/L (CTDEEP 2021).

New York City Department of Environmental Protection (NYCDEP) monitors water quality in 26 stations within the Upper East River–Western Long Island Sound (UER-WLIS). Sampling in 2018 identified average DO levels of 6.4 mg/L and 5.9 mg/L for surface and bottom waters, respectively, in the region and the annual report observed that there has been a consistent increase in average DO values since 2012 (NYCDEP 2018).

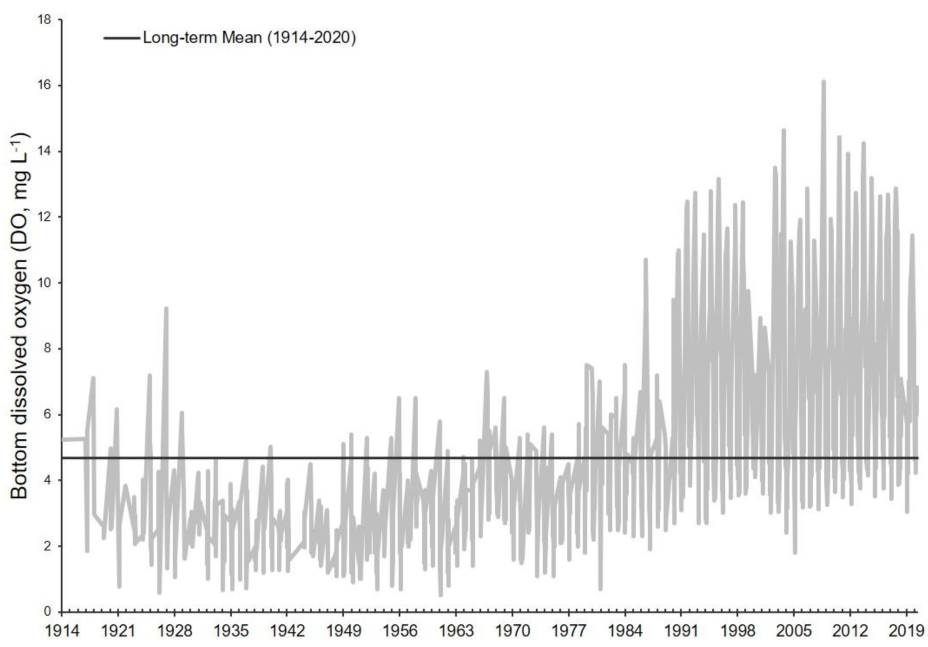
Figure 4.2-9 and **Figure 4.2-10** illustrate the long-term trends in DO concentrations at depth for the two NYCDEP Harbor Water Quality Survey locations near the Queens, New York interconnect **(Figure 4.2-2**). Seasonal variability in bottom DO concentrations are evident, as would be expected under stratified conditions. The measured DO concentrations did not fall below 2 mg/L at the location E14 from 1984 to 2020 (**Figure 4.2-9**), indicating DO levels did not reach hypoxic conditions. At location E6, with monitoring data back to the early 1900s, DO concentrations show an increasing trend over time (**Figure 4.2-10**). Lower DO concentrations occurred in this location up until approximately the 1980s, with increasing concentrations to present.

FIGURE 4.2-9. BOTTOM DISSOLVED OXYGEN CONCENTRATIONS FROM 1984 TO 2020 AT SAMPLING LOCATION E14 (40.8008, -73.8645)



Source: Data from the NYCDEP Harbor Water Quality Survey.

FIGURE 4.2-10. BOTTOM DISSOLVED OXYGEN CONCENTRATIONS FROM 1914 TO 2020 AT SAMPLING LOCATION E6 (40.7855, -73.8608)



Source: Data from the NYCDEP Harbor Water Quality Survey.

4.2.1.3.2 *Nutrients along the Nearshore Submarine Export Cable Routes*

Sources of nutrients to coastal systems vary and include nonpoint source inputs from watersheds via land uses (i.e., urban and agricultural runoff) as well as point source discharges from industry or water treatment facilities. A third source of nutrients to the water column occurs by “internal loading” of legacy nutrients found in the sediment, a result of hypoxic or anoxic conditions at depth that acts to release nutrients from sediment by a series of oxidation-reduction reactions. Internal loading of nutrients is a positive feedback loop, whereby increased nutrients fuel greater growth and biomass, which is subsequently broken down to lower DO concentrations at depth and result in additional nutrients released from the sediment layer. Direct disturbance of the sediment, through high-intensity storm events or dredging/construction activity that resuspend material, can also act to release sediment-bound nutrients to the water column.

Nitrogen

According to EPA (2004), DIN is the nutrient type most responsible for eutrophication in open estuarine and marine waters. It is comprised of nitrate plus nitrite and ammonium. These forms of nitrogen are readily available to phytoplankton and often control the formation of blooms. Dissolved inorganic nitrogen occurs naturally in marine ecosystems; however, anthropogenic influences such as fertilizers and wastewater can greatly increase concentrations. In 2000, most estuaries sampled by EPA as part of the NCCA in Long Island had low to moderate concentrations of nitrogen as DIN (approximately 77 percent of areas sampled) (EPA 2004). Concentrations of DIN in the 24 samples from Long Island Sound and Block Island Sound evaluated in the 2010 NCCA were below 0.1 mg/L and categorized as “good” (EPA 2015a).

Figure 4.2-4 illustrates the mean surface concentration of nitrate in the vicinity of the Lease Area and the submarine export cable routes in Long Island Sound to the Queens, New York landfall and the Waterford, Connecticut landfall. In general, there is an increase in mean annual nitrate in surface waters from the offshore Lease Area into Long Island Sound and the interconnect location in Queens, New York (Ramboll 2021). The submarine export cable routes within Long Island Sound pass through areas with nitrate concentrations ranging up to 8.5 µmol/L in the central portion of the Long Island Sound and up to 3.6 µmol/L near the Waterford, Connecticut landfall (**Figure 4.2-4**).

Near the Queens, New York interconnect location, average measures of DIN at the two NYCDEP Harbor Water Quality Survey locations identified above (E14 and E6; **Figure 4.2-2**) would be classified as “poor” (greater than 0.5 mg/L) based on EPA criteria used in the NCCA (EPA 2015a). Characterizing concentrations of bottom nitrogen is hindered by the limited number of samples.

Phosphorus

In 2000, the estuaries in Long Island Sound had low to moderate concentrations of phosphorus (approximately 86 percent of areas sampled) (EPA 2004). Concentrations of DIP in the 24 samples from Long Island Sound and Block Island Sound evaluated in the 2010 NCCA, ranged from 0.012 to 0.085 mg/L; 20 of these results were categorized as “fair” and four were categorized as “poor” (EPA 2015a).

Figure 4.2-5 illustrates the mean annual concentration of phosphate in the vicinity of the Lease Area and the submarine export cable routes in Long Island Sound to the Queens, New York landfall and the Waterford, Connecticut landfall. Mean annual concentrations of phosphate are generally uniform along the submarine export cable routes within the Long Island Sound (at or below 0.180 µmol/L) with a slight increase in phosphate concentrations (up to 0.372 µmol/L) near the Queens, New York interconnect location (Ramboll 2021).

Average total phosphorus (TP) concentrations in surface samples adjacent to the Queens, New York interconnect were 0.18 mg/L and 0.20 mg/L at NYCDEP locations E14 and E6 (**Figure 4.2-2**), respectively. Total phosphorus is a measure of the forms including DIP, dissolved organic, and particulate phosphorus. The EPA criteria for the NCCA evaluated only DIP; however, the TP concentrations measured by the NYCDEP near the interconnect location at Queens, New York would be categorized as "fair" (TP concentrations do not exceed threshold of greater than 0.5 mg/L DIP).

4.2.1.3.3 *Chlorophyll along the Nearshore Submarine Export Cable Routes*

Historically, high levels of chlorophyll *a* in the western portion of the Long Island Sound have been linked to summertime hypoxia conditions. In 2019, the spring bloom occurred in March with smaller blooms in May and September (CTDEEP, et al. 2019).

According to data collected by EPA in 2000, the coastal zone of Long Island Sound was generally characterized as "good" for chlorophyll *a* concentrations (less than 5 µg/L) (EPA 2004), including waters surrounding New York City and the Connecticut shoreline. Of the 24 samples of chlorophyll *a* from Long Island Sound and Block Island Sound evaluated in the 2010 NCCA, 20 were categorized as "good" and four were categorized as "fair" (EPA 2015a).

Figure 4.2-6 illustrates mean annual chlorophyll *a* concentrations in the vicinity of the Lease Area and the submarine export cable routes in Long Island Sound to the Queens, New York landfall and the Waterford, Connecticut landfall. In general, chlorophyll *a* concentrations increase from east to west along the submarine export cable routes through the Long Island Sound to the interconnect location in Queens, New York (Ramboll 2021).

Based on data collected by NYCDEP in the coastal waters adjacent to the Queens, New York interconnect location, surface concentrations of chlorophyll *a* at locations E14 and E6 (**Figure 4.2-2**) averaged 5.8 and 6.2 µg/L, respectively. According to EPA criteria used in the NCCA, these locations would be categorized as "fair" (5-20 µg/L)(EPA 2015a).

4.2.1.3.4 *Turbidity along the Nearshore Submarine Export Cable Routes*

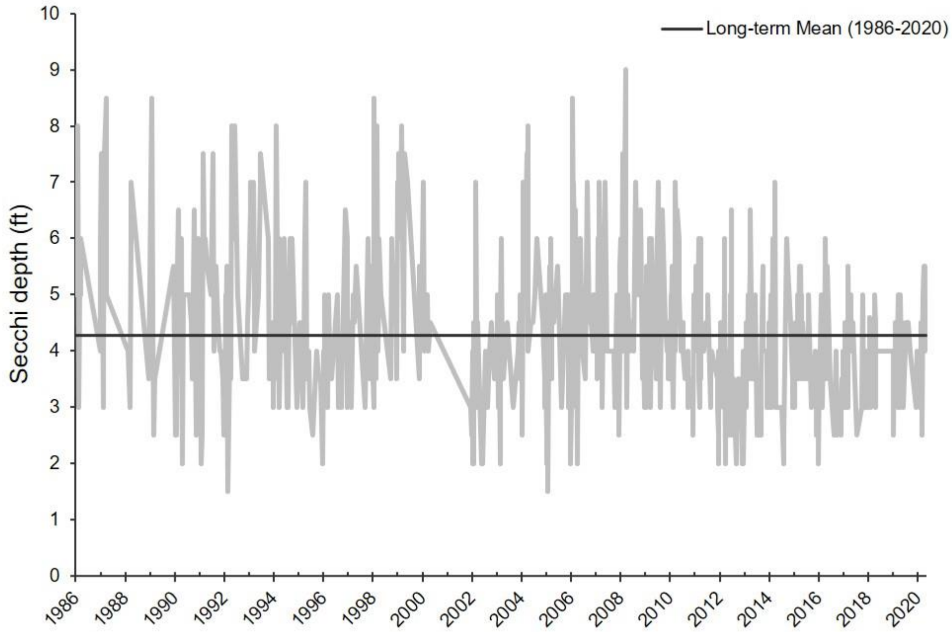
Estuaries, by nature, are turbid systems (EPA 2004). The supply of sediment from tributary rivers, especially during and post-storm events, can increase turbidity of surface waters locally. However, the delivery of sediment to estuaries is a natural process that supplies source material for maintaining coastal morphological features. However, prolonged or drastic increases in turbidity can have negative effects on local biota by burying organisms in the benthos, preventing effective filter feeding, or blocking light penetration to seagrass beds.

Within the Long Island Sound, water clarity improves from west to east. The western portion of the Long Island Sound is relatively narrow and shallow compared to the eastern portion, which is a wide deep channel with considerable influx from the Atlantic Ocean. The dense urban land use in the western portion of the Long Island Sound also increases the concentrations of pollutants in the water that may affect water clarity. In 2019, monitoring within the Long Island Sound showed water clarity (as yearly average Secchi disk depth) ranging from 4.9 ft (1.5 m) in western portion of the Long Island Sound to 12.8 ft (3.9 m) in the eastern portion of the Long Island Sound. Annual average Secchi disk depths greater than 7.5 ft (2.28 m) are considered very good while depths less than 5.9 ft (1.8 m) are considered very poor (CTDEEP et al. 2019).

According to data collected by EPA in 2000, water clarity in Long Island Sound coastal zones (quantified as light penetration at 3.3 ft [1 m] below the surface) was generally characterized as “good” for most of the Connecticut coastline (greater than 20 percent of total light penetration reaching 3.3 ft [1 m] depth) (EPA 2004). At locations closer to New York City, water clarity declines to “fair” (10 percent-20 percent total light penetration, 3.3 ft [1 m depth]) and “poor” (less than 10 percent total light penetration, 3.3 ft [1 m] depth) (EPA 2004). Light transmissivity, as a measure of water clarity, in the samples from Long Island Sound and Block Island Sound evaluated in the 2010 NCCA, was categorized as “good” in the 24 samples (EPA 2015a).

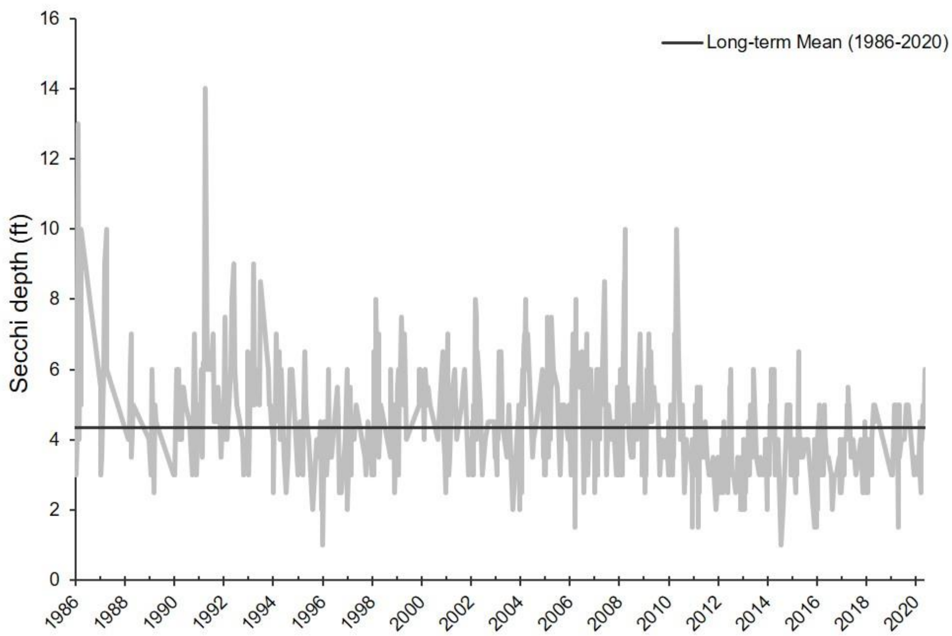
Figure 4.2-11 and **Figure 4.2-12** provide long-term Secchi disk depth measurements for NYCDEP survey locations E14 and E6 (shown on **Figure 4.2-2**). Secchi depth measurements display seasonal variability at both sites; however, the long-term trend has remained relatively constant from the mid-1980s to present. In general, average Secchi depths at these coastal locations near the Queens, New York interconnect location average approximately 16.4 ft (5.0 m).

FIGURE 4.2-11. LONG-TERM TIME SERIES OF SECCHI DEPTH FROM 1986 TO 2020 AT SAMPLING LOCATION E14 (40.8008, -73.8645)



Source: Data from the NYCDEP Harbor Water Quality Survey.

FIGURE 4.2-12. LONG-TERM TIME SERIES OF SECCHI DEPTH FROM 1986 TO 2020 AT SAMPLING LOCATION E6 (40.7855, -73.8608)



Source: Data from the NYCDEP Harbor Water Quality Survey.

4.2.1.3.5 *Bacteria along the Nearshore Submarine Export Cable Routes*

Bacterial sampling conducted by NYCDEP in the UER-WLIS in 2018 found that fecal coliform levels in the 11 historical/open-water monitoring sites were in compliance with their specified 'best use' classifications for bathing and fishing. The summer geometric mean for the UER-WLIS was 45 cells/100 mL, which is below the bathing and other recreational use standard of 200 cells/100mL. The regional summer geometric mean for *Enterococcus* was 5 cells/100mL, which is below the bathing standard of 35 cells/100mL. Bacteria concentrations have shown a downward trend for more than 20 years in the UER-WLIS region (NYCDEP 2018). Bacteria concentrations of fecal coliform are also monitored in the Long Island Sound by CTDEEP. In 2019, the majority (six of the seven coastal segments) of the Norwalk coast did not meet the State of Connecticut's Water Quality Standards due to elevated bacteria concentrations (CTDEEP 2019).

4.2.1.4 *Sediment Quality*

Contaminant data for sediment within the Lease Area were not identified. Along the submarine export cable routes, the 2010 NCCA (EPA 2015a) included an assessment of sediment chemistry and sediment toxicity information for 23 of the sampling locations identified on **Figure 4.2-8**. For sediment contaminants, 20 of the 23 samples within Long Island Sound and Block Island Sound were categorized as having "good" sediment quality and three samples were categorized as having "fair" sediment quality. Acceptable sediment toxicity testing results were available for 20 of the samples. On the basis of the toxicity tests, 14 samples were classified as having "good" sediment quality and six as having "poor" sediment quality. A Sediment Quality Index (SQI) was reported for each sample based on the sediment chemistry and toxicity testing results. Of the 23 samples, the SQI was classified as "good" for 13, "fair" for five, and "poor" for five. The five samples with "poor" SQI scores were located across the Long Island Sound and Block Island Sound and not clustered in a particular area. As discussed in **Section 8.10 Marine Energy and Infrastructure**, there are several active and historical dredge material disposal sites within Long Island Sound. Samples must meet various sediment chemistry, toxicity testing, and bioaccumulation criteria to be acceptable for disposal in these areas, so they are not expected to be sources of contamination within Long Island Sound.

Sediment chemistry data within Long Island Sound has been collected by a number of entities including the States of New York and Connecticut, NOAA's National Status and Trends program, the Coastal and Marine Geology Program of the U.S. Geological Survey, and the U.S. Army Corps of Engineers. Monitoring by the Army Corps of Engineers within Long Island Sound is generally focused on coastal harbors (for dredge material evaluations) and on three active unconfined open-water placement sites for dredged material that are located within Connecticut waters outside the submarine export cable corridors. Historically, sediment quality degrades from east to west in Long Island Sound along the submarine export cable routes. Levels of contaminants, such as heavy metals, pesticides, polycyclic aromatic hydrocarbons (PAHs), and chlorinated hydrocarbons are elevated in narrows and the East River. However, sediments in midsection of Long Island Sound and out through the Race are generally less contaminated (USGS 1999, EPA 2015b). Generally, contaminant concentrations are greater in the muddier sediments. In 1996 and 1997, the USGS looked at profiles of fallout isotopes (cesium-137), naturally occurring isotopes (lead-210), and metals within the sediments of Long Island Sound. The study found that mixing depths within the sediment vary greatly within Long Island Sound. Age determinations of the sediments show that sewage began to contaminate Long Island Sound in the late 1800s, with a marked increase of contaminant concentrations following World War II. However, in most depositional areas, the metal concentrations in sediment cores decrease near the surface, reflecting a reduction in contaminant sources during the 1980s and 1990s (USGS 1999).

Sediment quality improvement within Long Island Sound is one of the goals of the LISS, which targets a reduction in the area of impaired sediment by 20 percent by 2035 from 2006 baseline (LISS 2021a). The LISS considers the NCCA SQI in their assessment of sediment quality and noted that in 2006, 48.5 percent of 34 stations in Long Island Sound were considered impaired (falling into the “fair’’ or “poor” classifications). As indicated by the 2010 NCCA (EPA 2015a) results discussed above, the SQI scores showed 43 percent of the 23 stations within Long Island Sound and Block Island Sound were impaired. This finding is essentially consistent with the 2006 baseline conditions, particularly given that the 2015 results include stations in Block Island Sound, which has better water and sediment quality than Long Island Sound. NCCA surveys are typically done every five years and planning for the delayed NCCA 2020 effort is in progress (EPA 2021).

4.2.1.5 *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. New York State Department of Environmental Conservation maintains the Water Inventory/Priority Waterbodies List (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 general recreation, public bathing and support of aquatic life, with shellfishing identified for some areas. General recreation use waters (classification SB) include those where the public may occasionally come into contact with the water through uses such as boating. Public bathing water (classification I) includes those where the public may have prolonged contact with the water through uses such as swimming and include areas with public beaches. Class SA waters are suitable for shellfishing, in addition to bathing and recreational use. The submarine export cable routes intersect several impaired waterways. 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** and **Figure 4.2-13**).

Connecticut State Water Quality Standards promulgated under Regulations of Connecticut State Agencies Title 22a, establish the water quality goals of Connecticut’s waterbodies and form the foundation of Connecticut’s water management programs. Water quality class defines the quality of the water, and Connecticut has four classes for coastal/marine surface waters. The surface waters along the submarine export cable route to Waterford, Connecticut are classified as SA, with SB waters located along the coastline to the east and west of the landfall (**Figure 4.2-14**). Designated uses for SA waters in Connecticut are fishing, swimming and recreation, healthy marine habitat, direct shellfish consumption, and industrial supply. Designated uses for SB waters include fishing, swimming and recreation, healthy marine habitat, commercial shellfish harvesting, and industrial supply. Waterbodies that do not meet the criteria associated with their use classification are considered to be impaired and are reported every two years as required by Section 305(b) of the CWA. Based on the most recent Integrated Water Quality Report (CTDEEP 2020), the inner estuary, shore, and mid-shore Connecticut waters in the vicinity of the Waterford, Connecticut landfall are classified as impaired, most often based on water quality not supporting uses for shellfish consumption (**Table 4.2-2**). The offshore waters along the submarine export cable route were not identified as impaired.

TABLE 4.2-1. SUMMARY OF MARINE WATERBODY CLASSES POTENTIALLY CROSSED BY THE SUBMARINE EXPORT CABLE ROUTES WITHIN NEW YORK STATE WATERS

NYSDEC Segment	NYSDEC Classification	Best Usage (per 6 NYCRR 701)	Impairment	Impairment Sources
Block Island Sound (1701-0278)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	PCBs in migratory fish	Unknown
Long Island Sound, Suffolk County, East (1702-0266)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	PCBs in migratory fish	Unknown
Long Island Sound, Suffolk County, Central (1702-0265)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	Pathogens, PCBs in migratory fish	Urban/Storm Runoff
Long Island Sound, Suffolk County, West (1702-0098)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	Nutrients (nitrogen), Low DO, Pathogens, PCBs in migratory fish	Municipal Discharges, Urban/Storm Runoff
Long Island Sound, Nassau County, Central (1702-0028)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	Nutrients (nitrogen), Low DO, Pathogens, PCBs in migratory fish	Municipal Discharges, Combined Sewer Overflows, Urban/Storm Runoff
Long Island Sound, Westchester (East) (1702-0001)	SA	Suitable for shellfishing, public bathing and general recreation use, and support of aquatic life.	Nutrients (nitrogen), Low DO, Pathogens, Other Pollutants (floatable debris)	Municipal Discharges, Combined Sewer Overflows, Atmospheric deposition, Urban/Storm Runoff
Long Island Sound, Bronx (1702-0027)	SB	Suitable for public bathing and general recreation use, and support of aquatic life	Nutrients (nitrogen), Low DO, Pathogens, Other Pollutants (floatable debris)	Municipal Discharges, Combined Sewer Overflows, Atmospheric deposition, Urban/Storm Runoff
East River, Upper (1702-0032)	SB	Suitable for public bathing and general recreation use, and support of aquatic life	PCBs, Other Pollutants (floatable debris) Nutrients (nitrogen), Low DO, Oil and Grease	Urban/Storm Runoff, Combined Sewer Overflows, Toxic/ Contaminated sediment, Municipal Discharges

NYSDEC Segment	NYSDEC Classification	Best Usage (per 6 NYCRR 701)	Impairment	Impairment Sources
East River, Upper (1702-0010)	I	Assessed for general recreation use and support of aquatic life, but not for water supply or for public bathing use	PCBs, Other Pollutants (floatable debris) Nutrients (nitrogen), Low DO, Oil and Grease	Urban/Storm Runoff, Combined Sewer Overflows, Toxic/ Contaminated sediment, Municipal Discharges

TABLE 4.2-2. SUMMARY OF MARINE WATERBODY CLASSES AND IMPAIRMENT STATUS WITHIN CONNECTICUT STATE WATERS IN THE VICINITY OF THE WATERFORD, CONNECTICUT LANDFALL

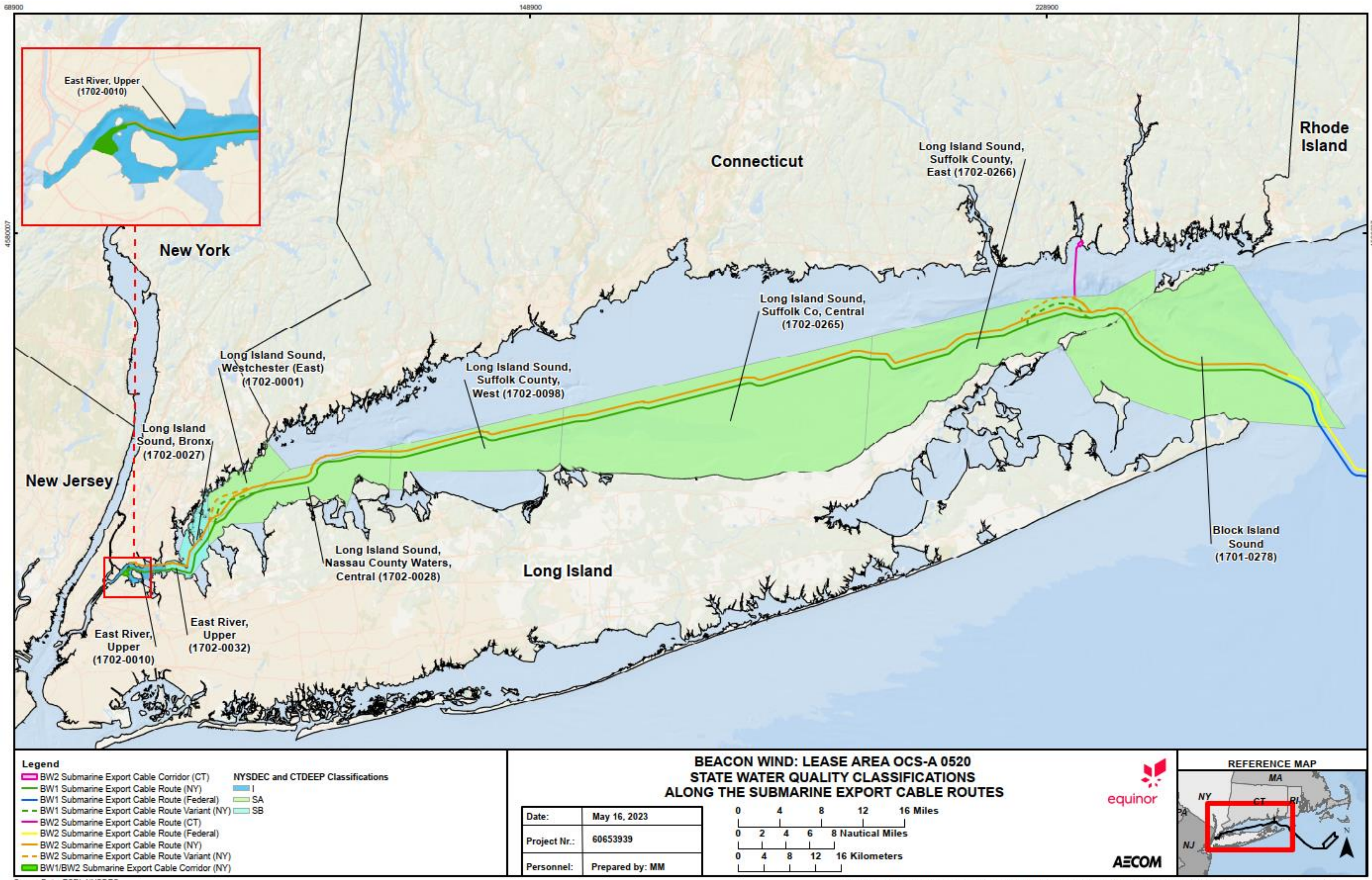
			2020 Connecticut 305(b) Assessment Results				
CTDEEP Segment Name	Segment ID	Surface Water Classification	Impaired	Aquatic Life	Recreation	Fish Consumption	Shellfish
LIS EB Inner - Alewife Cove, Waterford/New London	CT-E1_017	SA	Yes	Fully Supporting	NA	IS	Not Supporting
LIS EB Inner - Bride Brook, East Lyme	CT-E1_022	SA	Yes	NA	Not Supporting	IS	Not Supporting
LIS EB Inner - Fourmile River (mouth), Old Lyme	CT-E1_023	SA	Yes	NA	NA	IS	Not Supporting
LIS EB Inner - Jordan Cove, Waterford	CT-E1_019	SA	Yes	NA	NA	IS	Not Supporting
LIS EB Inner - Niantic River (mouth), Niantic	CT-E1_020	SA	Yes	Not Supporting	Not Supporting	IS	Not Supporting
LIS EB Inner - Pattagansett Rvr (mouth), East Lyme	CT-E1_021	SA	Yes	NA	NA	IS	Not Supporting
LIS EB Inner - Thames River (Mouth), New London	CT-E1_014-SB	SB	Yes	Not Supporting	Fully Supporting	IS	Not Supporting
LIS EB Midshore - East Lyme, Rocky Neck	CT-E3_007	SA	Yes	NA	NA	IS	Not Supporting
LIS EB Midshore - Niantic Bay	CT-E3_006	SA	Yes	Not Supporting	NA	IS	Not Supporting
LIS EB Midshore - Waterford, Thames River	CT-E3_005-SB	SB	Yes	Not Supporting	NA	IS	Fully Supporting
LIS EB Shore - Niantic Bay (Black Pt), East Lyme	CT-E2_015	SA	Yes	Not Supporting	NA	IS	Not Supporting
LIS EB Shore - Niantic Bay (East), Waterford	CT-E2_013	SA	Yes	Not Supporting	NA	IS	Not Supporting
LIS EB Shore - Niantic Bay (West), East Lyme	CT-E2_014	SA	Yes	Not Supporting	Fully Supporting	IS	Not Supporting
LIS EB Shore - Outer Jordan Cove, Waterford	CT-E2_012	SA	Yes	Fully Supporting	Fully Supporting	IS	Not Supporting
LIS EB Shore - Pattagansett River Mouth, East Lyme	CT-E2_016	SA	Yes	NA	NA	IS	Not Supporting
LIS EB Shore - Rocky Neck (Fourmile Rvr), Old Lyme	CT-E2_017	SA	Yes	NA	Fully Supporting	IS	Not Supporting

				2020 Connecticut 305(b) Assessment Results			
CTDEEP Segment Name	Segment ID	Surface Water Classification	Impaired	Aquatic Life	Recreation	Fish Consumption	Shellfish
LIS EB Shore - Thames River Mouth (East), Groton	CT-E2_009-SB	SB	Yes	Not Supporting	Fully Supporting	IS	Not Supporting
LIS EB Shore - Thames Rvr Mouth (West), New London	CT-E2_010-SB	SB	Yes	Not Supporting	Fully Supporting	IS	Not Supporting
LIS EB Shore - Thames Rvr Mouth (West), Waterford	CT-E2_011-SB	SB	Yes	Not Supporting	Fully Supporting	IS	Fully Supporting

Source: 2020 Integrated Water Quality Report (CTDEEP 2020)

Notes:
Designated uses for SA waters in Connecticut are fishing, swimming and recreation, healthy marine habitat, direct shellfish consumption (where authorized), industrial supply.
Designated uses for SB waters in Connecticut are fishing, swimming and recreation, healthy marine habitat, commercial shellfish harvesting (where authorized), industrial supply.
NA - Not Assessed
IS - Insufficient Information

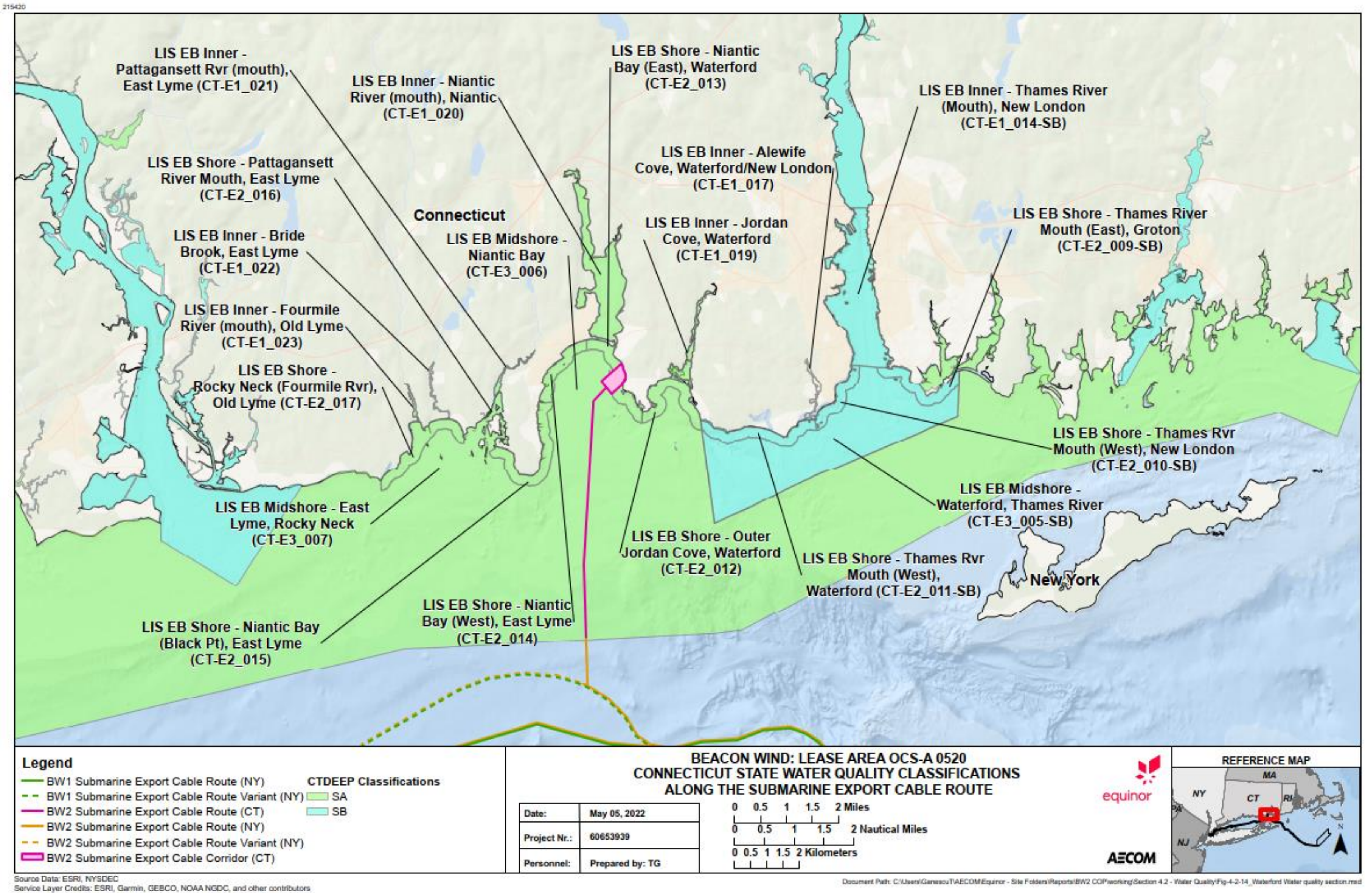
FIGURE 4.2-13. NYS CLASSIFIED WATERBODIES ALONG THE SUBMARINE EXPORT CABLE ROUTES



Source Data: ESRI, NYSDEC
Service Layer Credits: ESRI, Garmin, GEBCO, NOAA NGDC, and other contributors

Document Path: C:\Users\MereutaM\AECOM\Equinor - Site Folders\Reports\BW2 COP\working\Section 4.2 - Water Quality\Fig-4-2-13_Water quality section.mxd

FIGURE 4.2-14. CONNECTICUT STATE CLASSIFIED WATERBODIES IN THE VICINITY OF THE SUBMARINE EXPORT CABLE ROUTE



Long Island Sound is monitored by CTDEEP on a monthly schedule for DO and nutrients at 17 fixed stations. In addition, 25-30 stations are added to the core 17 stations and monitored bi-weekly during summer months. This monitoring is funded by the EPA Long Island Sound Study. Water quality does not support fish or other aquatic life during the summer in over 50 percent of marine waters examined by CTDEEP. These impairments are mostly due to low DO in the Long Island Sound and the coastal embayments, which is caused by excess nutrients. Legacy pollution in the sediments in some harbors also contributes to the problem. DO concentrations measured in the eastern portion of Long Island Sound, including at stations to the east and west of the submarine export cable route to Waterford, Connecticut, generally have DO concentrations that are protective of aquatic life (i.e., above 5 mg/L) (CTDEEP 2021). For recreational use, sufficient monitoring data are only available in a few areas. The state beaches on the coast are tested weekly and consistently meet standards (CTDEEP 2020).

4.2.1.6 *Groundwater*

The Queens, New York landfall and onshore export and interconnection cable route 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 Queens 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 Counties on western Long Island. The area has recovered, and water tables are now at pre-pumping levels (USGS 1995).

The USGS does not monitor groundwater elevations near the submarine export cable landfall location in Queens, New York, although they have a robust monitoring network to the north and east. The closest groundwater monitoring well is located almost 8 mi (12.9 km) away in Queens Borough and groundwater elevations ranged from 16.7 ft (5.1 m) above MSL in 2018 to 2.9 ft (0.9 m) above MSL in 2010. While 25 percent of New York State relies on groundwater for their drinking water source, the areas around the Queens, New York landfall receive their drinking water from the Catskills, located approximately 125 mi (201 km) north.

The USGS does not monitor groundwater elevations near the submarine export cable landfall in Waterford, Connecticut. The Waterford, Connecticut landfall is located in New London County, Connecticut, which receives its potable water needs from both groundwater and surface water sources. CTDEEP classifies the groundwater below the Waterford, Connecticut landfall as GA. Designated uses for GA classified groundwater are existing private and potential public or private supplies of water suitable for drinking without treatment and baseflow for hydraulically connected surface water bodies (CTDEEP 2018).

4.2.1.6.1 *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 consist of small freshwater wetlands near the Queens, New York and Waterford, Connecticut onshore export cable and interconnection cable routes. The wetlands were surveyed, and descriptions of their size, location, 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 below (**Table 4.2-3**) represent the maximum potential impact from full build-out of the Lease Area of BW1 and BW2 and incorporates a total of up to 157 structures within the Lease Area (made up of up to 155 wind turbines and two offshore substation facilities) with one submarine export cable route for BW1 to Queens, New York and one submarine export cable route for BW2 to Queens, New York or to Waterford, Connecticut.

TABLE 4.2-3. SUMMARY OF MAXIMUM DESIGN SCENARIO PARAMETERS FOR WATER QUALITY

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	Representative of the maximum number of structures.
Foundation installation method	Seabed preparation for suction bucket jacket.	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 the Project (BW1 and BW2): • BW1 to Queens, New York (202 nm [375 m]). • BW2: ○ To Queens, New York (202 nm [375 m]) or ○ To Waterford Connecticut (113 nm [209 km]).	Representative of the maximum length of new submarine export cable to be installed, which has the potential to result in the greatest amount of seabed sediment disturbance.
Interarray cables	Based on full build-out of the Project (BW1 and BW2) with the maximum number of structures (155 wind turbines and two offshore substation facilities) to connect: BW1: 162 nm (300 km). BW2: 162 nm (300 km).	Representative of the maximum length of interarray cables to be installed, which has 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.
Project-related vessels	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities, two submarine export cables, associated interarray cables), and maximum associated vessels.	Representative of the maximum predicted Project-related vessels, which have the potential to impact water quality.

Parameter	Maximum Design Scenario	Rationale

Submarine export cable landfall	Based on full build-out of the Project (BW1 and BW2):
	• BW1 to Queens, New York (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area offshore).
	• BW2:
	  ○ To Queens, New York (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area offshore) or
	  ○ To Waterford Connecticut (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area offshore).
		Representative of the maximum area to be utilized to facilitate the export cable landfalls, which has the potential to impact water quality.

Onshore export and interconnection cables	Based on full build-out of the Project (BW1 and BW2):
	• BW1 to Queens, New York (0.93 mi [1.5 km]).
	• BW2:
	  ○ To Queens, New York (0.93 mi [1.5 km]) or
	  ○ To Waterford, Connecticut (0.55 mi [0.89 km]).
		Representative of the maximum length of onshore export and interconnector cables to be installed.

Onshore substation facilities	Based on full build-out of the Project (BW1 and BW2):
	• BW1 Queens, New York (up to a 16-ac [6.5-ha] area).
	• BW2:
	  ○ Queens, New York (up to a 16 ac [6.5 ha]) or
	  ○ Waterford, Connecticut (up to a 16 ac [6.5 ha] area).
		Representative of the maximum area to be utilized to facilitate the construction of the onshore substation facilities.

Operations and Maintenance		
Wind turbine and offshore substation facilities foundation scour protection	<u>Wind Turbines</u> Based on suction bucket jacket, which represents the maximum overall footprint (155 x 3.0 ac [1.2 ha] with scour protection). Total 465 ac (188 ha) including scour protection. <u>Offshore Substation Facilities</u> Based on suction bucket jacket, which represents the maximum overall footprint (2 x 5.2 ac [2.1 ha] with scour protection). Total 10.4 ac (4.2 ha) including scour protection.	Representative of the maximum area of scour protection installed.
Offshore substation cooling system	Based on full build-out of the Project (BW1 and BW2) (two offshore substation facilities).	Representative of the maximum volume of water discharged and the maximum increase in water temperature.
Interarray cables	Based on full build-out of the Project (BW1 and BW2) with the maximum number of structures (155 wind turbines and two offshore substation facilities) to connect: BW1: 162 nm (300 km). BW2: 162 nm (300 km).	Representative of the maximum length of interarray cables, and associated scour protection installed.

Parameter	Maximum Design Scenario	Rationale

Submarine export cables	Based on full build-out of the Project (BW1 and BW2):
	• BW1 to Queens, New York (202 nm [375 m]).
	• BW2:
	  ○ To Queens, New York (202 nm [375 m]) or
	  ○ To Waterford Connecticut (113 nm [209 km]).
		Representative of the maximum number and length of submarine export cable, associated scour protection installed.

Project-related vessels	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities, two submarine export cables, associated 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 operations and maintenance activities	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York • BW2 to Queens, New York or Waterford, Connecticut. Longest operational duration, with the maximum number of Project-related activities expected per year.	Representative of the maximum number of activities from the Project during the operations 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:

- Installation 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 export cables and associated onshore substation facilities.

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 at the submarine export cable landfalls;
- 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 water quality parameters such as temperature, DO, or chlorophyll *a* as a result of Project-related activities are not anticipated and, therefore, will 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, the Project developed a conservative analytical sediment transport model using both publicly-available data and Project design to quantify potential maximum plume dispersion and sediment concentrations and potential maximum sediment deposition thicknesses. The model simulates 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 as detailed in **Appendix I Sediment Transport Analysis**.

Where bedforms such as sand waves, ripples, and dunes are present on the seafloor, these features may be removed prior to cable installation through a process called "pre-sweeping." **Appendix I Sediment Transport Analysis** indicated that sediment release rates for pre-sweeping activities (conservatively modeled assuming the use of mass flow excavation rather than trailing suction hopper dredger) were generally much greater than the release rates associated with cable installation. The suspended sediment plumes from pre-sweeping activities were predicted to have greater impact in migration extents and total suspended solids concentrations.

The suspended sediment plumes generated by the interarray cable installation oscillate due to the tidally dominated currents of the Lease Area with the maximum extent of the 50 mg/L total suspended solids plume during interarray cabling reaching approximately 1.79 mi (2.88 km). The maximum extent of deposited sediment thickness greater than 0.04 in (1 mm) is approximately 0.04 mi (0.06 km). Modeling indicated that, on average, the total suspended solids plume associated with the interarray cables would be below 50 mg/L within two to four hours.

The suspended sediment plumes generated by the submarine export cable installation have much higher variability in extent and direction due to the spatial variability in hydrodynamic regions that the submarine export cables pass through between the Lease Area and the landfall locations. For the submarine export cable to Queens, New York, the maximum extent of the 50 mg/L total suspended solids plume is 4.15 mi (6.69 km). The maximum extent of depositional thickness greater than 0.04 in (1 mm) is 2.37 mi (3.81 km). Modeling indicated that, on average, the total suspended solids plume associated with the submarine export cable route to Queens, New York would be below 50 mg/L within approximately one to ten hours.

For the submarine export cable route to Waterford, Connecticut, the suspended sediment plumes are largely similar to the plumes generated by the route to Queens, New York, as much of it traverses the same regions. However, as the BW2 submarine export cable turns north towards the Waterford, Connecticut landfall, there are very strong east-west currents in Long Island Sound that create large 50 mg/L plume extents of up to 6.92 mi (11.14 km). The maximum extent of depositional thickness greater than 0.04 in (1 mm) is 4.18 mi (6.73 km) and occurs in the same region near the Waterford, Connecticut landfall location. Modeling indicated that, on average, the total suspended solids plume associated with the associated with the submarine export cable route to Waterford, Connecticut would be below 50 mg/L within two to ten hours.

Sediments in the Lease Area are comprised of glacial deposits, sand, and clay. Sediments through Long Island Sound transition from sands and gravels with hard and complex sea floor near the mouth of the Long Island Sound to higher concentrations of silt with fewer areas of complex sea floor as the submarine export cable corridors extend to the west, toward the East River. In locations that are dominated by fine sand, silts, or clays, these sediments can be released into the water column. This will temporarily increase total suspended solids near the trench and cause sediment deposition outside of the trench.

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 Long Island Sound, 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). BOEM (2021) reported that water quality impacts would occur during construction of the Vineyard Wind project and would involve a temporary and localized increase in sediment suspension and turbidity for up to 12 hours at a time. No permanent effects to water quality are anticipated from these construction activities. Construction activities associated with installation of foundations in the Lease Area may increase water column suspended sediment concentrations in proximity to the foundations. 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).

Anchoring by installation vessels during survey activities as well as during the construction, and installation of wind turbine foundations, cables, and met towers or buoys will likely disrupt the seabed and cause temporary increases in suspended sediment and turbidity levels (BOEM 2021). 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 substation facilities 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 Beacon Wind 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. Beacon Wind 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 for each onshore component, as applicable to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment

Control (Blue Book) and in the Connecticut Guidelines for Soil Erosion and Sediment Control, 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 and the Connecticut Nonpoint Source Management Program Plan into the Project's site-specific best management practices for activities located within the Connecticut National Estuarine Research Reserve in Long Island Sound; and
- Obtain an industrial stormwater NPDES permit (if required) and develop a SWPPP if more than 1 ac (0.40 ha) of land is disturbed at any land fall or onshore substation facilities 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 into 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 substation facilities 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 substation facilities. As designs for the onshore export and interconnection cable corridors and the associated onshore substation facilities develop, Beacon Wind will determine, through site-specific test pits, whether groundwater is expected to be encountered during construction activities. If dewatering is expected to occur, Beacon Wind 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 the shoreline between the submarine export cable landfall locations on shore and the East River or at the Waterford, Connecticut landfall. The 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. Water quality in the immediate vicinity of an inadvertent return/release may be temporarily impacted in areas with a lack of water circulation that allows bentonite releases to the water column to settle on the seabed, potentially reducing dissolved oxygen levels and impacting local organisms (e.g., fish eggs, shellfish). Drilling fluids are composed of bentonite clay or mud which do not pose adverse impacts to water quality due to their organic composition and are considered non-toxic. 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. Beacon Wind proposes to implement the following measure 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. Beacon Wind 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 to identified construction sites, access roads, and work zones at the Waterford, Connecticut site, to the extent practicable. Restricting access through wetlands and waterbodies in Queens, New York is not anticipated to be required due to the absence of wetlands within the onshore area subject to construction activities.

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 and through contaminant releases (e.g., from grout used to seal the monopile to the transition piece). Project-related construction vessels also have the potential to accidentally spill or release oil and fuels; however, vessel operations are designed to minimize the potential for these types of releases into the environment. Project-related vessels will be subject to USCG regulations for wastewater and discharges and will operate in compliance with oil spill prevention and response plans that meet USCG requirements. Specifically, the 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.

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 and onshore substation facilities; and
- Operations and maintenance activities associated with seawater cooling systems associated with each of the offshore substation facilities.

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;
- Long-term effects due to stormwater run-off; and
- Localized increases in water temperature due to the operation of offshore substation facilities cooling systems.

Long-term effects due to offshore foundations and associated scour protection. During operations, scour processes around foundations and the submarine export 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, where tidal current flow can have a greater effect. The relatively low velocities expected in the Lease Area (BOEM 2021), combined with scour mitigation, will limit scour potential around foundations. Furthermore, scour is not expected to occur around the cables, 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 et al. 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). Current speeds of approximately 0.7 ft [0.2 m] per second and minimal scour were predicted for the Vineyard Wind lease area (OCS-A 501) which has water depths of at least 118 ft (36 m) (BOEM 2021; Epsilon Associates, Inc. [Epsilon] 2018; Nielsen et al. 2014; Whitehouse et al. 2011) and is located adjacent to the Beacon Wind Lease Area. As described in **Section 4.1.2 Geologic Conditions**, water depths within the Lease Area are at least 122 ft (37.2 m) so current speeds and scour conditions may be similar to those predicted for the Vineyard Wind lease area. Additional details about conditions in the Lease Area are provided in **Appendix G Marine Site Investigation Report**.

Beacon Wind may 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).

Scour modeling results for the Beacon Wind Project are provided within **Appendix EE Potential Scour Analysis**. The potential scour at monopile and piled jacket foundation structures without scour protection was estimated for every 16.4 ft (5 m) interval of water depth across the Lease Area. Average modeled scour depths ranged from 18.7 ft (5.7 m) to 21.7 ft (6.6 m) for monopile foundations and from 14.6 ft (4.4 m) to 16.2 ft (4.9 m) for piled jacket foundations for the wind turbines. Average scour depths for piled jacket foundations for the offshore substations were lower than for the wind turbines, ranging from 10.6 ft (3.2 m) to 11.9 ft (3.6 m). In all cases, the greatest scour depths were predicted in the shallowest portions of the Lease Area. Scour impacts appear to be influenced by currents, rather than wave action, with bottom currents decreasing as the water depth increases.

Several studies have shown that most scour tends to occur within the first month of installation (Harris 2011; Temple et al. 2004). However, scouring is a continuous process that can change over a period of years (Harris et al. 2011; Whitehouse et al. 2011). In addition, large storms with strong currents can temporarily increase the scour rate (Harris et al. 2011; Temple et al. 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).

Short-term effects due to accidental spills and/or releases: During operations, both the onshore and offshore substation facilities as well as vessels will contain oils, fuels, and/or lubricants (see **Section 3 Project Description** 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. Beacon Wind has provided an OSRP (**Appendix E Oil Spill Response Plan**), which details the 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 Public Health and Safety**. Beacon Wind 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 development of the onshore substation facilities 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 construction at the Astoria power complex in Queens, New York will follow green building guidelines established by New York City sustainability, which will influence the change in permeable surfaces and keep any increase to a minimum.

Development would be required at the Astoria power complex in Queens, New York and at the Waterford power complex in Waterford, Connecticut for landfall and the onshore substation facilities. While the construction disturbance area is likely several acres, expected long-term increases in impervious area within these existing power facilities are small, potentially less than an acre (0.41 ha) in Queens, New York and less than 5 ac (2.0 ha) in Waterford, Connecticut. 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) and CTDEEP General Permit for the Discharge of Stormwater Associated with Industrial Activities (DEEP-WPED-GP-014). The SWPPP and associated stormwater control practices will be developed to meet the NYSDEC industrial stormwater permit requirements.

Localized increases in water temperatures due to the operation of offshore substation cooling systems: The HVDC equipment and HVAC-to-HVDC converters on each of the two offshore substation facilities will require a CWIS to remove heat from the HVDC equipment and the heating ventilation and air conditioning system. Ocean water will be drawn in from the water column, approximately 49-131 ft (15-40 m) below the water surface. Seawater circulating volumes will vary depending on the cooling demand, seawater temperature, and air temperature. Hypochlorite or similar dosing into the seawater system will occur under normal operating conditions to prevent biological growth. Seawater volumes and hypochlorite dosing under normal operating conditions are regulated dependent on ambient conditions and cooling demand to use minimum amounts. The CWIS will discharge heated, treated seawater below the platform jacket approximately 66-112 ft (20-34 m) below the water surface. Discharged water temperature will be approximately 87.8°F (31°C) when the seawater inlet temperature is 68°F (20°C), though for much of the year the seawater will be cooler and the discharge temperature will accordingly be lower. Maximum discharged water temperature will not exceed 96.8°F (36°C), and this maximum temperature would correlate to a CWIS operating at a much smaller discharge volume than the maximum volume of 10.6 mgd. This release of heated water will be localized to the area around the discharge points at the two offshore substation facilities and is expected to dissipate into the surrounding water column, resulting in an increase in the temperature of the water in the immediate vicinity of the substations. Within a short distance from the CWIS, the temperature difference from surrounding seawater will drop to undetectable levels. No impingement of juvenile or adult fish is anticipated from operation of the CWIS.

The design, configuration, and operation of the offshore substation facilities cooling systems will be permitted as part of an individual NPDES permit and additional details will be included in the permit application submitted to the EPA. Beacon Wind is actively working with EPA to understand any additional modelling and assessment that may be required for this system.

4.2.2.3 *Decommissioning*

Impacts during decommissioning are expected to be similar or less 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 Beacon Wind anticipates will be needed for the Project, please see **Section 3 Project Description**.

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**, Beacon Wind is proposing to implement the following avoidance, minimization, and mitigation measures.

4.2.3.1 *Construction*

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

- 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;
- 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) and in the Connecticut Guidelines for Soil Erosion and Sediment Control, 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 and the Connecticut Nonpoint Source Management Program Plan into the Project's site-specific best management practices, as applicable;
- Obtain an industrial stormwater NPDES permit (if required) and develop a SWPPP if more than 1 ac (0.40 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 for HDD, if selected, approved by the applicable agencies, as necessary;
- The Project will utilize an existing O&M Base and will not require construction of a new O&M Base in the State of New York, thereby avoiding additional potential stormwater-generating activities as a result of new construction; and
- Restricting access through wetlands and waterbodies to identified construction sites, access roads, and work zones at the Waterford Connecticut site, to the extent practicable. Restricting access through wetlands and waterbodies is not anticipated to be required in Queens, New York due to the absence of wetlands within the onshore area subject to construction activities.

4.2.3.2 *Operations and Maintenance*

During operations, Beacon Wind 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;
- 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; and
- The offshore substation facilities' cooling systems will be operated such that the volume of hypochlorite used and the discharge of heated water into the water below the platform jacket is minimized. The design, configuration, and operation of the offshore substation facilities'

cooling systems will be permitted as part of an individual NPDES permit and additional details will be included in the permit application submitted to the EPA.

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 4.2-4. SUMMARY OF 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-andData/ATL_SLA(3).aspx	http://metadata.boem.gov/geospatial/OCS_SubmergedLandsActBoundary_Atlantic_NAD83.xml
BOEM and NOAA	Water Quality Data	https://marinecadastre.gov/	N/A
CT Environmental Conditions Online	305(b) Impaired Waterbodies	https://cteco.uconn.edu/viewer/index.html?viewer=advanced	N/A
Mayflower	Water Quality Data	http://www.neracoos.org/erddap/tabledap/SHELL_MAYFLOWER_csv_all.html	N/A
NOAA NCEI	Bathymetry	https://www.ngdc.noaa.gov/mgg/coa stal/crm.html	N/A
NYCEP	Water Quality Data	https://data.cityofnewyork.us/Environment/Harbor-Water-Quality/5uug-f49n	N/A
NYSDEC	NYSDEC Priority Waterbody Class	http://gis.ny.gov/gisdata/fileserver/?D SID=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 Beacon Wind 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 J**).

This section was prepared in accordance with:

- BOEM guidance and guidelines, as applicable; and
- BOEM's site characterization requirements in 30 CFR § 585.626.

Under the federal Clean Air Act (CAA), the EPA is responsible for developing and enforcing the regulations protecting air quality in the U.S. Project emissions associated with construction, operations, and decommissioning will be subject to EPA regulations governing both onshore and offshore air quality. The federal CAA established the National Ambient Air Quality Standards (NAAQS) for the following common pollutants, known as criteria pollutants: ground- level ozone, nitrogen dioxides (NO_2), carbon monoxide (CO); total particulate matter (PM); particulate matter with aerodynamic diameter 10 micrometers or less (PM_{10}); particulate matter with aerodynamic diameter 2.5 micrometers or less ($PM_{2.5}$); sulfur dioxide (SO_2); and lead (Pb). In addition, other regulated precursor pollutants include volatile organic compounds (VOC), oxides of nitrogen (NO_X), and greenhouse gases (GHGs). Volatile organic compounds and NO_X are the precursors and measured pollutants for the criteria pollutant ozone, and NO_X and SO_2 are precursors for $PM_{2.5}$. The standards are set by EPA to achieve protection of public health and the environment from harmful air pollutants. The EPA sets both primary and secondary NAAQS. The primary standards protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly (EPA 2021b). 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 2021b).

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 is formed in the atmosphere by reactions of VOCs and 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. The 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 state-wide networks 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 applicable 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 to avoid backsliding into nonattainment (EPA 2020). New York State follows the federal NAAQS with a few additions. **Table 4.3-2** notes additional air quality standards within New York State.

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 GHGs (as mentioned above). HAPs are pollutants known or suspected to cause adverse health and environmental effects (EPA 2020b). 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 (EPA 2020a).

GHGs are gases that trap heat in the atmosphere and contribute to global warming by retaining heat in the atmosphere (EPA 2021). Common GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), 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 2021). In the U.S., CO_2 accounted for approximately 80 percent of GHG emissions in 2019 (EPA 2021a). Although EPA has not established ambient air quality standards for HAPs or GHGs, emissions of HAPs and GHGs are regulated through federal and state emissions standards and specific regulatory requirements.

TABLE 4.3-1. NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant		Primary/ Secondary	Averaging Time	Level a/	Form
CO		Primary	8 Hours	9 ppm (9,000 ppb)	Not to be exceeded more than once per year
			1 Hour	35 ppm (35,000 ppb)	
Lead		Primary and Secondary	Rolling 3-Month Average	0.15 µg/m³	Not to be exceeded.
NO_2		Primary	1 Hour	0.1 ppm (100 ppb)	98th percentile of 1-hour daily maximum concentration, averaged over 3 years
		Primary and Secondary	1 Year	0.053 ppm (53 ppb)	Annual Mean
Ozone		Primary and Secondary	8 Hours	2008: 0.075 ppm (75 ppb) 2015: 0.070 ppm (70 ppb)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter	$PM_{2.5}$	Primary	1 Year	12 µg/m³	Annual mean, averaged over 3 years
		Secondary	1 Year	15 µg/m³	Annual mean, averaged over 3 years
		Primary and Secondary	24 Hours	35 µg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24 Hours	150 µg/m³	Not to be exceeded more than once per year on average over 3 years
SO_2		Primary	1 Hour	0.075 ppm (75 ppb)	99th percentile of 1-hour daily maximum concentration, averaged over 3 years
		Secondary	3 Hours	0.5 ppm (500 ppb)	Not to be exceeded more than once per year

Notes:
a/ µg/m³ = micrograms per standard cubic meter
ppb = parts per billion (by volume)
ppm = parts per million (by volume)
Source: https://www.epa.gov/criteria-air-pollutants/naaqs-table (EPA 2021b)

TABLE 4.3-2. NEW YORK STATE AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Level c/	Form
SO_2	3-Hour	0.25 ppm (250 ppb)	99th percentile of 3-hour average shall not exceed 0.25 ppm a/
	3-Hour	0.50 ppm (500 ppb)	Not to be exceeded more than once per year (NAAQS [EPA 2021b])
	24-Hour	0.10 ppm (100 ppb)	99th percentile of 24-hour average shall not exceed 0.10 ppm b/
	24-Hour	0.14 ppm (140 ppb) (365 µg/m^3)	Not to be exceeded more than once per year
	Annual	0.03 ppm (30 ppb) (80 µg/m^3)	Annual average of the 24-hour average concentrations shall not exceed
Gaseous Fluorides	12-Hour	0.0045 ppm (4.5 ppb) (3.7 µg/m^3)	Not to be exceeded
	24-Hour	0.0034 ppm (3.5 ppb) (2.85 µg/m^3)	Not to be exceeded
	1 Week	0.002 ppm (2.0 ppb) (1.65 µg/m^3)	Not to be exceeded
	1 Month	0.001 ppm (1.0 ppb) (0.8 µg/m^3)	Not to be exceeded
Hydrogen Sulfide	1-Hour	0.010 ppm (10 ppb) (14 µg/m^3)	Not to be exceeded

Notes:
a/ For predicting future concentrations, predicted conformity with the 0.50 standard will be sufficient to demonstrate prediction of conformity with the 99 percent standard.
b/ For predicting future concentrations, predicted conformity with the 0.14 standard will be sufficient to demonstrate prediction of conformity with the 99 percent standard.
c/ µg/m^3 = micrograms per standard cubic meter
ppb = parts per billion (by volume)
ppm = parts per million (by volume)
Source: 6 NYCRR 257-2.3

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 definition 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, Beacon Wind developed an inventory of anticipated emissions from Project-related construction and operations and maintenance vessels operating at or within 25 mi (21.7 nm, 40.2 km) of the Lease Area. This inventory does not fulfill the requirements of the OCS permit application but can be used as a pre-assessment. Future decommissioning emissions were estimated by assuming they will be equivalent to 20 percent of the commissioning emissions.

In addition to the federal OCS air regulations, the OCS sources operating within 25 mi 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 closest geographic COA is Massachusetts, in which case the OCS sources associated with the Project activities are expected to be subject to the air permitting requirements of the Massachusetts Department of Environmental Protection (MassDEP). This encompasses applicable Massachusetts air quality regulations under 310 Code of Massachusetts Regulations (CMR) 7.00, which include stringent control requirements for Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER). In addition to the same standards as NAAQS (EPA 2021b), the Massachusetts Ambient Air Quality Standards include standards listed in **Table 4.3-3**.

TABLE 4.3-3. ADDITIONAL MASSACHUSETTS AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary/Secondary	Averaging Time	Level a/	Form
SO_2	Secondary	3-Hour	0.5 ppm (500 ppb)	Not to be exceeded more than once per year

Note:
a/ ppm = parts per million (by volume)
ppb = parts per billion (by volume)
Source: 310 CMR 6.04

As stipulated in 30 CFR § 585.659 and BOEM guidelines, Beacon Wind will follow the OCS air regulations and will apply for a permit application with the EPA. In preparation for an OCS permit application, Beacon Wind has developed a preliminary emissions inventory presented in **Appendix J Air Emissions Calculations and Methodology**. In addition to the information provided pursuant to 30 CFR § 585.659, Beacon Wind intends to submit an NOI to EPA Region 1. Following submission of the NOI, Beacon Wind will submit an air permit application to EPA. For the OCS air permit application, Beacon Wind 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, and compared to all applicable air quality standards, including evaluation of air quality impacts on Class I areas, if required. As previously explained, the Project decommissioning emissions will be subject to a future OCS air permit application.

Beacon Wind will compare the anticipated construction and operations 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 GHGs. If the Project's anticipated emissions do not exceed the NSR permitting thresholds for one or more pollutant, the Project may be considered a minor source and may be subject to minor source permitting; the minor source permitting programs are largely state specific. If the Project's anticipated emissions exceed the NSR permitting 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 Massachusetts, the major source thresholds for attainment areas are 100 tons per year (tpy) for NSR-regulated pollutants. For ozone nonattainment areas, thresholds are limited to 50 tpy in areas classified as "serious," 25 tpy in areas classified as "severe," and 10 tpy in areas classified as "extreme". Ozone transport regions have a threshold of 50 tpy of VOCs (the Northeastern states adjacent to this project are a part of the ozone transport region). For nonattainment areas, thresholds are 50 tpy and for PM_{10} nonattainment areas, the major source threshold is 70 tpy. (310 CMR 7.00 Appendix C Major Source). Although Massachusetts is the closest geographic onshore area to the Lease Area, New York will experience the majority of the port traffic and at least one of the onshore cable landfall sites, potentially two. Connecticut may also be impacted if Waterford, Connecticut is selected as the landfall location for BW2 due to entry into Connecticut state waters as part of the construction process and construction and operational emissions of the onshore substation facility. In New York, the major source thresholds for attainment areas are 100 tpy for NSR-regulated pollutants (6 NYCRR 231-13.5), while thresholds for severe/serious ozone nonattainment areas (which includes the counties of the New York Metropolitan Area) are limited to 25 tpy each for VOCs and NO_X (6 NYCRR 231-13.1). In Connecticut, the major source thresholds for attainment areas are 100 tpy for any regulated pollutant that is not a GHG, 50 tpy of VOC or NOx in a serious ozone non-attainment area (which includes Waterford, Connecticut) or 25 tpy of VOC or NOx in a severe ozone non-attainment area (R.C.S.A 22a-173-33(a)(10)(F)).

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. The General Conformity rule requires federal agencies to demonstrate proposed actions comply with the NAAQS (EPA 2020). 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."

The General Conformity thresholds are presented in **Table 4.3-4** and only apply to nonattainment areas or maintenance areas. As shown in **Section 4.3.3.2 Operations and Maintenance**, operating emissions estimates are below general conformity thresholds.

For informational purposes, Beacon Wind has developed an emissions inventory for construction, operations and maintenance, and decommissioning emissions for comparison to the General Conformity thresholds. The emissions inventory includes construction, operations and maintenance, and decommissioning emissions that occur in nonattainment and maintenance areas impacted by the Project. Emissions in these nonattainment and maintenance areas include vessel emissions associated with the transportation of materials and construction, operation and maintenance and decommissioning activities. However, 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 mi [40.2 km] of the Lease Area). Onshore areas impacted by the Project are listed in **Table 4.3-5** below and nonattainment and maintenance areas are delineated in by state **Sections 4.3.1.1 New York** through **4.3.1.5 Texas** (see

Table 4.3-6 through **Table 4.3-10**). New York, New Jersey, Connecticut, Texas, and Massachusetts may be impacted by the Project either from on land activities or by vessels traversing state waters.

In addition, the emissions inventory includes construction emissions that would occur in several jurisdictions that are designated as attainment for the current NAAQS, but which have been included for the purpose of NEPA review.

TABLE 4.3-4. GENERAL CONFORMITY THRESHOLDS

Pollutant	Designation	Tons per Year
Nonattainment Area (NAA) Thresholds		
Ozone (VOCs or NOx precursors)	Extreme NAA	10
	Severe NAA	25
	Serious NAA	50
	Other ozone NAA outside ozone transport region	100
	Other ozone NAA inside ozone transport region	50 (VOCs)
		100 (NOx)
CO	All NAAs	100
SO_2	All NAAs	100
NO_2	All NAAs	100
PM_{10}	Moderate NAA	100
	Serious NAA	70
$PM_{2.5}$	Moderate NAA	100
	Serious NAA	70
Lead	All NAAs	25
Maintenance Area Thresholds		
Ozone (VOCs or NOx precursors)	All Maintenance Areas	100 (NO_x)
	Maintenance areas outside ozone transport region	100 (VOCs)
	Maintenance areas inside ozone transport region	50 (VOCs)
CO	All Maintenance Areas	100
SO_2	All Maintenance Areas	100
NO_2	All Maintenance Areas	100
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)		

TABLE 4.3-5. ONSHORE AREAS IMPACTED BY THE PROJECT

State	County	Air Quality Control Region (AQCR)
New York	Albany	Hudson Valley Intrastate
	Columbia	
	Dutchess	
	Greene	
	Orange	
	Putnam	
	Rensselaer	
	Ulster	
	Bronx	New Jersey-New York-Connecticut Interstate
	Kings	
	Nassau	
	New York	
	Queens	
	Richmond	
	Rockland	
	Suffolk	
	Westchester	
New Jersey	Bergen	
	Hudson	
Connecticut	New London	Eastern Connecticut Intrastate
Massachusetts	Bristol	Metropolitan Providence
	Dukes	
Texas	Nueces	Corpus Christi-Victoria Intrastate

Data Relied Upon and Studies Completed

For the purpose of this section, the OCS Air Quality Study Area includes a 25-mi (40.2-km) buffer around the Lease Area within federal waters (e.g., stops at the 3-nm [5.6-km] state waters boundary). The General Conformity Determination Air Quality Study Area includes the counties in which the Project construction, operations and maintenance, and decommissioning activities are proposed to occur (see **Figure 4.3-1** below and **Table 4.3-5**). Beacon Wind will utilize SBMT[4] as the local port and staging area during construction and operations and maintenance of the Project, with the following exceptions:

- Port of Albany on the Hudson River in upstate New York is assumed to be the starting point for the wind turbine towers themselves (regardless of foundation design option). Vessels coming from the Port of Albany will pass through New York and New Jersey state waters;

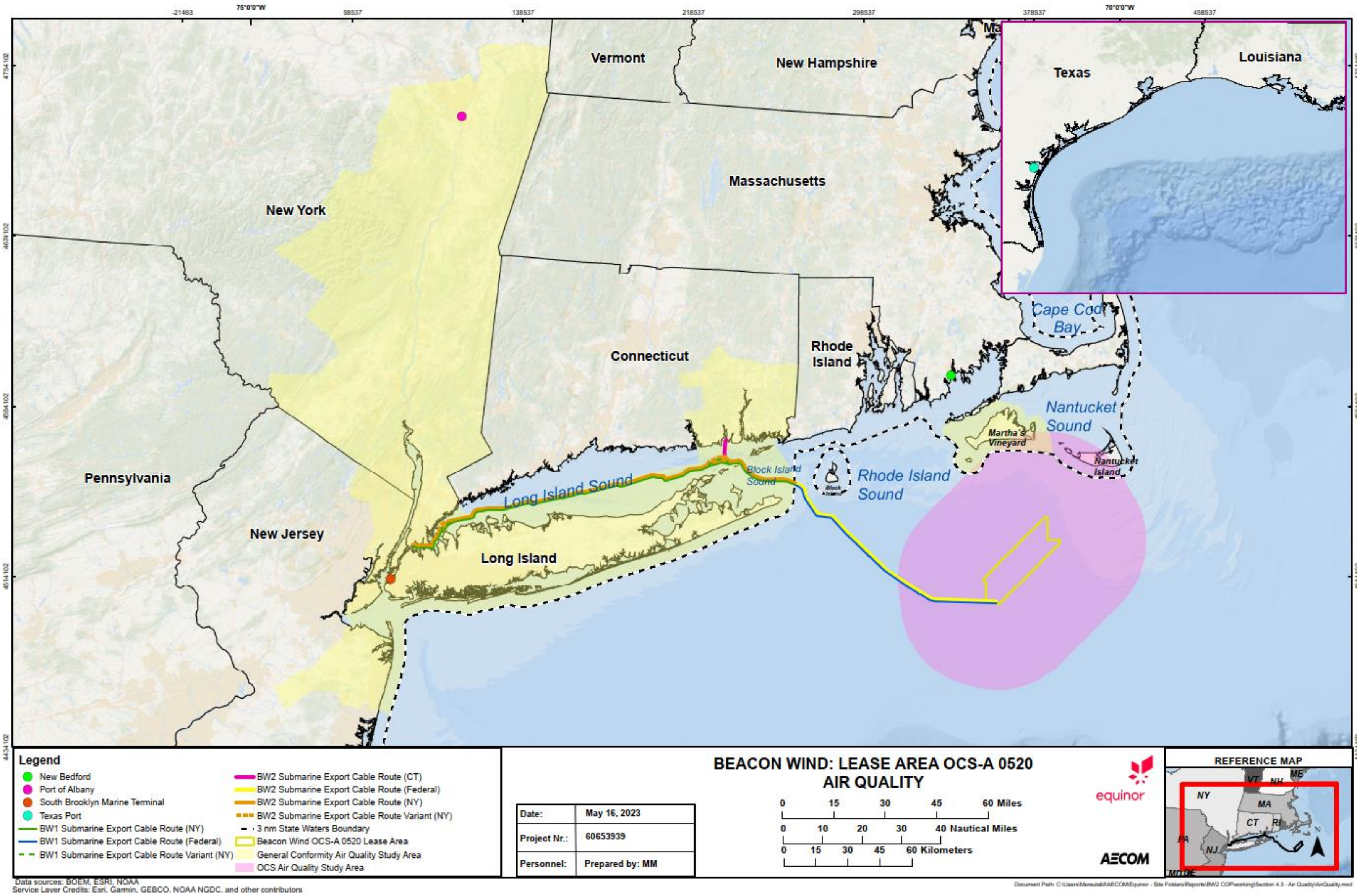
[4] The O&M Base will be located at the SBMT and will be constructed to support both the Empire Wind project and the Beacon Wind project. As indicated in **Section 3.5 Operations and Maintenance Activities**, construction of the O&M Base is addressed by the Empire Wind permitting process.

- Satellite location located in New Bedford, Massachusetts for smaller transit vessels used during operations and maintenance. Martha's Vineyard is still a potential satellite location option but is currently unlikely and New Bedford is assumed for current analysis;
- A yet-to-be-determined port in the Corpus Christi, Texas area is assumed to be the starting point for the bubble curtain vessel associated with various foundation installations; and
- Halifax, Nova Scotia is assumed to be the starting point for the transit of scour protection rock and gravel (although a local U.S. port could be selected instead as construction planning continues). Rock and gravel will be brought directly to the offshore construction locations by a fall pipe vessel.

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 (to be fulfilled by separate permitting with EPA); 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."

FIGURE 4.3-1. AIR QUALITY STUDY AREA



4.3.1 Affected Environment

This section describes the affected environment, inclusive of the onshore and offshore areas potentially impacted by Project construction, operations and maintenance, and decommissioning activities; this includes areas associated with permanent Project facilities and operation and maintenance ports, as well as areas that will temporarily host construction activities. These areas include the OCS area located at or within 25 mi (40.2 km) of the Lease Area, the Hudson Valley Intrastate AQCR, the New Jersey-New York-Connecticut Interstate AQCR (New York – New Jersey - Connecticut), Eastern Connecticut Intrastate AQCR, Metropolitan Providence AQCR, and the Corpus Christi - Victoria AQCR. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities.

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 55 active air pollution monitoring stations collecting meteorological data and ambient concentrations of criteria pollutants, VOCs, and other air toxics across the state (NYSDEC 2021). The data collected at these monitoring stations inform air pollution control programs and policies. Of the 55 monitoring stations, approximately 17 stations collect air quality data in the New York City metropolitan area, including Nassau County, Rockland County, Suffolk County, and Westchester County, and the five counties within New York City (NYSDEC 2021).

Table 4.3-6 lists counties in New York State where Project emissions could potentially occur during construction or operations and maintenance that are classified as non-attainment or maintenance areas. If a county is not listed, it is classified as attainment or unclassified for criteria pollutants. An unclassified area is defined as an area that cannot be classified as meeting or not meeting NAAQS based on available information but is treated as an attainment area.

TABLE 4.3-6. PROJECT-RELATED NON-ATTAINMENT OR MAINTENANCE COUNTIES – NEW YORK

Pollutant	County	AQCR	Designation
Ozone (2008 and 2015 8-Hour NAAQS)	Bronx	New Jersey-New York-Connecticut Interstate	Serious (2008)/Moderate (2015)
	Kings		Serious (2008)/Moderate (2015)
	Nassau		Serious (2008)/Moderate (2015)
	New York		Serious (2008)/Moderate (2015)
	Queens		Serious (2008)/Moderate (2015)
	Richmond		Serious (2008)/Moderate (2015)
	Rockland		Serious (2008)/Moderate (2015)
	Suffolk		Serious (2008)/Moderate (2015)
	Westchester		Serious (2008)/Moderate (2015)
CO (1971 NAAQS)	Bronx	New Jersey-New York-Connecticut Interstate	Maintenance
	Kings		Maintenance
	Nassau		Maintenance
	New York		Maintenance
	Queens		Maintenance
	Richmond		Maintenance
	Westchester		Maintenance

Pollutant	County	AQCR	Designation
PM_{10} (1987 Annual NAAQS)	New York	New Jersey-New York-Connecticut Interstate	Moderate
$PM_{2.5}$ (1997 Annual NAAQS)	Bronx	New Jersey-New York-Connecticut Interstate	Maintenance
	Kings		Maintenance
	Nassau		Maintenance
	New York		Maintenance
	Orange	Hudson Valley Intrastate	Maintenance
	Queens	New Jersey-New York-Connecticut Interstate	Maintenance
	Richmond		Maintenance
	Rockland		Maintenance
	Suffolk		Maintenance
	Westchester		Maintenance
$PM_{2.5}$ (2006 24-Hour NAAQS)	Bronx	New Jersey-New York-Connecticut Interstate	Maintenance
	Kings		Maintenance
	Nassau		Maintenance
	New York		Maintenance
	Orange	Hudson Valley Intrastate	Maintenance
	Queens	New Jersey-New York-Connecticut Interstate	Maintenance
	Richmond		Maintenance
	Rockland		Maintenance
	Suffolk		Maintenance
	Westchester		Maintenance

Source: EPA Green Book (https://www3.epa.gov/airquality/greenbook/anayo_ny.html). (EPA 2021c)

In addition to monitoring criteria pollutants in order 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 2021). While some compounds exhibit more variable trends, data from 2015 to 2020 indicates that annual average concentrations have generally decreased since 2015 (NYSDEC 2021).

In July 2019, NYSERDA finalized the New York State Greenhouse Gas Inventory: 1990-2016, which inventories GHG emissions by sector. The report indicates that, while GHG emissions, in terms of carbon dioxide equivalent (CO_2e) 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 CO_2e in 1990 to 206 million metric tons of CO_2e in 2016, achieving a 13 percent decrease in GHG emissions over this period. These emissions assume 100-year global warming potential factors. The state reduced GHG emissions, while national emissions increased approximately two percent over the same period from 1990 to 2016 (NYSERDA 2019).

In 2021, NYSDEC published their 2021 Statewide GHG Emissions Report. This report noted that in 2019, statewide gross emissions were 379.44 million metric tons of CO_2e, based on the 20-year global warming potential factors. This amount is six percent lower than 1990 levels, when calculating using the same global warming potential (NYSDEC 2021a).

4.3.1.2 *New Jersey*

In New Jersey, the New Jersey Department of Environmental Protection (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 2020). 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 Middlesex and Union counties. The data collected at these monitoring stations inform air pollution control programs and policies. **Table 4.3-7** lists counties in New Jersey State where Project emissions could potentially occur during construction or operations that are classified as non-attainment or maintenance areas.

TABLE 4.3-7. PROJECT-RELATED NON-ATTAINMENT OR MAINTENANCE COUNTIES – NEW JERSEY

Pollutant	County	AQCR	Designation
Ozone (2008 and 2015 8-Hour NAAQS)	Bergen	New Jersey-New York-Connecticut Interstate	Serious (2008)/Moderate (2015)
	Hudson		Serious (2008)/Moderate (2015)
	Monmouth		Serious (2008)/Moderate (2015)
CO (1971 NAAQS)	Bergen	New Jersey-New York-Connecticut Interstate	Maintenance
	Hudson		Maintenance
	Monmouth		Maintenance
$PM_{2.5}$ (1997 Annual NAAQS)	Bergen	New Jersey-New York-Connecticut Interstate	Maintenance
	Hudson		Maintenance
	Monmouth		Maintenance
$PM_{2.5}$ (2006 24-Hour NAAQS)	Bergen	New Jersey-New York-Connecticut Interstate	Maintenance
	Hudson		Maintenance
	Monmouth		Maintenance

Source: EPA Green Book (https://www3.epa.gov/airquality/greenbook/anayo_nj.html). (EPA 2021c)

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 to evaluate toxics (NJDEP 2020). Of the primary toxic emissions evaluated for trend analysis, acetaldehyde, benzene, and carbon tetrachloride increased slightly over past since 2018; 1,3-butadiene, chloroform, chloromethane, and 1,2-dichloroethane decreased slightly since 2018; and formaldehyde stayed fairly consistent since 2018 (NJDEP 2020).

NJDEP produces a Statewide GHG Emissions Inventory, which inventories GHG emissions in the state every two years. A “Mid-Cycle Update” is produced during the intervening years. Although the GHG emissions have periodically increased, the report indicates that GHG emissions have trended downward since 2005 (NJDEP 2021). 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., as cited in NJDEP 2021). The statewide GHG emissions have been under the 2020 target since 2008. In order to achieve the 2050 target, New Jersey issued the Global Warming Response Act 80x50 Report in the fall of 2020 (as cited in NJDEP 2021), which outlines pathways and offers recommendations. This report, in tandem with the Energy Master Plan, will guide the state's work in decarbonizing its economy (NJDEP 2021).

4.3.1.3 *Connecticut*

In Connecticut, the Connecticut Department of Energy and Environmental Protection (CTDEEP) Bureau of Air Management monitors the air quality within the state. CTDEEP operates 14 air pollution monitoring stations collecting meteorological data and ambient concentrations of criteria pollutants across the state (CTDEEP 2020). Of these 14 monitoring stations, the Groton-Fort Griswold monitor is the closest station to Waterford, Connecticut. The data collected at these monitoring stations inform air pollution control programs and policies. The Connecticut standards are the same as the Federal NAAQS with a few additions. In addition to the same standards as NAAQS, the Connecticut primary and secondary ambient air quality standards includes standards listed in **Table 4.3-8**. **Table 4.3-9** shows the county in Connecticut where Project emissions could potentially occur that is classified as non-attainment or maintenance areas.

TABLE 4.3-8. CONNECTICUT STATE AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Level a/	Form
SO_2	24-Hour	0.14 ppm (140 ppb)	Not to be exceeded more than once per calendar year
	Annual	0.03 ppm (30 ppb) (80 µg/m^3)	Not to be exceeded
Dioxin	Annual	1 picograms/m^3	Not to be exceeded on annual average

Notes:
a/ µg/m^3 = micrograms per standard cubic meter
ppb = parts per billion (by volume)
ppm = parts per million (by volume)
Source: R.C.S.A 22a-174-24

TABLE 4.3-9. PROJECT-RELATED NON-ATTAINMENT OR MAINTENANCE COUNTIES – CONNECTICUT

Pollutant	County	AQCR	Designation
Ozone (2008 8-Hour NAAQS)	New London	Eastern Connecticut	Serious (2008)
Ozone (2015 8-Hour NAAQS)	New London	Eastern Connecticut	Marginal (2015)

Source: EPA Green Book (https://www3.epa.gov/airquality/greenbook/anayo_ma.html). (EPA 2021c) Accessed August 2021.

In addition to monitoring criteria pollutants in order to determine compliance with the NAAQS, CTDEEP also produces annual GHG emission inventory reports. The latest CTDEEP GHG report is the "2018 Connecticut Greenhouse Gas Emissions Inventory" that was released in 2021. The Global Warming

Solutions Act (GWSA), enacted in 2008, established a requirement for the state to reduce the level of GHG emissions to 80 percent below 2001 levels by 2050 and 45 percent below 2001 levels by 2030. The annual GHG emission inventory reports track progress towards these goals. In 2018, Connecticut emitted 42.2 million metric tons of carbon dioxide equivalent (CO_2e), which is 17.8 percent below 2001 emission levels and 24 percent below the level reported in 2004, the current peak recorded year. According to the latest emission inventory report, the transportation sector continues to be Connecticut's largest source of GHG emissions, primarily from the combustion of fossil fuels in vehicles (CTDEEP 2018).

4.3.1.4 *Massachusetts*

In Massachusetts, MassDEP Division of Air Quality is responsible for ensuring clean air and managing the state and federal air pollution control programs. MassDEP operates 22 air pollution monitoring stations collecting meteorological data and ambient concentrations of criteria pollutants across the state (MassDEP 2021). An additional ozone monitoring station on Martha's Vineyard is operated by the Wampanoag Tribe of Gay Head. Of these 23 monitoring stations, the following three stations collect air quality data in or near areas potentially affected by the Project: Aquinnah, Fairhaven, and Fall River. The data collected at these monitoring stations inform air pollution control programs and policies. Massachusetts follows Federal NAAQS with a few additions. As previously noted, in addition to the same standards as NAAQS, the Massachusetts Ambient Air Quality Standards includes standards listed in **Table 4.3-3**. **Table 4.3-10** lists counties in Massachusetts where Project emissions could potentially occur during construction or operations and maintenance that are classified as non-attainment or maintenance areas.

TABLE 4.3-10. PROJECT-RELATED NON-ATTAINMENT OR MAINTENANCE COUNTIES – MASSACHUSETTS

Pollutant	County	AQCR	Designation
Ozone (2008 8-Hour NAAQS)	Dukes	Metropolitan Providence	Marginal (2008)

Source: EPA Green Book (https://www3.epa.gov/airquality/greenbook/anayo_ma.html). (EPA 2021c) Accessed August 2021.

In addition to monitoring criteria pollutants in order to determine compliance with the NAAQS, MassDEP monitors the ambient concentration of VOCs at three of the 23 monitoring stations within the state to evaluate toxics (MassDEP 2021). MassDEP also produces annual GHG Emissions Reports for facilities and retail sellers. This is part of the Massachusetts Global Warming Solutions Act (GWSA), which became law in 2008, requires mandatory reporting regulations. Facilities required to report and the methodologies for calculating and verifying emissions of CO_2, CH_4, N_2O, sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) were codified in 310 CMR 7.71. The latest MassDEP GHG Reporting Program Summary Report and Facility list available online is for emissions year 2015 and it shows that CO_2 equivalent (CO_2e) emissions from facilities required to report have decreased from 2010 to 2015. Reported CO_2e emissions in 2010 were over 25,000,000 metric tons while they were below 19,000,000 in 2015. Fossil CO_2 emissions account for 80 percent of the CO_2e emissions, and 60 percent of emissions are from power generation (MassDEP 2016).

4.3.1.5 *Texas*

Due to a yet-to-be-determined port in the Corpus Christi, Texas area being assumed to be the starting point for the bubble curtain vessel associated with various foundation installations, existing air quality in Texas has been reviewed. 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 252 monitoring stations in the state of Texas, nine of which are located in the Corpus Christi area (TCEQ 2020). The following jurisdictions in Texas where Project emissions could potentially occur during construction are designated as attainment for the current NAAQS: Aransas County, Nueces County, and San Patricio County. These counties are part of the Corpus Christi - Victoria AQCR. Summaries of ambient monitoring data for approximately the past 20 years (2000 - 2020) show that concentrations for most criteria pollutants, aside from SO_2, have either decreased or remained roughly steady (TCEQ 2020a). SO_2 (1-hour) saw a sharp increase in 2019 after several years of decreasing (TCEQ 2020a).

TCEQ currently does not publish an official inventory of greenhouse gas GHG emissions in Texas. However, the U.S. Energy Information Administration has published trends for fossil-fuel CO_2 emissions in Texas. Texas emitted 684 million metric tons of fossil-fuel CO_2 in 2018, which is the most recent year available and is a high compared to records dating back to 1980. Since 1980, the lowest annual total was 489.6 million metric tons in 1983 (EIA 2021).

4.3.2 Impact Analysis for Construction, Operations, and Decommissioning

Air emissions from construction, operations, and decommissioning activities are generated from commercial marine vehicles (CMVs), non-road construction equipment, helicopters, generators, on-road vehicles, and some fugitive emissions. These emissions will occur both onshore and offshore, within New York, New Jersey, Connecticut, Massachusetts, and Texas state waters, the OCS, and possibly other Atlantic port(s). Onshore emissions will occur at the two landfall sites, along the onshore export cable routes, at the onshore substation facilities, and at the construction staging areas. The first landfall location and associated onshore substation facility will be in Queens, New York and associated with BW1. The second landfall location and associated onshore substation facility will either be in Queens, New York or will be in Waterford, Connecticut and will be associated with BW2 . Offshore emissions will occur within the Lease Area, along the submarine export cable routes, at one or more ports and along the vessel routes between the Lease Area and the port(s). As previously noted, the Project intends to use SBMT as the Project's primary construction staging area, with vessels traveling to the Lease Area from the waters south of Long Island. A satellite location in New Bedford, Massachusetts will also be utilized during operations and maintenance to allow for closer access to the Lease Area..

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 4.3-11**. The parameters provided below represent the maximum potential impact from the full build-out. This design concept incorporates a total of up to 157 structures within the Lease Area (made up of up to 155 wind turbines and two offshore substation facilities) with one submarine export cable route to Queens, New York and the associated onshore substation facility for BW1 and one submarine export cable route either also going to Queens, New York or to Waterford, Connecticut and the associated onshore substation facility for BW2. Emission calculations assumes 82 wind turbines and one offshore substation facility associated with BW1 and 73 wind turbines and one offshore substation facility associated with BW2.

TABLE 4.3-11. SUMMARY OF MAXIMUM DESIGN SCENARIO PARAMETERS FOR AIR QUALITY

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	Representative of the maximum number of structures.
Wind turbine Foundation	Monopile, piled jacket	Representative of the foundation options that have the installation methods that would result in the maximum amount of Project-related emissions.
Submarine export cables	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York (202 nm [375 km]). • BW2: ○ To Queens, New York (202 nm [375 km]) or ○ To Waterford, Connecticut (113 nm [209 km]).	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 the Project (BW1 and BW2): BW1: 162 nm (300 km). BW2: 162 nm (300 km).	Representative of the maximum number and 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 the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), submarine export cables, 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 installation	Based on full build-out of the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), 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.

Parameter	Maximum Design Scenario	Rationale
Project-related vehicles and equipment	Based on BW1 and BW2 (construction and installation of two export cable landfalls, onshore export and interconnection cables, and two 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.
Staging and construction areas, including port facilities, work compounds, and lay-down areas	Based on full build-out of the Project (BW1 and BW2). Maximum number of work compounds and lay-down areas required. Some ground disturbing activities may be anticipated at Queens, New York with grading and minor tree clearing in Waterford, Connecticut. 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.

Duration onshore construction	Based on full build-out of the Project (BW1 and BW2):
	• BW1 Queens, New York (up to a 16 ac [6.5 ha] area).
	• BW2:
	  ○ Queens, New York (up to a 16 ac [6.5 ha] area)
	  ○ Waterford, Connecticut (up to a 16 ac [6.5 ha]).
	Construction and installation of export cable landfalls, onshore export and interconnection cables, and onshore substation facilities 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 and Maintenance		
Offshore structures	Based on a full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	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 the Project (BW1 and BW2), which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), submarine export cables 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 operations and maintenance activities	Based on a full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities, submarine export cables, and associated 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 operations phase, which would result in the maximum amount of Project-related emissions.

Parameter	Maximum Design Scenario	Rationale
Onshore operations and maintenance activities	Based on full build-out of the Project (BW1 and BW2): • BW1to Queens, New York • BW2 to Queens, New York or Waterford, Connecticut. 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 operations phase, which would result in the maximum amount of Project-related emissions.

Onshore substation facilities	Based on full build-out of the Project (BW1 and BW2):
	• BW1to Queens, New York (up to a 7-ac [2.8-ha] area).
	• BW2:
	  ○ Queens, New York (up to a 7 ac [2.8 ha] area)
	  ○ Waterford, Connecticut (up to a 7 ac [2.8 ha] area).
		Representative of the presence of new sources of emissions.

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;
- Installation of the offshore components, including the wind turbines, offshore substation facilities, submarine export cables, and interarray cables; and
- Construction of the onshore components, including the onshore export and interconnection cables and onshore substation facilities.

With the following potential consequential impact-producing factor:

- 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, Connecticut, Massachusetts, 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 a heavier fuel oil. There is the possibility that some vessels may be electric or use alternative fuels but, at this time, the most conservative emissions estimates were used, which is limited to fuel consumption. Construction staging and laydown for offshore and onshore construction may occur at port facilities in New York State, the location for the BW1 onshore substation facility and export cable interconnection in Queens, New York, and the location of the BW2 onshore substation facility and export cable interconnection in either Queens, New York or in Waterford, Connecticut.. Onshore construction activities will primarily utilize diesel-powered equipment for activities including HDD operations, if selected, 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 J Air Emissions Calculations and Methodology**. The emission inventory includes emissions of criteria pollutants, GHGs and HAPs from all pollutant-emitting sources, including CMVs, helicopters, stationary diesel generator engines, gas-insulated switchgears, nonroad engines, on-road vehicles and fugitive/construction dust. The avoidance, minimization, and mitigation measures that have been incorporated in the inventory assumptions area are also provided in **Appendix J Air Emissions Calculations and Methodology** and include, but are not limited to: use of low-sulfur fuels; use of vessels that meet BACT and LAER requirements; acquisition of Emission Reduction Credits (ERC); and minimization of engine idling time.

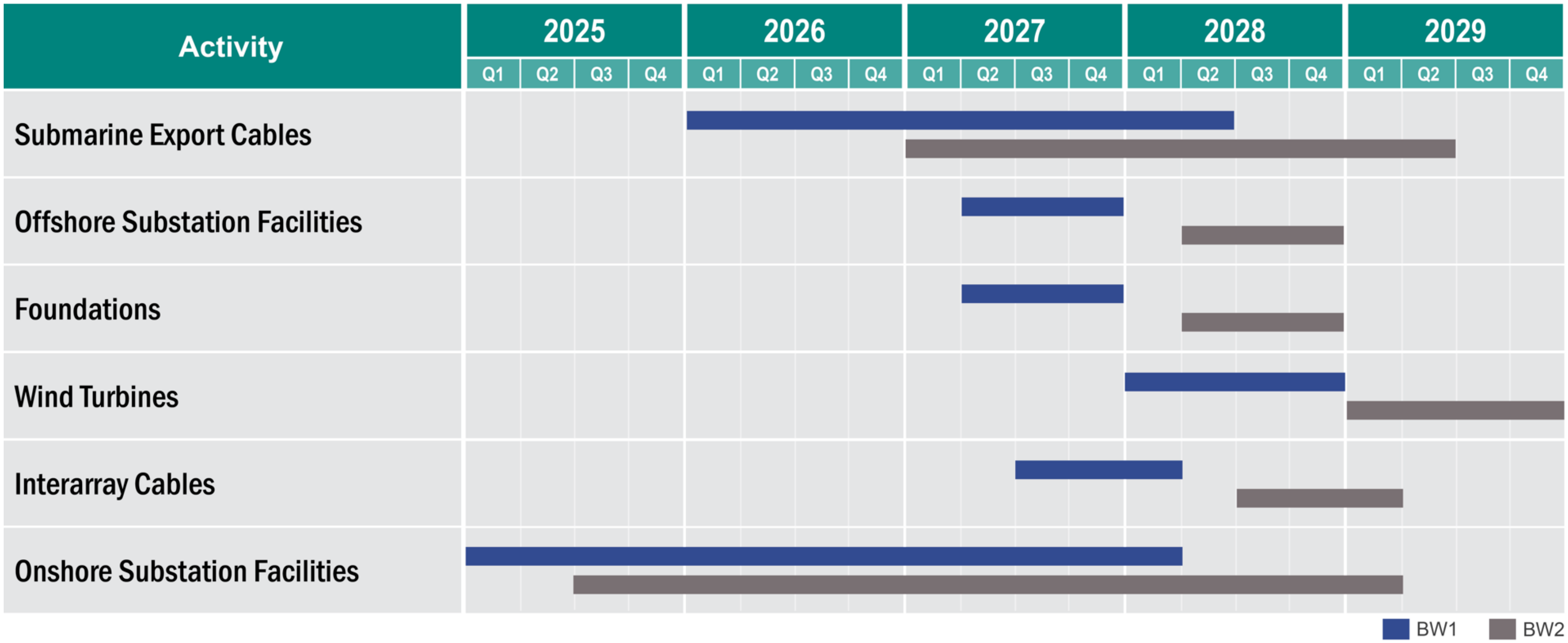
Estimated emissions are presented as total annual emissions for the purpose of comparison to OCS air permitting and General Conformity thresholds. OCS air permit emissions include those from OCS sources, vessels meeting the definition of OCS Source (40 CFR § 55.2), and vessels traveling to and from the Project when within 25 mi (21.7 nm, 40.2 km) of the Lease Area's perimeter. General Conformity air emissions include emissions outside the 25-mi (21.7-nm, 40.2-km) perimeter and within the defined nonattainment areas (NAAs) and maintenance areas (described in **Table 4.3-12** through **Table 4.3-24**, below, as 'Inside OCS Radius'). These areas extend outward to 3 nm (5.6 km) of a state's seaward boundary with one exception along the Long Island Sound. Because the Long Island Sound is a juridical bay within the U.S. coastline, New York and Connecticut have jurisdiction over the Long Island Sound waters from coastal boundaries to edge of state and county boundaries. Thus, nonattainment or maintenance area boundaries along the Long Island Sound are based on state and county lines versus 3 nm (5.6 km) beyond coastline. Conformity emissions are apportioned to the nonattainment areas 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 submarine export cable routes (described in **Table 4.3-12** through **Table 4.3-24**, below, through the associated AQCR). Emissions are presented by the pollutants identified in technical guidance. Note since the location of any specific port in Massachusetts is not finalized, current emission calculations assume no vessels travel within any Massachusetts nonattainment areas.

Table 4.3-12 through **Table 4.3-24** present the potential emissions for the projected construction window, by calendar year, for each geographic area considered. The total emissions listed per pollutant for the geographic area of a specific state with the attainment qualifier are total emissions from all counties in that state noted in **Table 4.3-5** that are in attainment for that pollutant.

GHG emissions were provided as short tons CO_2e and are based on three different Global Warming Potential factors – the 100-year factors from the latest Fifth Assessment Report (AR5) produced by the Intergovernmental Panel on Climate Change (IPCC), the 100-year factors from the Fourth Assessment Report (AR4), and the 20-year factors from AR5.

Each onshore landing location option for BW2 is examined to evaluate emissions for both scenarios. The emissions in each area include total emissions from construction (both onshore and offshore) and operations, including vessel transits. The potential construction window for BW1 and BW2 is a scenario in which construction begins in 2025 for BW1 and 2025 for BW2 and has a total duration of just over five years (see **Figure 4.3-2** below). Commissioning emissions were assigned to calendar year 2029 for BW1 and 2030 for BW2.

FIGURE 4.3-2. BW1 AND BW2 ANTICIPATED CONSTRUCTION SCHEDULE



As shown in **Table 4.3-12** through **Table 4.3-24**, the potential construction window for BW1 and BW2 has the potential to exceed the General Conformity thresholds for the following nonattainment or maintenance areas:

Calendar years 2025 through 2030

- 1971 CO Maintenance
  - New York – (New Jersey-New York-Connecticut Interstate) - NO_x as an ozone precursor; and
- 2008 Serious Ozone NAA
  - New York - (New Jersey-New York-Connecticut Interstate) - NO_x as an ozone precursor;
  - Connecticut – (Eastern Connecticut Intrastate); and
- 2015 Moderate Ozone NAA
  - New York - (New Jersey-New York-Connecticut Interstate) - NO_x as an ozone precursor;
- Connecticut – (Eastern Connecticut Intrastate); andPM_{10} 1987 Annual Moderate NAA
  - New York - (New Jersey-New York-Connecticut Interstate) - NO_x as a $PM_{2.5}$ precursor; and
- $PM_{2.5}$ 1997 Annual Maintenance Area
  - New York - (New Jersey-New York-Connecticut Interstate) - NO_x as a $PM_{2.5}$ precursor;
  - Hudson Valley Intrastate; and
- $PM_{2.5}$ 2006 24-Hour Maintenance Area
  - New York - (New Jersey-New York-Connecticut Interstate) - NO_x as a $PM_{2.5}$ precursor; and
  - Hudson Valley Intrastate.

TABLE 4.3-12. CALENDAR YEAR 2025 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	1.02	19.30	3.16	0.51	0.48	0.53	0.27	3,630.75	3,632.67	3,632.78	0.00003
Other Federal Waters	0.89	20.71	2.02	0.34	0.32	0.75	0.10	1,249.43	1,251.14	1,250.33	0.00004
New York State (Attainment)	0.00	0.00	4.33	23.90	0.00	2.13	0.40	5,205.97	5,212.19	5,209.41	0.00015
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	3.01	71.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Ozone NAA (Eastern Connecticut Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	3.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (1997 Annual) New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	4.66	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	4.66	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Total, All Areas	**4.92**	**111.27**	**13.47**	**24.83**	**5.46**	**3.42**	**0.78**	**10,086.15**	**10,095.99**	**10,092.51**	**0.0002**

TABLE 4.3-13. CALENDAR YEAR 2025 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	1.19	23.30	3.55	0.57	0.54	0.68	0.29	3,871.92	3,874.16	3,874.11	0.00004
Other Federal Waters	1.14	26.45	2.58	0.44	0.40	0.96	0.13	1,595.37	1,597.55	1,596.52	0.00005
New York State (Attainment)	0.00	0.00	4.02	16.86	0.00	1.72	0.33	4,239.62	4,244.83	4,242.38	0.00012
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Connecticut State (Attainment)	0.00	0.00	0.42	6.90	1.08	0.06	0.03	379.24	379.45	379.49	0.00000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	2.47	59.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Ozone NAA (Eastern Connecticut Interstate)	0.12	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	3.43	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	3.43	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00000
Total, All Areas	**4.92**	**111.27**	**13.47**	**24.83**	**5.46**	**3.42**	**0.78**	**10,086.15**	**10,095.99**	**10,092.51**	**0.0002**

TABLE 4.3-14. CALENDAR YEAR 2026 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	4.31	112.85	13.84	2.14	2.02	2.42	0.51	7,747.27	7,758.72	7,751.51	0.0003
Other Federal Waters	5.83	151.97	18.43	2.68	2.52	3.51	0.69	11,298.69	11,315.42	11,304.38	0.0003
New York State (Attainment)	0.00	0.00	23.69	34.97	0.00	9.64	1.68	21,876.94	21,906.79	21,891.23	0.0006
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	13.77	332.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	11.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	9.64	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	9.64	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Total, All Areas	**23.92**	**597.11**	**67.66**	**39.89**	**14.18**	**15.57**	**2.88**	**40,922.91**	**40,980.93**	**40,947.11**	**0.001**

TABLE 4.3-15. CALENDAR YEAR 2026 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	4.66	120.85	14.62	2.28	2.15	2.71	0.55	8,229.61	8,241.71	8,234.19	0.0003
Other Federal Waters	6.33	163.44	19.55	2.87	2.69	3.93	0.75	11,990.58	12,008.25	11,996.76	0.0003
New York State (Attainment)	0.00	0.00	23.07	20.89	0.00	8.82	1.52	19,944.24	19,972.07	19,957.18	0.0006
New Jersey State(Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Connecticut State (Attainment)	0.00	0.00	0.83	13.79	2.16	0.11	0.06	758.48	758.89	758.98	0.0000
Massachusetts (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	12.70	308.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Ozone NAA (Eastern Connecticut Interstate)	0.23	4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	9.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	7.18	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	7.18	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Total, All Areas	**23.92**	**597.11**	**67.66**	**39.89**	**14.18**	**15.57**	**2.88**	**40,922.91**	**40,980.93**	**40,947.11**	**0.001**

TABLE 4.3-16. CALENDAR YEAR 2027 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	296.11	7,086.39	701.78	117.50	109.15	207.09	34.66	402,765.58	403,337.23	403,063.00	0.014
Other Federal Waters	81.85	2,204.76	284.74	45.49	43.26	37.81	9.84	146,104.87	146,323.12	146,185.91	0.005
New York State (Attainment)	0.00	0.00	50.78	45.08	0.00	23.51	4.33	58,063.41	58,145.90	58,100.52	0.002
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Texas State (Attainment)	0.03	0.96	0.16	0.03	0.03	0.00	0.00	68.58	68.69	68.61	0.000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Massachusetts (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	36.35	899.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	48.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	19.13	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	19.13	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**414.34**	**10,191.18**	**1,085.45**	**208.20**	**171.57**	**268.41**	**48.84**	**607,002.43**	**607,874.94**	**607,418.03**	**0.021**

TABLE 4.3-17. CALENDAR YEAR 2027 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	298.63	7,146.56	707.75	118.47	110.04	208.93	34.96	406,419.95	406,996.80	406,719.88	0.014
Other Federal Waters	85.59	2,295.49	294.12	46.95	44.61	40.46	10.28	151,939.74	152,166.37	152,024.49	0.006
New York State (Attainment)	0.00	0.00	40.32	28.60	0.00	18.33	3.45	46,648.63	46,715.47	46,678.20	0.001
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Texas State (Attainment)	0.03	0.96	0.16	0.03	0.03	0.00	0.00	68.58	68.69	68.61	0.000
Connecticut State (Attainment)	0.00	0.00	2.75	14.10	2.45	0.69	0.15	1,925.54	1,927.61	1,926.85	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	29.05	724.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	1.05	24.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	40.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	14.44	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	14.44	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**414.34**	**10,191.18**	**1,085.45**	**208.20**	**171.57**	**268.41**	**48.84**	**607,002.43**	**607,874.94**	**607,418.03**	**0.021**

Table 4.3-18. Calendar Year 2028 Potential Emissions (short tons) Associated with BW1and BW2 (Queens, New York Option)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	358.55	8,566.59	853.36	141.97	131.87	250.82	41.96	488,354.93	489,044.63	488,720.40	0.016
Other Federal Waters	97.42	2,717.30	373.61	59.90	57.26	36.69	11.82	183,388.32	183,665.21	183,484.74	0.007
New York State (Attainment)	3.89	124.80	67.60	37.83	2.91	20.86	4.78	68,974.50	69,075.43	69,014.93	0.002
New Jersey State (Attainment)	0.00	0.00	0.00	0.40	0.00	0.01	0.06	1,072.07	1,073.75	1,072.51	0.000
Texas State Attainment)	0.03	0.96	0.16	0.03	0.03	0.00	0.00	68.58	68.69	68.61	0.000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	36.42	931.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	63.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	19.21	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	19.21	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**496.31**	**12,341.57**	**1,357.99**	**240.45**	**211.63**	**308.38**	**58.62**	**741,858.40**	**742,927.70**	**742,361.19**	**0.026**

TABLE 4.3-19. CALENDAR YEAR 2028 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	362.15	8,652.85	861.93	143.35	133.15	253.43	42.38	493,595.32	494,292.48	493,964.39	0.017
Other Federal Waters	102.77	2,847.66	387.13	61.99	59.20	40.46	12.44	191,794.68	192,083.67	191,896.42	0.007
New York State (Attainment)	3.89	124.80	52.21	20.15	2.91	13.50	3.53	52,818.69	52,897.15	52,848.48	0.002
New Jersey State (Attainment)	0.00	0.00	0.00	0.40	0.00	0.01	0.06	1,072.07	1,073.75	1,072.51	0.000
Texas State (Attainment)	0.03	0.96	0.16	0.03	0.03	0.00	0.00	68.58	68.69	68.61	0.000
Connecticut State (Attainment)	0.00	0.00	3.71	14.26	2.59	0.98	0.20	2,509.07	2,511.97	2,510.78	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	26.01	681.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	1.45	33.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	52.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	13.40	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	13.40	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**496.31**	**12,341.57**	**1,357.99**	**240.45**	**211.63**	**308.38**	**58.62**	**741,858.40**	**742,927.70**	**742,361.19**	**0.026**

TABLE 4.3-20. CALENDAR YEAR 2029 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	66.85	1,598.17	167.25	26.67	24.80	46.02	7.82	94,743.55	94,875.28	94,815.90	0.003
Other Federal Waters	22.33	699.72	113.93	17.48	16.91	2.59	2.78	54,511.80	54,596.56	54,533.57	0.002
New York State (Attainment)	3.69	118.27	36.55	12.55	2.76	5.72	1.85	29,633.73	29,678.28	29,649.04	0.001
New Jersey State (Attainment)	0.00	0.00	0.00	0.38	0.00	0.01	0.06	1,015.95	1,017.54	1,016.37	0.000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	12.02	322.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	24.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	6.77	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	6.77	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**104.89**	**2,738.67**	**342.68**	**57.34**	**51.56**	**54.34**	**12.51**	**179,905.02**	**180,167.65**	**180,014.88**	**0.006**

TABLE 4.3-21. CALENDAR YEAR 2029 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	68.57	1,639.30	171.34	27.32	25.41	47.25	8.02	97,243.16	97,378.46	97,317.23	0.003
Other Federal Waters	24.88	762.03	120.41	18.48	17.83	4.37	3.08	58,542.01	58,632.58	58,566.32	0.002
New York State (Attainment)	3.69	118.27	29.01	7.23	2.76	2.24	1.27	22,039.00	22,072.81	22,049.33	0.001
New Jersey State (Attainment)	0.00	0.00	0.00	0.38	0.00	0.01	0.06	1,015.95	1,017.54	1,016.37	0.000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Connecticut State (Attainment)	0.00	0.00	1.65	3.68	0.75	0.46	0.09	1,064.91	1,066.26	1,065.65	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	7.08	203.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.67	15.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	20.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	4.48	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	4.48	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**104.89**	**2,738.67**	**342.68**	**57.34**	**51.56**	**54.34**	**12.51**	**179,905.02**	**180,167.65**	**180,014.88**	**0.006**

Table 4.3-22. Calendar Year 2030 Potential Emissions (short tons) Associated with BW2 (Queens, New York Option) – Construction/Commissioning

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	0.43	14.37	3.16	0.27	0.26	0.02	0.05	2,059.75	2,062.95	2,060.14	0.0000
Other Federal Waters	1.29	48.90	9.47	0.85	0.83	0.06	0.16	7,086.35	7,097.59	7,087.37	0.0001
New York State (Attainment)	0.00	0.00	0.00	0.10	0.00	0.01	0.02	812.27	813.56	812.39	0.0000
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	0.15	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Total, All Areas	**1.87**	**68.88**	**13.71**	**1.22**	**1.19**	**0.09**	**0.22**	**9,958.37**	**9,974.10**	**9,959.90**	**0.0001**

TABLE 4.3-23. CALENDAR YEAR 2030 POTENTIAL EMISSIONS (SHORT TONS) ASSOCIATED WITH BW2 (WATERFORD, CONNECTICUT OPTION) – CONSTRUCTION/COMMISSIONING

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	0.43	14.37	3.16	0.27	0.26	0.02	0.05	2,059.75	2,062.95	2,060.14	0.0000
Other Federal Waters	1.29	48.90	9.47	0.85	0.83	0.06	0.16	7,086.35	7,097.59	7,087.37	0.0001
New York State (Attainment)	0.00	0.00	0.00	0.10	0.00	0.01	0.02	812.27	813.56	812.39	0.0000
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	0.15	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Total, All Areas	**1.87**	**68.88**	**13.71**	**1.22**	**1.19**	**0.09**	**0.22**	**9,958.37**	**9,974.10**	**9,959.90**	**0.0001**

Table 4.3-24. Calendar Year 2030 Potential Emissions (short tons) Associated with BW1 - Operations

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	2.68	84.76	16.89	1.60	1.54	0.61	0.40	16,110.29	16,057.06	15,528.53	0.0002
Other Federal Waters	5.08	149.58	22.14	2.99	2.86	1.83	0.62	13,121.42	13,141.62	13,126.20	0.0004
New York State (Attainment)	0.00	0.00	0.00	0.27	0.00	0.21	0.06	2,021.79	1,997.55	1,804.54	0.0000
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Massachusetts (Attainment)	0.91	34.71	6.72	0.61	0.59	0.04	0.11	5,029.81	5,037.80	5,030.54	0.0001
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	0.52	12.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
Total, All Areas	**9.20**	**281.49**	**48.53**	**5.47**	**5.26**	**2.69**	**1.19**	**36,283.31**	**36,234.03**	**35,489.81**	**0.0007**

4.3.2.2 *Operation and Maintenance*

During operations, 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 sites;
- Operations and maintenance of the offshore components, including the wind turbines, offshore substation facilities, submarine export cables, and interarray cables;
- Operations and maintenance of the onshore components, including the onshore export cables; and
- Interconnection cables and onshore substation facilities, and limited O&M Base activities.

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 facility platforms, the operation of emergency generators at each offshore substation facility platforms and onshore substation facilities, and GHG emissions of SF_6 from gas-insulated switchgear installed at the offshore substation facility platforms, onshore substation facilities, and wind turbines. **Table 4.3-25** details estimated SF_6 operational emissions.

TABLE 4.3-25. SF_6 EMISSIONS

Source	SF_6 Storage (pounds)	Leak Rate (percent)	SF_6 Emissions (short tons)
BW1 Offshore Substation	16,000	0.5	0.040
BW2 Offshore Substation	16,000	0.5	0.040
Wind Turbines (155)	44,485 (287 per turbine)	0.5	0.111
BW1 Onshore Substation	14,550	0.5	0.036
BW2 Onshore Substation	14,550	0.5	0.036
		Project Total:	**0.263**

As detailed in **Appendix J Air Emissions Calculations and Methodology**, operations and maintenance activities are assumed to include one SOV along with smaller crew transfer vessels transiting to and from the Project to service the wind turbines over the operational life of the Project. Operations and maintenance support vessels will operate out of SBMT. **Table 4.3-26** and **Table 4.3-27** presents the potential operations and maintenance emissions.

Under the current potential construction window, construction would be completed by the end of calendar year 2028 for BW1 and end of 2029 for BW2, and emissions for calendar year 2031 onward would only include routine operations and maintenance emissions (calendar year 2030 would be a mixture of commissioning and routine operations and maintenance emissions). 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 operation and maintenance emissions values in **Table 4.3-26** and **Table 4.3-27** are based on the following Project operating assumptions:

- 500 operating hours per year per engine, for the emergency generator engine at each offshore substation facility and onshore substation facilities;
- 328.5 operating days for one SOV, with 26 annual round trips to port; and
- 240.9 operating days for each of the crew transfer vessels, with approximately 92 annual round trips to port.

TABLE 4.3-26. ANNUAL OPERATIONS AND MAINTENANCE POTENTIAL EMISSIONS (SHORT TONS) FOR BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	5.36	169.53	33.78	3.20	3.09	1.22	0.80	32,068.83	31,966.89	30,944.05	0.0004
Other Federal Waters	10.15	299.17	44.29	5.97	5.72	3.65	1.23	26,242.84	26,283.24	26,252.40	0.001
New York State (Attainment)	0.00	0.00	0.00	0.53	0.00	0.41	0.12	3,852.20	3,803.66	3,417.65	0.000
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Massachusetts State (Attainment)	1.83	69.42	13.44	1.21	1.18	0.09	0.22	10,059.62	10,075.59	10,061.08	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	1.03	24.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**18.38**	**562.73**	**96.98**	**10.92**	**10.50**	**5.37**	**2.38**	**72,223.50**	**72,129.38**	**70,675.17**	**0.001**

TABLE 4.3-27. ANNUAL OPERATIONS AND MAINTENANCE POTENTIAL EMISSIONS (SHORT TONS) FOR BW1 AND BW2 (WATERFORD, CONNECTICUT OPTION)

Geographic Area	VOC	NO_x	CO	PM/PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS Source Radius	5.36	169.53	33.78	3.20	3.09	1.22	0.80	32,068.83	31,966.89	30,944.05	0.000
Other Federal Waters	10.15	299.17	44.29	5.97	5.72	3.65	1.23	26,242.84	26,283.24	26,252.40	0.001
New York State (Attainment)	0.00	0.00	0.00	0.52	0.00	0.41	0.12	3,629.39	3,580.81	3,194.33	0.000
New Jersey State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Texas State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Connecticut State (Attainment)	0.00	0.00	1.16	0.01	0.01	0.00	0.00	222.81	222.84	223.31	0.000
Massachusetts State (Attainment)	1.83	69.42	13.44	1.21	1.18	0.09	0.22	10,059.62	10,075.59	10,061.08	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	0.97	24.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.06	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**18.38**	**562.73**	**96.98**	**10.92**	**10.50**	**5.37**	**2.38**	**72,223.50**	**72,129.38**	**70,675.17**	**0.001**

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 Construction**. Emissions have been assumed to include the same marine vessels and activities as construction. However, these steps would be performed in reverse. 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. In addition, the following equipment and/or activities would not be included in decommissioning:

- Seabed preparation vessels, such as fall pipe vessels and pre-trenching vessels;
- Bubble curtain vessels;
- Commissioning activities;
- Routine operation and maintenance activities;
- All onshore facilities, including onshore substations, transmissions cables, and the O$M Base would be assumed to remain in use or repurposed for other uses and thus have no decommissioning emissions.

As estimated emissions, to account for future advances in decommissioning methods/technologies and emission reduction technologies, along with acknowledgement not all construction vessels and activities would be repeated for decommissioning, it is assumed future decommissioning emissions will be equivalent to 20 percent of the combined construction and commissioning emissions. It is also assumed there will be no emissions of SF_6 from the switchgear during decommissioning. These emissions are listed with **Table 4.3-28** and **Table 4.3-29**.

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 Beacon Wind anticipates will be needed for the Project, please see **Section 3 Project Description**.

TABLE 4.3-28. DECOMMISSIONING EMISSIONS (SHORT TONS) ASSOCIATED WITH BW1 AND BW2 (QUEENS, NEW YORK OPTION)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS- Source Radius	145.45	3,479.53	348.51	57.81	53.72	101.38	17.05	199,860.36	200,142.30	200,008.75	0.007
Other Federal Waters	41.92	1,168.67	160.44	25.35	24.22	16.28	5.08	80,727.89	80,849.81	80,769.26	0.003
New York State (Attainment)	1.52	48.61	36.59	30.88	1.13	12.37	2.61	36,913.36	36,966.43	36,935.50	0.001
New Jersey State(Attainment)	0.00	0.00	0.00	0.16	0.00	0.00	0.02	417.60	418.26	417.78	0.000
Texas State (Attainment)	0.01	0.38	0.06	0.01	0.01	0.00	0.00	27.43	27.47	27.44	0.000
Connecticut State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	20.34	512.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	30.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	11.90	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	11.90	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**209.25**	**5,209.73**	**576.19**	**114.39**	**91.12**	**130.04**	**24.77**	**317,946.66**	**318404.26**	**318158.73**	**0.011**

Table 4.3-29. Decommissioning Emissions (short tons) Associated with BW1 and BW2 (Waterford, Connecticut Option)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	AR5 100-year GHG (CO_2e)	AR4 100-year GHG (CO_2e)	AR5 20-year GHG (CO_2e)	Pb
Inside OCS- Source Radius	147.13	3,519.45	352.47	58.45	54.31	102.60	17.25	202,283.94	202,569.31	202,433.99	0.007
Other Federal Waters	44.40	1,228.79	166.65	26.32	25.12	18.05	5.37	84,589.75	84,717.20	84,633.58	0.003
New York State (Attainment)	1.52	48.61	29.72	18.77	1.13	8.92	2.02	29,300.49	29,343.18	29,317.59	0.001
New Jersey State(Attainment)	0.00	0.00	0.00	0.16	0.00	0.00	0.02	417.60	418.26	417.78	0.000
Texas State (Attainment)	0.01	0.38	0.06	0.01	0.01	0.00	0.00	27.43	27.47	27.44	0.000
Connecticut State (Attainment)	0.00	0.00	1.87	10.55	1.81	0.46	0.10	1,327.45	1,328.84	1,,328.35	0.000
Massachusetts State (Attainment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
General Conformity											
Ozone NAA (New Jersey-New York-Connecticut Interstate)	15.49	396.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Ozone NAA (Eastern Connecticut Interstate)	0.70	16.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Carbon Monoxide Maintenance Area (New Jersey-New York-Connecticut Interstate)	0.00	0.00	25.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
PM_{10} NAA (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	8.61	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (New Jersey-New York-Connecticut Interstate)	0.00	0.00	0.00	0.00	8.61	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (1997 Annual) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.000
$PM_{2.5}$ Maintenance Area (2006 24-Hour) (Hudson Valley Intrastate)	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.000
Total, All Areas	**209.25**	**5,209.73**	**576.19**	**114.39**	**91.12**	**130.04**	**24.77**	**317,946.66**	**318,404.26**	**318,158.73**	**0.011**

4.3.2.4 *Avoided Emissions*

As the proposed wind turbines will not themselves add to air emissions during operations, the use of the power generated by their operation will avoid conventional power emissions in New York and potentially Connecticut. **Table 4.3-30** and **Table 4.3-31** list avoided emissions from the use of the wind turbine power generation associated with BW1 and BW2. Details on this calculation are proved in **Appendix J Air Emissions Calculations and Methodology**.

TABLE 4.3-30. AVOIDED EMISSIONS FROM BW1 AND BW2 OPERATION (QUEENS, NEW YORK OPTION)

	CO_2	NO_x	$PM_{2.5}$	SO_2
eGrid Avoided Emission Factor (lb/MWh)	1,004	0.31	0.05	0.17
Annual Avoided Emissions in New York (tons/year)	5,204,524.73	1,606.97	259.19	881.24
Avoided Emissions over Project Lifespan in New York (tons) [assuming 35 years]	182,158,365.42	56,244.12	9,071.63	30,843.55

Note:
lb/MWh = pounds per megawatt-hour

TABLE 4.3-31. AVOIDED EMISSIONS FROM BW1 AND BW2 OPERATION (WATERFORD, CONNECTICUT OPTION)

	CO_2	NO_x	$PM_{2.5}$	SO_2
eGrid Avoided Emission Factor - New England (lb/MWh)	1,023	0.18	0.03	0.08
eGrid Avoided Emission Factor – New York (lb/MWh)	1,004	0.31	0.05	0.17
Annual Avoided Emissions - combined New England and New York (tons/year)	5,250,544.52	1,292.10	210.75	663.26
Avoided Emissions over Project Lifespan – combined New England and New York (tons) [assuming 35 years]	183,769,058.23	45,223.59	7,376.17	23,213.95

Note:
lb/MWh = pounds per megawatt-hour

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**, Beacon Wind is proposing to implement the following avoidance, minimization, and mitigation measures.

4.3.3.1 *Construction*

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

- The SBMT in Sunset Park, New York is considered to be a Project staging area and an O&M Base. The O&M Base at the SBMT will be constructed to support both the Empire Wind project and the Beacon Wind project. As indicated in **Section 3.5 Operations and Maintenance Activities**, construction of the O&M Base is addressed within the Empire Wind permitting process. As a result, with the Project utilizing an existing O&M Base it will not require construction of a new O&M Base in the State of New York, thereby avoiding additional potential air emissions impacts as a result of new construction.

- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements;
- Project-related diesel-powered equipment will use ultra-low sulfur diesel fuel, per the requirements of 40 CFR § 80.510(b);[5]
- Project-related vessels will use Very Low Sulphur Fuel Oil (VLSFO) 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;
- Beacon Wind 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 on-road diesel-fueled and non-diesel-fueled heavy-duty vehicles from idling for more than five minutes. In Connecticut, RCSA 22a-174-18b(3) also prohibits idling for more than three consecutive minutes unless operating under exempt circumstances.

4.3.3.2 *Operations and Maintenance*

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

- Vessels constructed on or after January 1, 2016 will meet Tier III NO_X requirements;
- Project-related vessels will use VLSFO 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;
- Beacon Wind 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
- Switchgears at the offshore substation facilities will meet the applicable requirements of 310 CMR 7.72. Emissions will be certified by the manufacturer to have a 1.0 percent maximum annual leak rate and Beacon Wind will follow manufacturer-recommended maintenance procedures and best industry practices to avoid leakage. Personnel handling and monitoring the switchgear will be properly trained and, upon removal of any switchgear containing SF_6, Beacon Wind will provide for the secure storage, re-use, recycling, or destruction of the SF_6.

In addition, during construction, Beacon Wind will consider the following avoidance, minimization, and mitigation measures to mitigate for potential impacts:

- Beacon Wind is actively collaborating with a naval architect to assess the concept of a fully-decarbonized SOV that will allow for zero emissions during operations. The technology is further supported by Beacon Wind's carbon reduction strategy and roadmap. Additionally, Beacon Wind is engaged in an in-house project that is evaluating bespoke offshore charging of hybrid SOV batteries through the gangway system, directly from a wind turbine or offshore

[5] 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.

substation facilities. It is anticipated that this technology could be ready for implementation for Beacon Wind operations.

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 4.3-32. 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

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EPA (United States Environmental Protection Agency). 2021. “Overview of Greenhouse Gases.” Last updated July 27, 2021. Available online at: https://www.epa.gov/ghgemissions/overview-greenhouse-gases. Accessed August 9, 2021.

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4.4 Acoustics

4.4.1 In-Air Acoustic Environment

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

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

- Underwater Acoustic Assessment (**Section 4.4.2**);
- In-Air Acoustic Assessment (**Appendix K**); and
- Underwater Acoustic Assessment (**Appendix L**).

There are no federal noise regulations directly applicable to assessing noise impacts resulting from the Project at off-site noise-sensitive receptors (e.g., residences, schools, healthcare facilities, and houses of worship); however, construction and operational workers' exposure to Project-related noise 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 and Connecticut, state regulations and guidelines will be applicable to the in-air acoustic aspect of the Project. The onshore substation facilities and export cable landfalls will be located in Queens, New York and Waterford, Connecticut. There are local noise requirements for the proposed onshore substation facility locations and export cable landfalls that are under consideration at this time. These restrictions will be followed unless construction work outside of daytime hours is authorized by the appropriate regulatory authority.

State of New York Noise Guidelines

The NYSDEC guidelines are defined in the publication *Assessing and Mitigating Noise Impacts* (NYSDEC 2001). This document states that sound pressure level (SPL) increases from 0 to 3 decibels, A-scale (dBA) should have no 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 more detailed analysis of impact potential depending on existing sound levels and the surrounding land uses. A-weighted sound pressure levels (in units of dBA) take into account human frequency sensitivity to moderate sound levels and are therefore used by most regulatory agencies to rate sound levels for human annoyance. 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} 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 considers a limit of 40 dBA to be adequately protective.

The NYSDEC policy further states that the EPA "Protective Noise Levels" guidance found that an annual day-night average 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 24-hour level of approximately 49 dBA L_{eq}. In terms of absolute threshold values, the introduction of any new noise 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 concerns. In most cases, NYSDEC recommends that projects exceeding either of these threshold levels or resulting in an increase of 10 dBA should consider mitigation measures.

New York City Noise Code

Title 24, Chapter 2 of the New York City Administrative Code regulates noise by the existing land use of receiving property rather than zoning designation. There are two separate regulations that apply to the Project operations: (1) octave band limits at residential and commercial properties per Administrative Code Section 24-232, and (2) relative increase limits for off-site locations per Administrative Code Section 24-218. These provisions do not apply to construction noise; however, construction is limited to Monday through Friday from 7 a.m. to 6 p.m., unless otherwise authorized. A noise mitigation plan must be completed for any construction activity before construction begins. Work may take place after hours and on weekends only with express authorization from the Departments of Buildings and Transportation. A noise mitigation plan must be in place before any authorization is granted.

The octave band limits in Administrative Code Section 24-232 are summarized in **Table 4.4-1** and apply to residential and commercial properties as measured inside a room with windows open. The octave band limits are prescribed in unweighted decibels, equivalent to overall limits of 45 dBA for residential uses and 49 dBA for commercial uses.

TABLE 4.4-1. NEW YORK CITY NOISE CODE SECTION 24-232 OCTAVE BAND LIMITS (dB)

Octave Band Center Frequency hertz (Hz) a/	Maximum Sound Pressure Level (dB)	
	Interior of a Residential Use with Windows Open	Interior Office Space of Commercial Use with Windows Open
31.5	70	74
63	61	64
125	53	56
250	46	50
500	40	45
1000	36	41
2000	64	39
4000	33	38
8000	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 relative increase 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 p.m. to 7 a.m. at any receiving property. Ambient sound is defined in Administrative Code Section 24-203 as the total sound level “at a location that exists” excluding “extraneous sounds,” which are defined as “intense, intermittent” sounds. Although the Administrative Code assigns no sound metric to the term “ambient sound,” it is typical practice in noise assessments to represent this condition as the L_{eq} sound level.

In addition to the Administrative Code, New York City also has a zoning regulation, 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 octave bands from 31.5 to 16,000 Hz differ depending on manufacturing districts. The manufacturing district relevant to the Project is M3-1, as shown in **Table 4.4-2**, given in unweighted decibels.

New York City zoning regulations classify the onshore components of the Project Area situated within the Astoria, New York power complex within an "M-3" (Heavy Manufacturing) zone.

TABLE 4.4-2. NEW YORK CITY ZONING RESOLUTION SECTIONS 42-213 AND 214 OCTAVE BAND LIMITS

Octave Band Center Frequency (Hz)	At Project Property Line Manufacturing District M3 (dB)
31.5	80
63	80
125	75
250	70
500	64
1000	58
2000	53
4000	49
8000	46

State of Connecticut Regulations and Town of Waterford Noise Code

The State of Connecticut and the Town of Waterford have identical noise restrictions in Chapter 442, Section 22a-69-3 of the Regulations of Connecticut State Agencies – Department of Environmental Protection and Title 9, Section 9.06.050 of the Town of Waterford Code (CTDEEP 2022, Waterford 2022). These limits are listed in **Table 4.4-3**, in terms of Zoning Classes A, B, and C. Class A Zones include residential uses and other noise-sensitive uses such as healthcare facilities, houses of worship, hotels, and other uses where people sleep or in areas where serenity and tranquility are essential to the intended use of the land. Class B Zones generally include commercial and institutional uses (including offices and educational uses) and Class C Zones generally include manufacturing and industrial uses.

TABLE 4.4-3. STATE OF CONNECTICUT AND TOWN OF WATERFORD NOISE ORDINANCE LIMITS

Noise-Emitting Zone Class	Receiving Noise Zone Class			
	C	B	A (day)	A (night)
Class C	70 dBA	66 dBA	61 dBA	51 dBA
Class B	62 dBA	62 dBA	55 dBA	45 dBA
Class A	62 dBA	55 dBA	55 dBA	45 dBA

If the current background noise levels are higher than the limits listed in **Table 4-4-3**, the regulatory limits are 5 dBA above the background level up to a limit of 80 dBA.

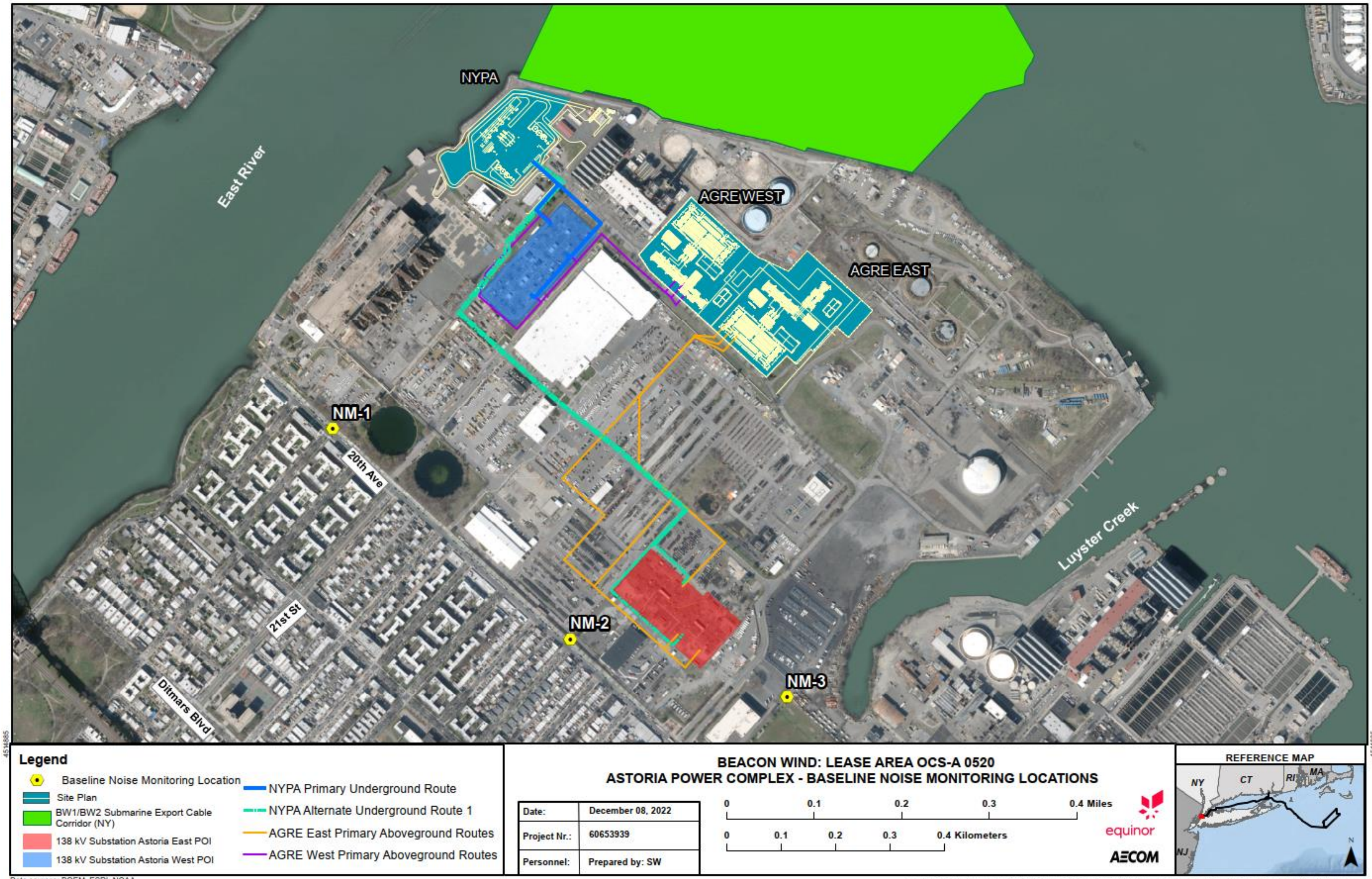
Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the coastal areas that may be directly and/or indirectly impacted by the onshore components, including the onshore export and interconnection cable routes, underground interconnection cable routes, and the onshore substation facilities, and the staging and construction areas associated with the construction, operations, and decommissioning of the Project **(Figure 4.4-1** and **Figure 4.4-2**). Offshore components, including the wind turbines and offshore substation facilities, are located approximately 20 statute mi (17 nm, 32 km) south of Nantucket, Massachusetts and 60 mi (52 nm, 97 km) east of Montauk, New York, and will be far enough from any noise-sensitive receptors (such as residences, schools, healthcare facilities, and houses of worship) to not generate noise impacts. The Study Area is depicted for the Lease Area and submarine export cables in **Figure 4.4-3**, and for the submarine export cables the Study Area aligns to the installation corridor for federal, New York State and Connecticut State waters.

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 K 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 facilities and export cable landfall sites within the Astoria, New York and Waterford, Connecticut power complexes, unattended baseline sound measurements were conducted for multiple days in accordance with industry-accepted practices.

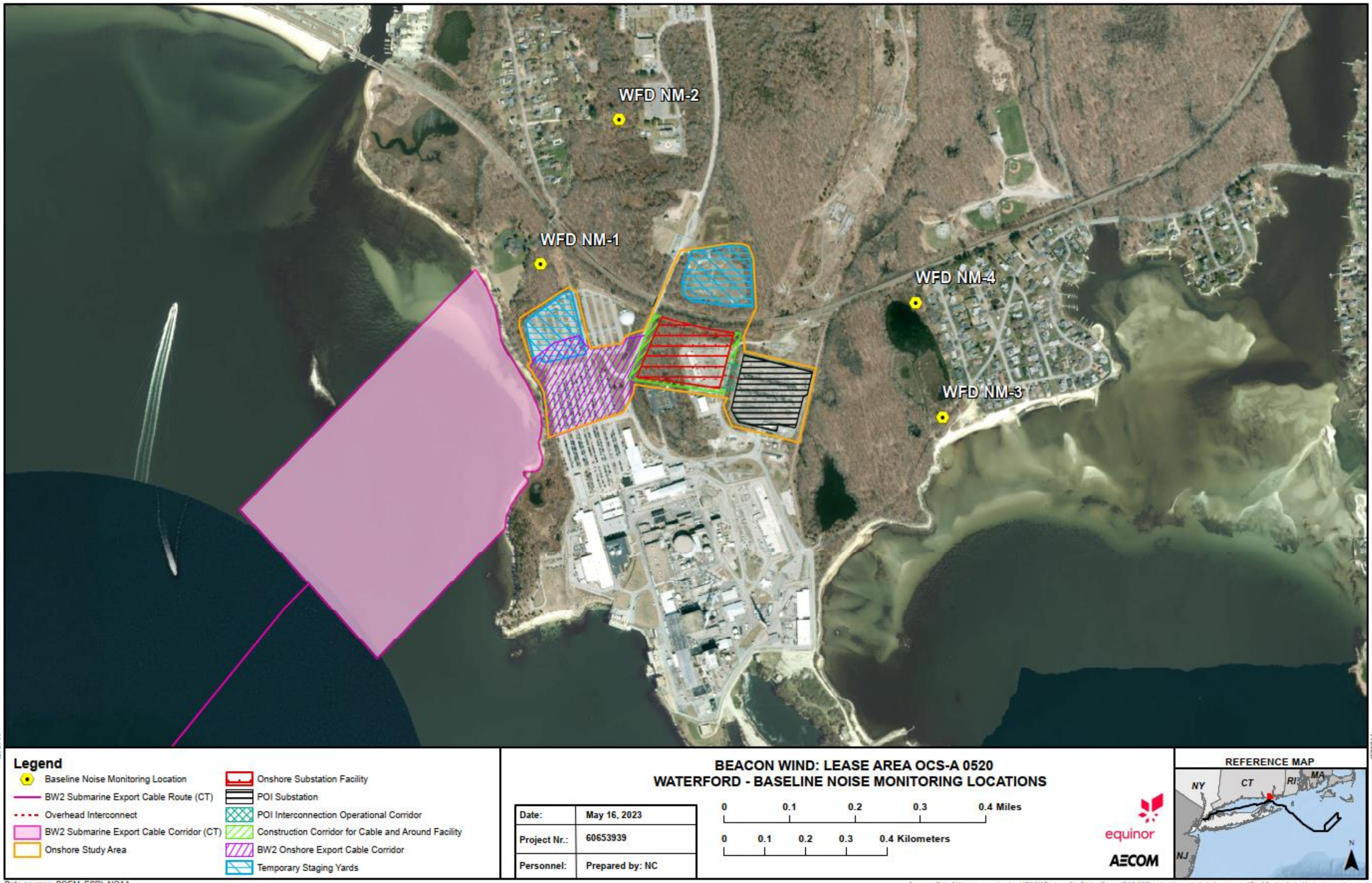
Acoustic modeling was then performed to assess the impacts associated with Project-related construction and operations activities. The acoustical modeling for the Project was conducted using the CadnaA® sound prediction model from DataKustik GmbH (version 2022). The outdoor sound propagation model is based on the International Organization for Standardization (ISO) 9613 Part 2: “General method of calculation,” (ISO 1996). It is used internationally by acoustical engineers to describe sound emissions and propagation from complex facilities in terms of sound pressure level contour lines (lines of constant sound pressure level) that can be mapped onto aerial imagery, taking into account the effects of topography and structures on outdoor sound propagation.

FIGURE 4.4-1. ONSHORE STUDY AREA AND BASELINE NOISE MONITORING LOCATIONS – QUEENS, NEW YORK



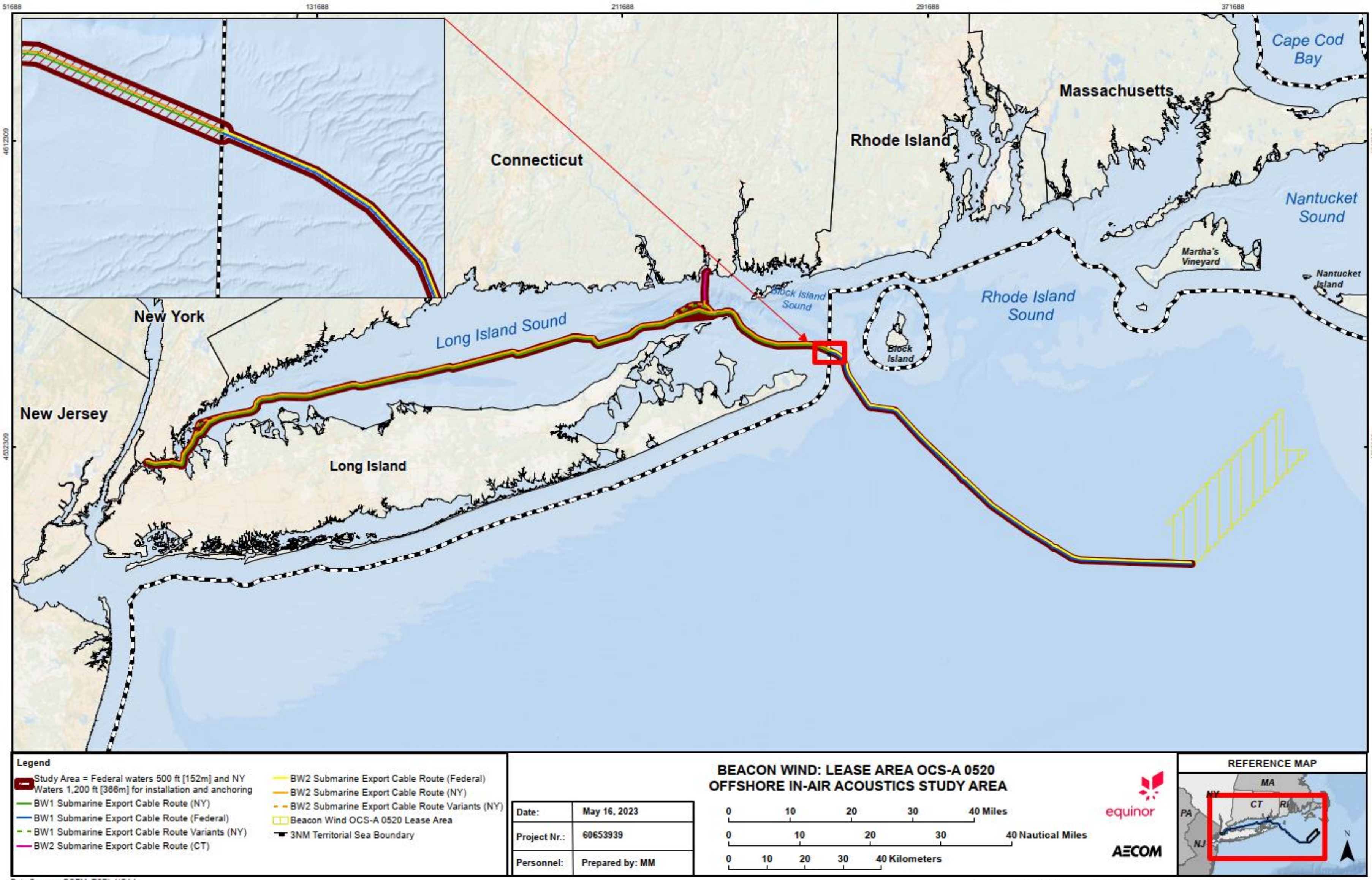
Data sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

FIGURE 4.4-2. ONSHORE STUDY AREA AND BASELINE NOISE MONITORING LOCATIONS – WATERFORD, CONNECTICUT



Data sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

FIGURE 4.4-3. OFFSHORE STUDY AREA



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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, and the onshore substation facilities. Permits necessary for the improvement of port and construction/staging facilities will be the responsibility of the owners of these facilities. Beacon Wind expects such improvements will broadly support the offshore wind industry and will be governed by applicable environmental standards, which Beacon Wind will comply with in using the facilities. The SBMT in Sunset Park, New York is considered to be a Project staging area and an O&M Base. The O&M Base at the SBMT will be constructed to support both the Empire Wind project and the Beacon Wind project. As indicated in **Section 3.5 Operations and Maintenance Activities**, construction of the O&M Base is addressed within the Empire Wind permitting process. The Project is assessing New Bedford, Massachusetts to act as a satellite O&M facility.

Two locations are under consideration in Queens, New York (NYPA and AGRE) for the single proposed BW1 landfall and onshore substation facility. The Queens, New York onshore substation facility site that is not used (NYPA and AGRE) for BW1 will remain under consideration, in addition to the Waterford, Connecticut site, for the single proposed BW2 onshore substation facility. The affected environment as it relates to in-air noise depends on the location of the onshore substation facilities in relation to existing residences and recreation areas that may be affected directly or indirectly by the Project. For the two onshore substation facility sites being considered in Queens, New York the onshore substation facilities are in manufacturing/industrial areas, with residential communities roughly 1,500 ft (457 m) to the south of each site, as shown in **Figure 4.4-1**. In Waterford, Connecticut, the one onshore substation facility is sited within an industrial area with residential communities roughly 1,525 ft (465 m) to the northwest, north, and east. as shown in **Figure 4.4-2**.

Ambient sound levels are characterized by different sound levels. In order to consider 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. Near the Queens, New York facilities, the ambient acoustic environment 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 is also present during both daytime and night-time hours. Natural sounds from birds, rustling leaves, 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 Queens Study Area are shown in **Figure 4.4-1**. Near the Waterford, Connecticut onshore substation facility, the ambient acoustic environment is largely influenced by distant vehicular traffic, operation of the Dominion Millstone PowerStation, and regular commuter rail pass-bys. Noise from planes is also present during both daytime and night-time hours. During late night-time periods, the commuter rail corridor is used for freight activities. Natural sounds from birds, rustling leaves, 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 Waterford Study Area are shown in **Figure 4.4-2.** Measurements are discussed in the following subsections.

4.4.1.1.1 *Noise Measurements*

Ambient noise levels were monitored at the closest representative noise-sensitive receptors to each site and were used as the baseline for the impact analysis. In Queens, New York three baseline noise monitoring systems were deployed near each of the two onshore substation facilities' locations and four at the Waterford, Connecticut location with all systems installed at sites representative of the closest noise-sensitive receptor property lines to each potential facility. At Queens, New York, the long-term monitors were left unattended and secured until retrieved by the investigator after 48 continuous hours of data recording. Long-term monitors were deployed in the Waterford, Connecticut Study Area for up to 119 hours due to the anticipated fluctuation of commuter rail noise between weekday and weekend rail operations.

Sound pressure level monitoring was performed with Larson Davis Model LxT sound level meters, rated by the American National Standards Institute (ANSI) as Class 1, per ANSI S1.4-2014 (ANSI 2014). The sound level meter microphones were fitted with standard open-cell foam windscreens and positioned approximately 5 to 9 ft (1.5 to 2.7 m) above grade. The sound level meters were set using slow time-response and the A-weighting scale. Sound level meter calibration was field-checked before and after each measurement period with a Larson Davis Model CAL200 acoustic calibrator, and the meters were factory-calibrated within one year of the measurement period. Where not already described, sound level measurements performed for this field survey were conducted in a manner based on guidance from applicable portions of ISO 1996-1 (ISO 2016) and ISO 1996-2 (ISO 2017) standards.

A Kestrel Model 3500 handheld weather meter was used to determine or measure average wind speed, temperature, barometric pressure, and relative humidity at the beginning of each measurement. There were no adverse weather conditions for monitoring (such as high winds or precipitation) during the measurement period at Queens, New York. There were intermittent rain events that occurred during the Waterford, Connecticut monitoring period but these were generally limited in both intensity and duration.

4.4.1.1.2 *Monitoring Locations*

The sound pressure level measurement locations near the two onshore substation facilities in Queens, New York and the one in Waterford, Connecticut are described in the following paragraphs and photographs of the locations are included in **Appendix K In-Air Acoustic Assessment**.

Sound level measurements for the Queens, New York sites were conducted continuously from August 25 through August 27, 2021, and from September 27 through September 29, 2022, to collect sound pressure level data in the onshore substation facility Study Area. Observed meteorological data was considered adequate for the duration of ambient noise monitoring.

NM-1: Long-term measurement deployment at the southwestern boundary of the manufacturing district along 20th Avenue and adjacent to 21st Street. This measurement is representative of baseline noise levels experienced at the nearest noise-sensitive receptors to the NYPA onshore substation facility along the south side of 20th Avenue. The dominant noise sources during the measurement period were continuous nondescript mechanical noise from the manufacturing district, heating, ventilation, and air conditioning (HVAC) unit operation at residential properties, and insect noise. Additional daytime noise sources included intermittent bird calls, aircraft flyovers, vehicle pass-bys, and bicycle pass-bys.

NM-2: Long-term measurement deployment at the southwestern boundary of the manufacturing district along 20th Avenue and adjacent to 27th Street. This measurement is representative of baseline noise levels experienced at the nearest noise-sensitive receptors to the AGRE onshore substation facilities along the south side of 20th Avenue. The dominant noise source during the measurement period was continuous transformer-type noise from the Con Edison Astoria East substation. Additional daytime noise sources included intermittent bird call, aircraft flyovers, vehicle pass-bys, pedestrian pass-bys, and bicycle pass-bys.

NM-3: Long-term measurement deployment at the northern boundary of the Con Edison Fields (recreational/youth sports fields) within the existing manufacturing district. This measurement is representative of baseline noise levels experienced at this noise-sensitive sporting field and the homes on the opposing side of 20th Avenue. The dominant noise sources during the measurement period were continuous nondescript mechanical noise from the manufacturing district, insect noise, and intermittent distant daytime construction noise from the northeast. Additional daytime noise sources included intermittent bird calls, aircraft flyovers, and distant vehicle traffic noise.

Sound level measurements for the Waterford, Connecticut site were conducted continuously from March 31 through April 4, 2022.

Observed meteorological data during sound level meter setups showed a temperature of 47 °F (8.3 °C), humidity of 25 percent, and wind speeds ranging from 0 to 2 miles per hour (mph) (0 to 3 km per hour). There were intermittent rain events that occurred during the monitoring period but these were generally limited in both intensity and duration.

WFD NM-1: Long-term measurement deployment at the northwest boundary of the Dominion Millstone Power Station along a fence line bordering a residential home on Millstone Road West. This measurement is representative of a baseline noise level experienced at the nearest noise sensitive receptor to the Dominion Millstone Power Station facility at the southern terminus of Millstone Road West. The dominant noise sources during the measurement period were continuous and nondescript mechanical noise from the vicinity of the power station, intermittent train pass-bys, and insect noise. Additional noise sources included intermittent bird calls, aircraft flyovers, distant vehicular noise, and rustling leaves.

WFD NM-2: Long-term measurement deployment at a western boundary of Dominion Millstone Power Station property, north of the power station and west of the administrative buildings. This deployment is along the property line of an abandoned residence in disrepair between Millstone Road and Millstone Road West. This measurement is representative of a baseline noise level experienced at the nearest noise sensitive receptors further north from the railroad corridor. The dominant noise sources during the measurement period were continuous and nondescript mechanical noise from the power station, HVAC unit operation at residential properties, and insect noise. Additional daytime noise sources included intermittent bird calls, aircraft flyovers, vehicle pass-bys, railroad operations, and distant home construction activities (roofing nailer) observed during monitoring system deployment.

WFD NM-3: Long-term measurement deployment at the east boundary of the Dominion Millstone Power Station on an access path at the corner to Gun Shot Road and Winward Way. This measurement is representative of a baseline noise level experienced at the nearest noise sensitive receptors to the Dominion Millstone Power Station facility along the southern end of Gun Shot Road. The dominant noise sources during the measurement period were continuous and nondescript mechanical noise from the power station, HVAC unit operation at residential properties, and insect noise. Additional daytime noise sources included intermittent bird calls, vehicle pass-bys, and railroad operations.

WFD NM-4: Long-term measurement deployment at the east boundary of the Dominion Millstone Power Station along the shoreline of a pond towards the northern end of Gun Shot Road. This measurement is representative of a baseline noise level experienced at the nearest noise sensitive receptors to the Dominion Millstone Power Station facility along the northern end of Gun Shot Road. The dominant noise sources during the measurement period were continuous and nondescript mechanical noise from the power station, HVAC unit operation at residential properties, and insect noise. Additional daytime noise sources included intermittent bird calls, aircraft flyovers, vehicle pass-bys, and railroad operations.

4.4.1.1.3 *Monitoring Results*

A summary of the noise monitoring results from the Queens, New York baseline survey is shown in **Figure 4.4-4**, **Figure 4.4-5**, and **Figure 4.4-6** for the three monitored locations (NM-1 through NM-3). The noise monitoring results from the Waterford, Connecticut baseline survey are shown in **Figure 4.4-7, Figure 4.4-8, Figure 4.4-9,** and **Figure 4.4-10 f**or the four monitored locations (WFD NM-1 through NM-4).

FIGURE 4.4-4. NOISE MONITORING RESULTS FOR THE QUEENS, NEW YORK ONSHORE SUBSTATION FACILITIES SITE NM-1, AUGUST 25-27, 2021

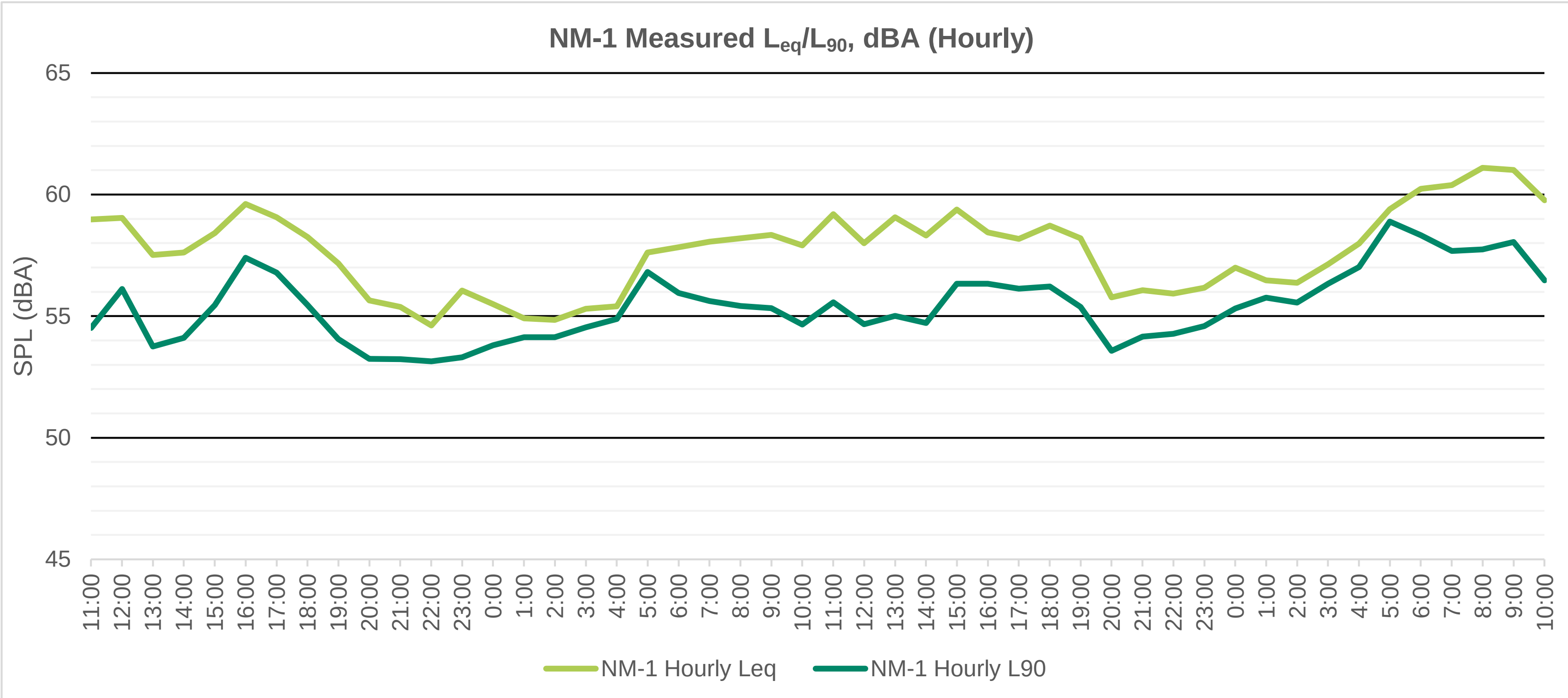


Figure 4.4-5. Noise Monitoring Results for the Queens, New York Onshore Substation Facilities Site NM-2, September 27-28, 2022

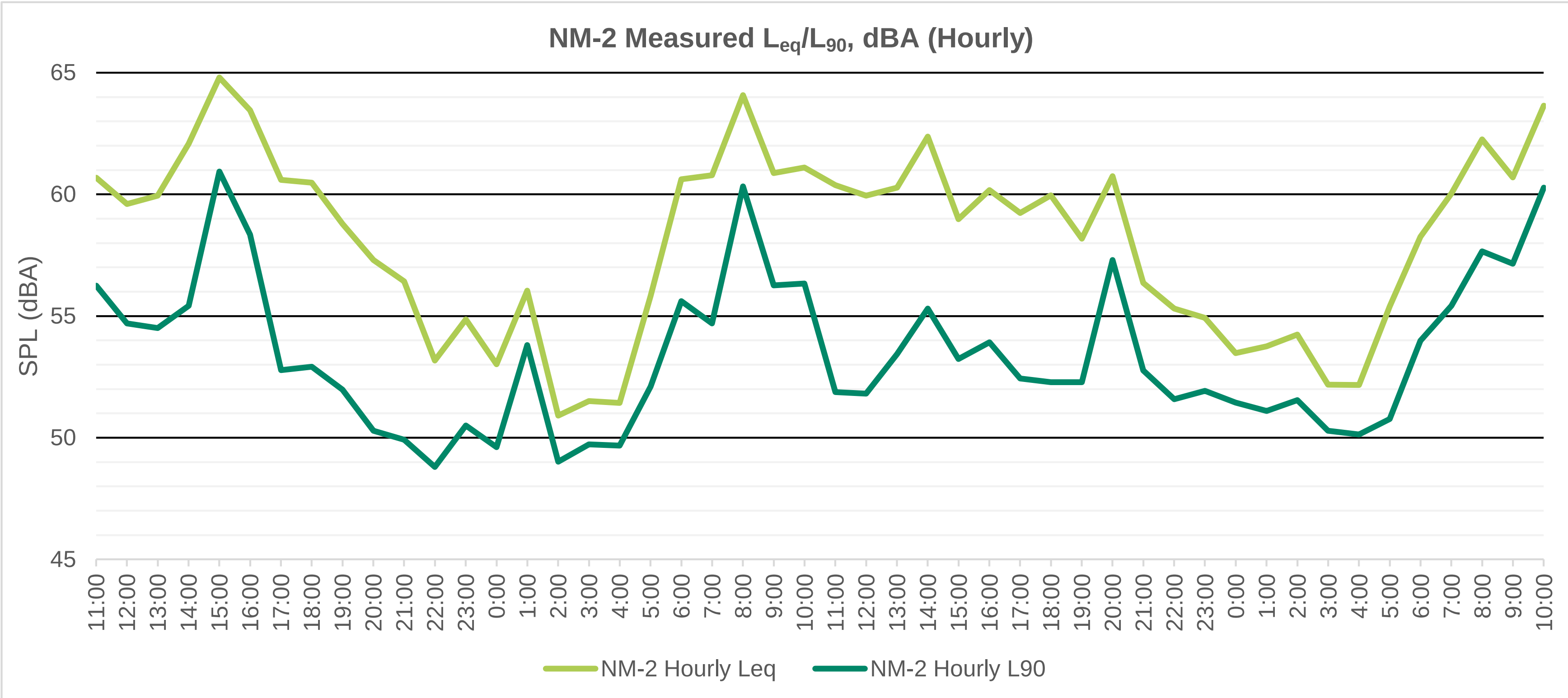


FIGURE 4.4-6. NOISE MONITORING RESULTS FOR THE QUEENS, NEW YORK ONSHORE SUBSTATION FACILITIES SITE NM-3, SEPTEMBER 27-29, 2022

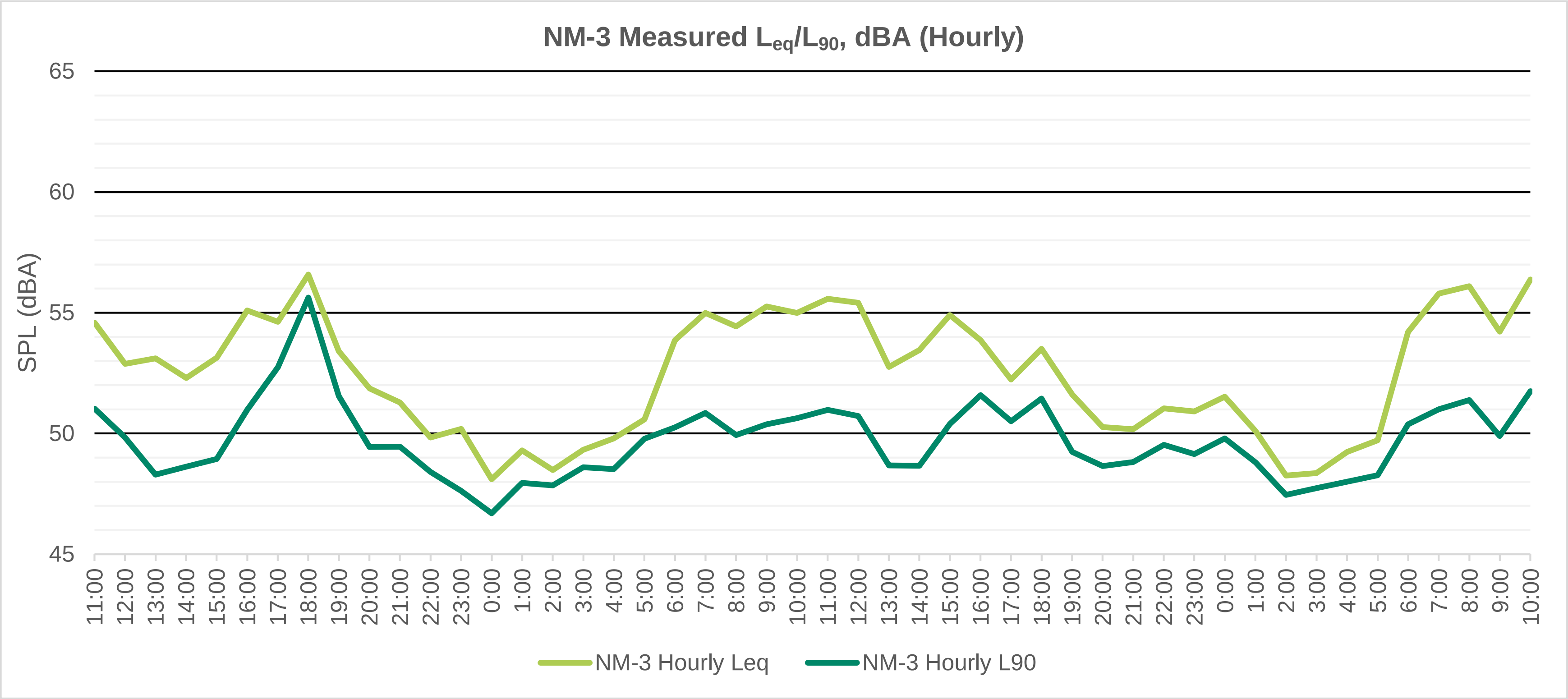


FIGURE 4.4-7. NOISE MONITORING RESULTS FOR THE WATERFORD, CONNECTICUT ONSHORE SUBSTATION FACILITY SITE WFD NM-1, MARCH 30-APRIL 3, 2022

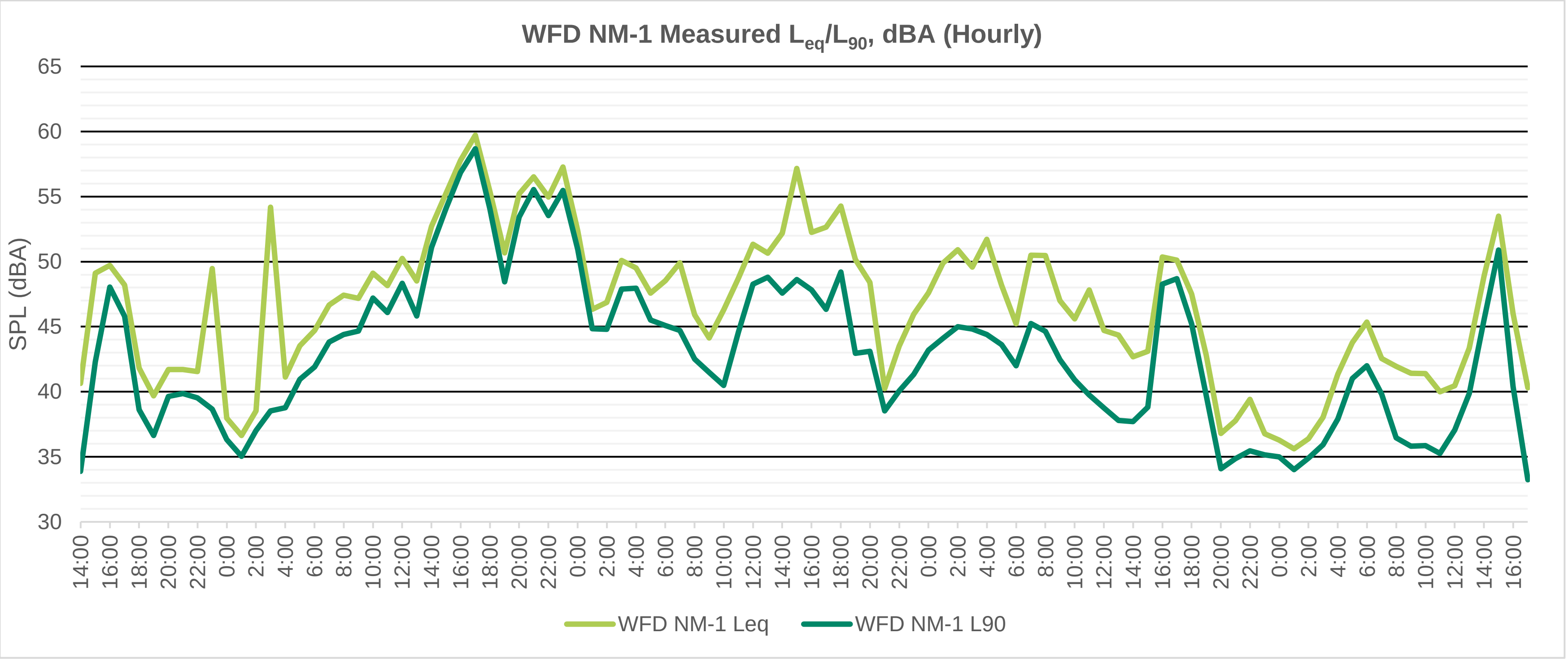
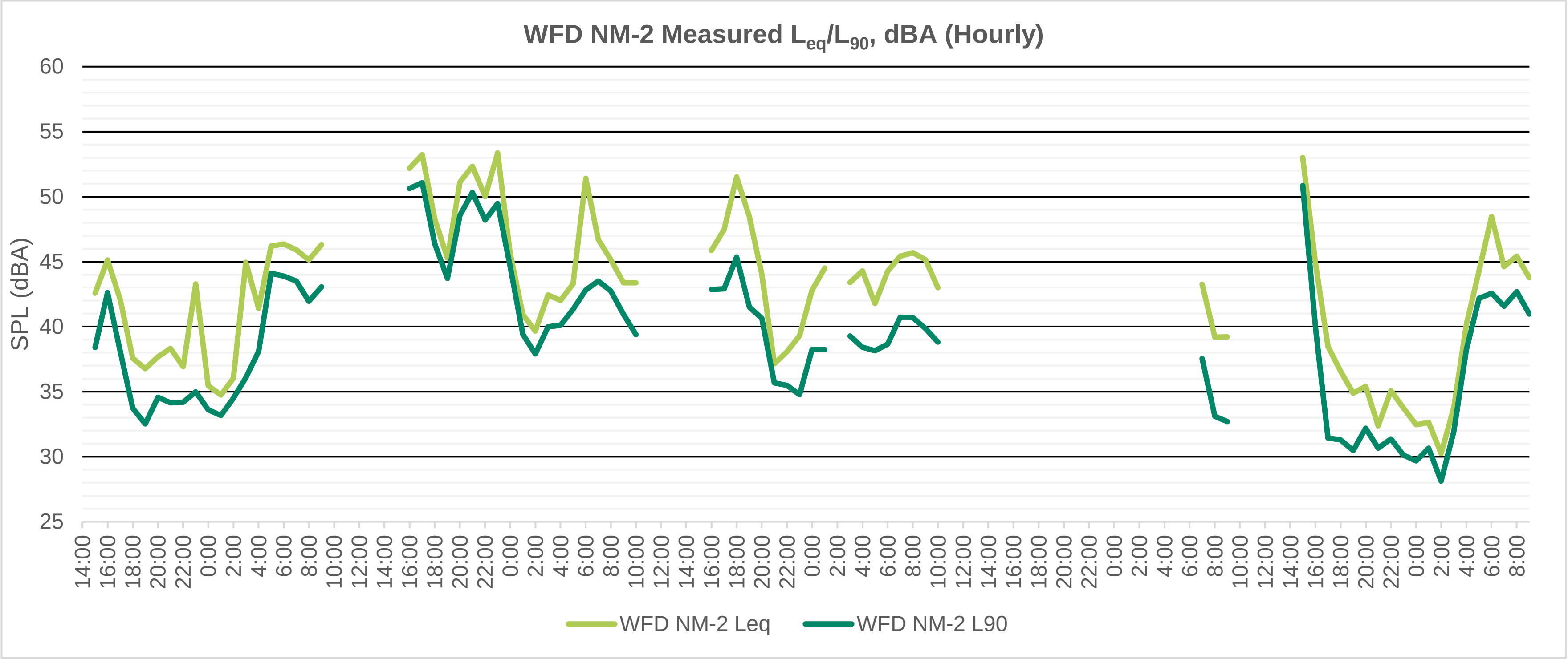


FIGURE 4.4-8. NOISE MONITORING RESULTS FOR THE WATERFORD , CONNECTICUT ONSHORE SUBSTATION FACILITY SITE WFD NM-2, MARCH 30-APRIL 4, 2022



Note: Gaps in measured SPL represent periods where data suggest the connection between the sound level meter and microphone were interrupted or disconnected due to unknown factors.

FIGURE 4.4-9. NOISE MONITORING RESULTS FOR THE WATERFORD, CONNECTICUT ONSHORE SUBSTATION FACILITY SITE WFD NM-3, MARCH 30-APRIL 4, 2022

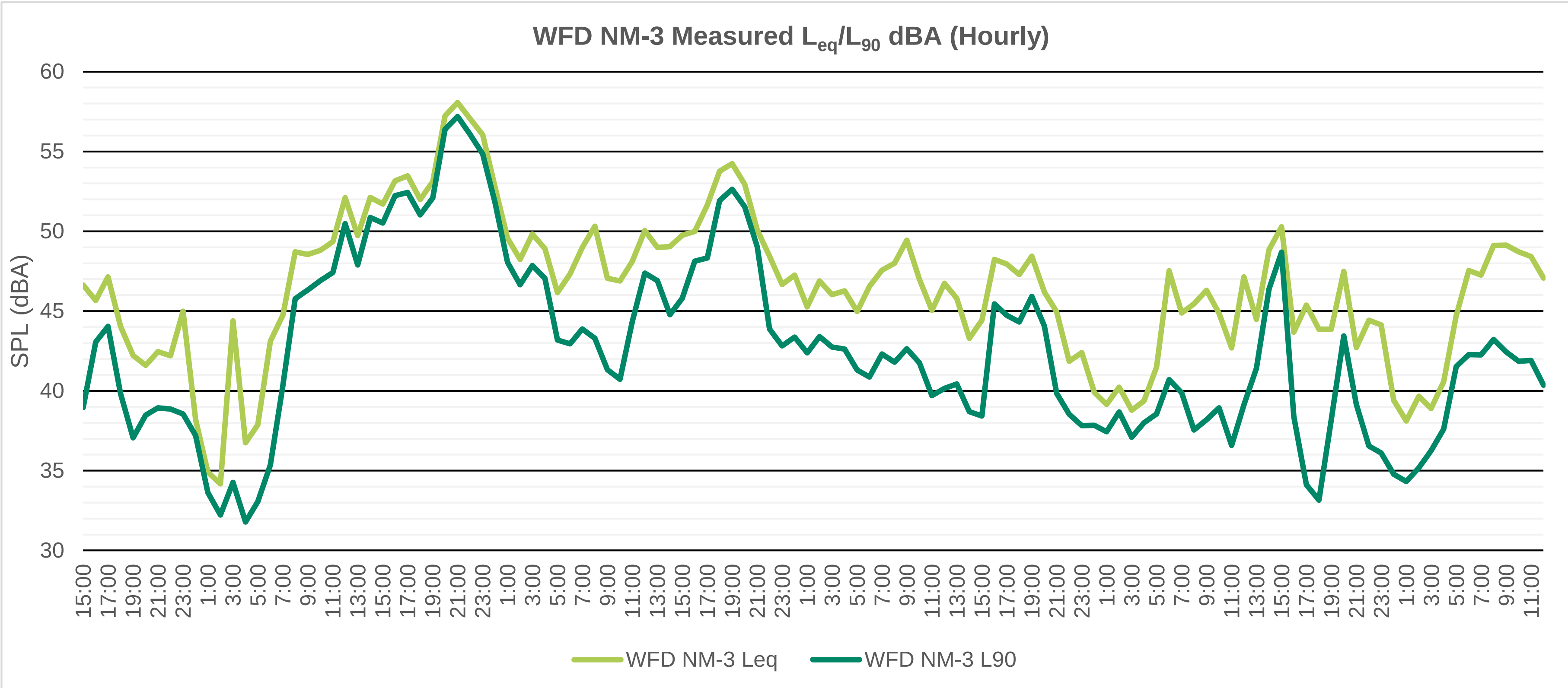
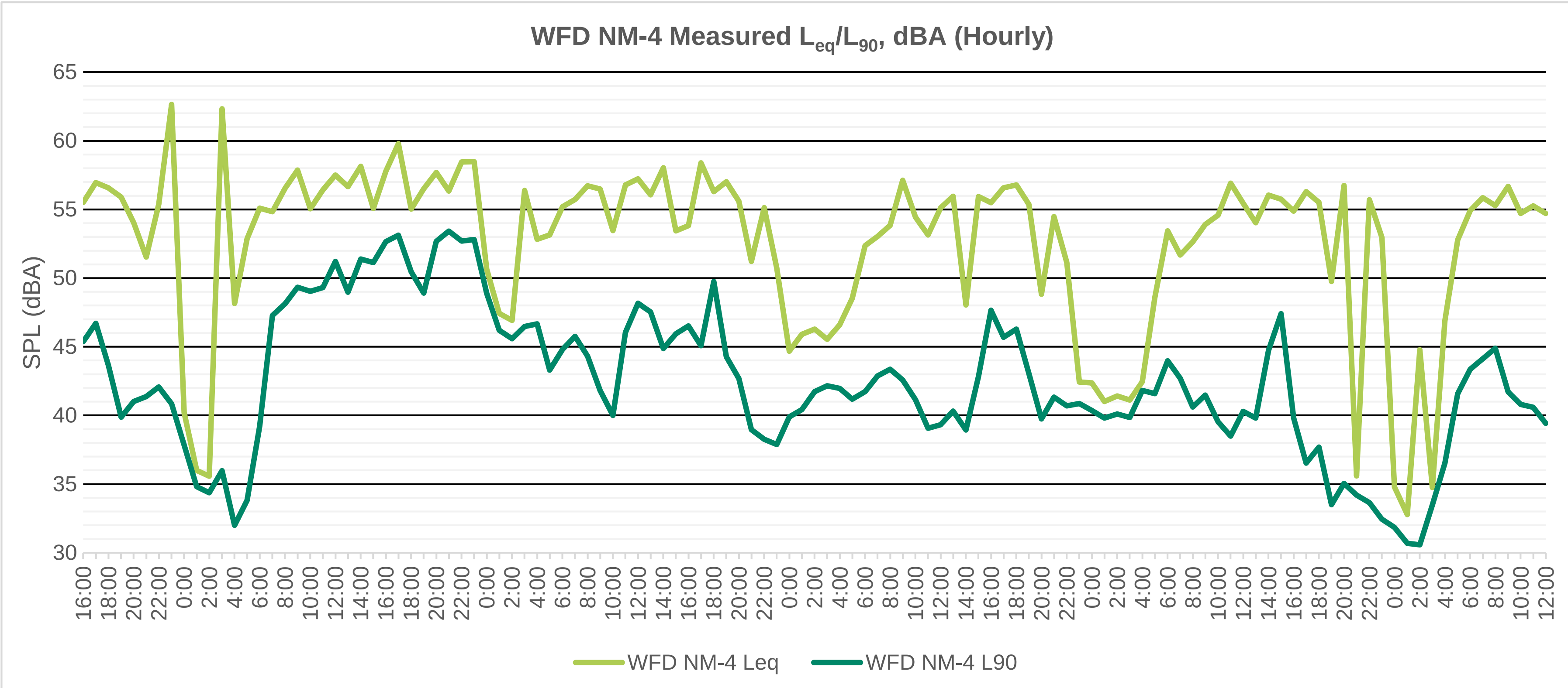


FIGURE 4.4-10. NOISE MONITORING RESULTS FOR THE WATERFORD, CONNECTICUT ONSHORE SUBSTATION FACILITY SITE WFD NM-4, MARCH 30-APRIL 4, 2022



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 noise, the onshore maximum design scenario from a regional perspective is the full build-out of the Lease Area, which will include installation of onshore export and interconnection cables, and the onshore substation facility, as described in **Table 4.4-4**. The parameters provided in this table represent the maximum potential impact from the full build-out. This design concept incorporates a total of up to 157 structures within the Lease Area (made up of up to 155 wind turbines and two offshore substation facilities) with two submarine export cable routes (one to Queens, New York for BW1 and one to either Queens, New York or Waterford, Connecticut for BW2) and the associated onshore substation facilities.

TABLE 4.4-4. SUMMARY OF MAXIMUM DESIGN SCENARIO PARAMETERS FOR IN-AIR NOISE

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of the Project (BW1 and BW2) (155 wind turbines and two offshore substation facilities).	Representative of the maximum number of structures.
Foundation	Monopile	Representative of the foundation options that have the installation method that would result in the maximum introduction of in-air noise.
Duration offshore installation	Based on full build-out of the Project (BW1 and BW2) which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), 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 has the potential to disturb local marine users through installation-related noises.
Submarine export cable landfalls	Based on full build-out of the Project (BW1 and BW2): • BW1 to Queens, New York (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area). • BW2: ○ To Queens, New York (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area) or ○ To Waterford, Connecticut (HDD casing pipe and goalposts in a 60 ft x 7 ft [18 m x 2 m] area).	Representative of the loudest landfall installation method at the landfalls and nearshore environment, which has the potential to disturb the local public.

Parameter	Maximum Design Scenario	Rationale
Duration onshore construction	Based on full build-out of the Project (BW1 and BW2) to Queens, New York and to Waterford, Connecticut. Construction and installation of export cable landfalls, onshore export and interconnection cables, and onshore substation facilities and 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.
Operations and Maintenance		
Onshore substation facility	Based on full build-out of the Project (BW1 and BW2): • BW1: Queens, New York (up to a 7 ac [2.8 ha] area). • BW2: ○ Queens, New York (up to a 7 ac [2.8 ha]) or ○ Waterford, Connecticut (up to a 7 ac [2.8 ha] area).	Representative of the presence of new structures in an area where there was previously none, which would introduce the maximum Project-related operations sound levels.
Onshore O&M activities	Based on full build-out of the Project (BW1 and BW2) to Queens, New York and to Waterford, Connecticut. 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 sound levels.

4.4.1.2.1 *Construction*

Offshore construction activities will mostly be occurring more than 20 mi (32 km) from any in-air noise-sensitive receptors, with the exception of vessel operations to and from the shoreline and for installation of the submarine export cable nearshore in Long Island Sound. The dominant noise sources from these operations would include vessel engines, and these would be close enough to noise-sensitive receptors to be audible for short periods of time. The greatest potential for noise impacts from offshore installation of wind turbine and offshore substation facilities are being addressed in a separate study (See **Section 4.4.2 Underwater Acoustic Environment** and **Appendix L Underwater Acoustic Assessment**).

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

- Installation of the offshore components, including the foundations and submarine export cables;
- The submarine export cable landfalls, including HDD as the base case installation method, and the use of casing pipe and goalposts;
- 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, and the onshore substation facilities.

With the following potential consequential impact-producing factors:

- Short-term elevated in-air noise levels associated with impact pile driving activities for casing pipe and goalposts;
- Short-term elevated in-air noise levels associated with potential 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, and the onshore substation facilities.

Elevated in-air noise levels associated with impact pile driving nearshore of casing pipe and goalposts for the HDD exits: The temporary installation of casing pipe by pneumatic pipe ramming and the temporary installation of goal posts by impact pile driving will be required. At Queens, New York installation of offshore casing pipe and goalposts will be required in the water northeast of the NYPA and AGRE sites and at Waterford, Connecticut to the west within Niantic Bay, to support the HDD. The noise-intensive operation associated with the casing pipe and goalpost is the installation of the piles using an impact pile driver. Casing pipe and goalpost installation would require multiple days of offshore construction activities during daytime periods and using a single vibratory pile driving system with an assumed reference noise level of 126 LwA. The modeling results for offshore casing pipe and goalpost installation activities for the submarine export cable landfall to the onshore substation facilities without mitigation are provided in **Table 4.4-5** and **Table 4.4-6**.

TABLE 4.4-5. SOUND LEVELS (DBA) DURING CASING PIPE AND GOAL POST INSTALLATION – QUEENS, NEW YORK

Site	Location	Approximate Distance from Casing Pipe/Goalpost Center Point ft [m]	Sound Levels at NSAs due to Casing Pipe/Goalpost Construction
NYPA	R-1	4,921 [1,500]	39
	R-2	4,960 [1,512]	39
	R-3	5,209 [1,588]	39
	R-4	5,293 [1,613]	46
	R-5	5,371 [1,637]	46
	R-6	5,317 [1,621]	38
	R-7	6,125 [1,867]	36
NRG East/West	R-1	4,640 [1,414]	40
	R-2	4,523 [1,379]	41
	R-3	4,551 [1,387]	40
	R-4	4,565 [1,392]	48
	R-5	4,608 [1,404]	48
	R-6	4,336 [1,322]	41
	R-7	5,146 [1,569]	39

Table 4.4-6. Sound Levels (dBA) during Casing Pipe and Goalpost Installation – Waterford, Connecticut

Site	Location	Approximate Distance from Casing Pipe and Goalpost Center Point ft [m]	Sound Levels at NSAs due to Casing Pipe and Goalpost Construction
Waterford	WFD-1	2,599 [792]	56
	WFD-2	3,366 [1,026]	44
	WFD-3	5,004 [1,392]	39
	WFD-4	4,999 [1,525]	39
	WFD-5	5,012 [1,528]	39

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 L Underwater Acoustic Assessment** for details on the level of impact anticipated underwater. Given the extended distances between the Project and coastal shorelines from the offshore components, approximately 20 statute mi (17 nm, 32 km) south of Nantucket, Massachusetts and 60 mi (52 nm, 97 km) east of Montauk, New York, these activities will be far enough from noise-sensitive receptors that they will not generate noise impacts; therefore, no negative impacts are expected. Offshore, marine users may be potentially disturbed due to the sound levels generated from pile driving. Because Beacon Wind 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 Federal Register [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 used 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 noise 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 cable activities will move along the cable in a lateral construction sequence. 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 cable will cause any significant impact in the communities along the shoreline.

Elevated in-air noise levels associated with HDD at the export cable landfalls: The loudest construction activities will be associated with the entry and exit locations of HDD activities, if this base case construction method is selected. The noise associated with HDD operations are evaluated in the subsequent paragraph and tables. Landfall of the export cable at both locations under consideration (NYPA and AGRE), under the base case, will be completed using HDD techniques to bring the submarine export cable onshore from the East River to the landfall locations. **Table 4.4-7** lists the dominant noise sources associated with the HDD operations (independent of site), along with their referenced sound levels.

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 4.4-7** presents the HDD components included in the analysis and **Table 4.4-8** 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 periods unless a situation arises that would require construction operations to continue into the night or as deemed acceptable by the appropriate regulatory authority. In the case of night operations, only the HDD drill rig and power unit will be used unless deemed acceptable by the appropriate regulatory authority.

TABLE 4.4-7. HDD EQUIPMENT SOUND LEVEL PRESSURE SOURCE LEVELS, dBA AT 3FT

HDD Equipment Component	Reference Sound Level
HDD Drill Rig and Power Unit	102
Drilling Mud Mixer/Recycling Unit	90
Mud Pumping Unit	102
Generator Set, 100 kilowatts	100
Generator Set, 200 kilowatts	102
Vertical Sump Pump	75

TABLE 4.4-8. 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 and exhaust silencers.
Mud Pumping Units	Acoustical enclosures for mud pumps and engines equipped with exhaust silencers.
Loaders/Forklifts	Engines equipped with exhaust silencers. Modification of back-up 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.
Cranes and Boom Trucks	Exhausts equipped with silencers. Engine compartment acoustically treated. Usage restrictions.

Table 4.4-9 summarizes the predicted sound levels at the closest NSAs in Queens, New York assuming the HDD sources operate continually for daytime and nighttime construction scenarios.

These predictive results demonstrate that without application of the proposed noise mitigation strategies, resulting sound levels will not constitute a violation of local nuisance by-laws for New York City, nor result in a potential imminent hazard to public health or the environment.

TABLE 4.4-9. SOUND LEVELS (DBA) DURING HDD CONSTRUCTION – QUEENS, NEW YORK

Site	Location	Distance from Entry Pit ft [m]	Sound Levels at NSAs due to Drill Rig Only (Nighttime Operations)	Sound Levels at NSAs due to All HDD Sources (Daytime Operations)
NYPA	R-1	1,916 [584]	44	47
	R-2	2,108 [643]	27	45
	R-3	2,713 [827]	18	37
	R-4	2,942 [897]	27	41
	R-5	3,093 [943]	19	37
	R-6	3,709 [1,131]	26	33
	R-7	4,365 [1,331]	16	27
AGRE East/West	R-1	2,664 [812]	33	39
	R-2	2,426 [739]	35	41
	R-3	2,398 [731]	41	46
	R-4	2,438 [743]	41	47
	R-5	2,503 [763]	40	46
	R-6	2,551 [778]	34	40
	R-7	3,332 [1,016]	31	37

Note:
a/ Significant noise reduction occurs during nighttime hours due to acoustic shielding of the drill rig by an existing off-site building. During daytime construction, several pieces of ancillary equipment are not shielded by the structure.

Table 4.4-10 summarizes the predicted sound levels at the closest NSAs in Waterford, Connecticut, assuming the HDD sources operate continually for daytime and nighttime construction scenarios. These predictive results demonstrate that without application of the proposed noise mitigation strategies, resulting sound levels will not constitute a violation of local nuisance by-laws for the State of Connecticut and Town of Waterford, nor result in a potential imminent hazard to public health or the environment.

TABLE 4.4-10. SOUND LEVELS (DBA) DURING HDD CONSTRUCTION – WATERFORD, CONNECTICUT

Location	Distance from Entry Pit ft [m]	Sound Levels at NSAs due to Drill Rig Only (Nighttime Operations)	Sound Levels at NSAs due to All HDD Sources (Daytime Operations)
WFD-1	1,226 [374]	40	46
WFD-2	1,569 [478]	38	44
WFD-3	2,190 [668]	37	41
WFD-4	2,271 [692]	36	40
WFD-5	2,375 [724]	36	40

Once the HDD and pull-backs are complete, noise from the export cable landfall areas 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 periods unless a situation arises that would require construction operations to continue into the night or as deemed acceptable by the appropriate regulatory authority. In the case of night operations, only the HDD drill rig and power unit will be used unless deemed acceptable by the appropriate regulatory authority. If necessary, subject to regulatory requirements and stakeholder engagement, Beacon Wind will install moveable temporary noise barriers as close to the noise sources as possible, which have been shown to effectively reduce sound levels by 5 to 15 dBA.

Elevated in-air noise levels associated with construction of the onshore substation facilities and onshore export and interconnection cables: The construction of the onshore substation facilities, 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.

There are no relevant quantitative construction noise policy limits for the Project. Therefore, a generally accepted guideline goal of 65 dBA L_{eq} for daytime noise exposures at residential buildings (based on noise ordinances throughout the country) is being used as the goal for these activities (Cowan 1994).

The potential for noise impacts from onshore cable installation is a function of the specific receptors in the onshore areas as well as the equipment used and the proposed hours of operation. Construction is anticipated to occur during typical work hours. However, in specific instances at some locations, or at the request of the New York City Department of Public Works or the Town of Waterford, the Project may seek municipal approval to work at night or outside the normal hours of construction allowed by local by-law. Nighttime work will be minimized and performed only on an as-needed basis, such as when crossing a busy road, and will be coordinated with New York City and Town of Waterford. Construction of either underground electric transmission route associated with the onshore substation facility sites under consideration, to the Astoria East POI, Astoria West POI, and/or aboveground electric transmission route and to the Waterford POI, would have the same noise characteristics as that of the export cable.

Many potential noise sources will be used for export cable installation, with the loudest expected equipment being excavators and drills. The location and operational duration of each piece of equipment will vary within the onshore portion of the Project Area, with no single location having extended periods of noise exposure.

Table 4.4-11 summarizes the predicted maximum daytime hourly construction sound levels at the closest NSAs. These predictive results demonstrate that without application of the proposed noise mitigation strategies, resulting sound levels will not exceed typical guideline goals such as 65 dBA, L_{eq}. 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 associated with the NYPA, AGRE, and Waterford locations under consideration for the onshore substation facilities as shown in **Figure 4.4-11**, **Figure 4.4-12**, and

Figure 4.4-13. 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 and show estimated maximum construction sound levels, with the highest levels expected in proximity to the closest neighborhoods during the site excavation phase.

TABLE 4.4-11. PREDICTED SUBSTATION CONSTRUCTION NOISE LEVELS (DBA)

Site	Location	Distance from Approximate Site Center ft [m]	Predicted Construction Noise Level (L_{eq}, dBA)
NYPA	R-1	2,106 [642]	51
	R-2	2,283 [696]	55
	R-3	2,854 [870]	46
	R-4	3,071 [936]	48
	R-5	3,216 [980]	45
	R-6	3,779 [1,152]	42
	R-7	4,455 [1,358]	39
AGRE West	R-1	2,536 [773]	48
	R-2	2,349 [716]	49
	R-3	2,417 [737]	55
	R-4	2,489 [759]	56
	R-5	2,570 [783]	55
	R-6	2,718 [828]	48
	R-7	3,484 [1,062]	45
Combined AGRE West + AGRE East	R-1	2,536 [773]	51
	R-2	2,349 [716]	52
	R-3	2,417 [737]	58
	R-4	2,436 [743]	59
	R-5	2,473 [754]	60
	R-6	2,340 [713]	52
	R-7	3,140 [957]	50
Combined NYPA + AGRE East	R-1	2,106 [642]	53
	R-2	2,283 [696]	56
	R-3	2,450 [747]	56
	R-4	2,436 [743]	56
	R-5	2,473 [754]	58
	R-6	2,340 [713]	50
	R-7	3,140 [957]	49
Waterford	WFD-1	1,445 [440]	55
	WFD-2	1,697 [517]	53
	WFD-3	1,939 [591]	52
	WFD-4	2,012 [613]	51
	WFD-5	2,117 [645]	50

In addition to the construction equipment listed in **Table 4.4-7**, pile driving may be needed to install the foundation for the onshore substation facility. 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. If impact pile driving is required, higher noise levels may be produced for temporary short-term periods.

Construction of the onshore substation facilities will take up to 24 months. Substation construction will include the following activities:

- Site preparation, excavation, and grading;
- Construction of foundations for the control building, transformers, reactors, and switchgear;
- Construction of electrical grounding, duct banks, and underground conduits;
- Installation of appropriate drainage systems, security fences, noise barriers (where determined to be applicable), and station service; and
- Installation of above-ground structures including transformers, switchgears, and cable systems.

4.4.1.2.2 *Operations and Maintenance*

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

- Operation of offshore wind turbines and offshore substation facilities;
- Operation of onshore substation facility; 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 substation facilities is expected; however, the increase will be below audibility thresholds at the coastal areas due to the distance from shore, as well as the masking effect (e.g., the 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 the immediate proximity of the wind turbine and offshore substation locations.

Elevated in-air sound levels associated with the operations of the onshore substation facilities: During operations, the onshore substation equipment is anticipated to generate operational noise. Noise modeling of onshore substation components was completed in support of this COP and can be found in **Appendix K In-Air Acoustic Assessment**. As the onshore substation facility engineering design is at a conceptual level and the final locations have not been determined, it is possible that the final warranty noise specifications could vary slightly. **Table 4.4-12** lists the dominant noise sources associated with the onshore substation facilities (independent of site), along with their referenced sound levels. L_wA values are sound power levels in dBA, provided by the listed references. Sound power levels, unlike sound pressure levels, are independent of location with respect to a source. The overall A-weighted levels are based on octave band center frequency (OBCF) data from the listed sources.

TABLE 4.4-12. PRIMARY NOISE SOURCES AND REFERENCE LEVELS FOR ONSHORE SUBSTATION FACILITY SITES

Source	Quantity in Layout	Relative Height ft [m]	L_wA	OBCF Source
540-MVA Transformer	3 (+1 back-up)	22 [7]	100	EEI XFMR a/
540-MVA Transformer Battery	3 (+1 back-up)	20 [6]	88	Harris XFMR b/
1600-kVA Auxiliary Transformer	2	22 [7] e/	68	Harris XFMR b/
Converter Reactor	8	34 [10]	105	EEI XFMR a/
Converter Module (indoors)	46	39 [12]	88	Harris XFMR b/
Star Point Reactor	1	20 [6] e/	85	Harris XFMR b/
Converter Building HVAC	3	20 [6] e/	81	Johnson Controls c/
Converter Cooling Fan Array	1	20 [6] e/	95	Wartsila d/

Notes:
a/ EEI: Edison Electric Institute 1984
b/ Harris: Harris 1998
c/ Johnson Controls Series 100 20,000 CFM Unit. Johnson Controls, Series 100 Performance Specification.
d/ Wartsila: Standard-Noise Radiator (6-Fan Array) (Wartsila 2012)
e/ Estimated height
HVAC – heating, ventilation, and air conditioning
kVA – kilovolt ampere
L_wA – sound power levels in dBA (provided by the listed references)
MVA – megavolt ampere
OBCF – octave band center frequency
XFMR - transformer

The modeling results for both Queens substation sites without mitigation are shown in **Figure 4.4-11** for AGRE West, **Figure 4.4-12** for NYPA, **Figure 4.4-13** for combined operations of AGRE East and AGRE West, and **Figure 4.4-14** for combined operations of NYPA and AGRE East.

All figures demonstrate that overall predicted noise levels are less than the sound level increase limit of 7 dBA above the measured minimum ambient levels at select noise-sensitive receiver locations.

Upon calculation, onshore substation facility operations were determined to exceed New York City's octave band Noise Code limits (**Table 4.4-1**). Noise mitigation measures are required for either of the proposed onshore substation sites, including a combined operational scenario, based on the relative increase criterion of the New York City Noise Code as further detailed in **Section 4.4.1.3.2**.

The modeling results for the Waterford onshore substation facility site without mitigation are shown in **Figure 4.4-15**. This figure demonstrates that overall predicted noise levels are less than the State of Connecticut and Town of Waterford sound level limit of 51 dBA, L_{eq}.

FIGURE 4.4-11. PREDICTED NOISE CONTOURS FOR THE AGRE WEST ONSHORE SUBSTATION FACILITY

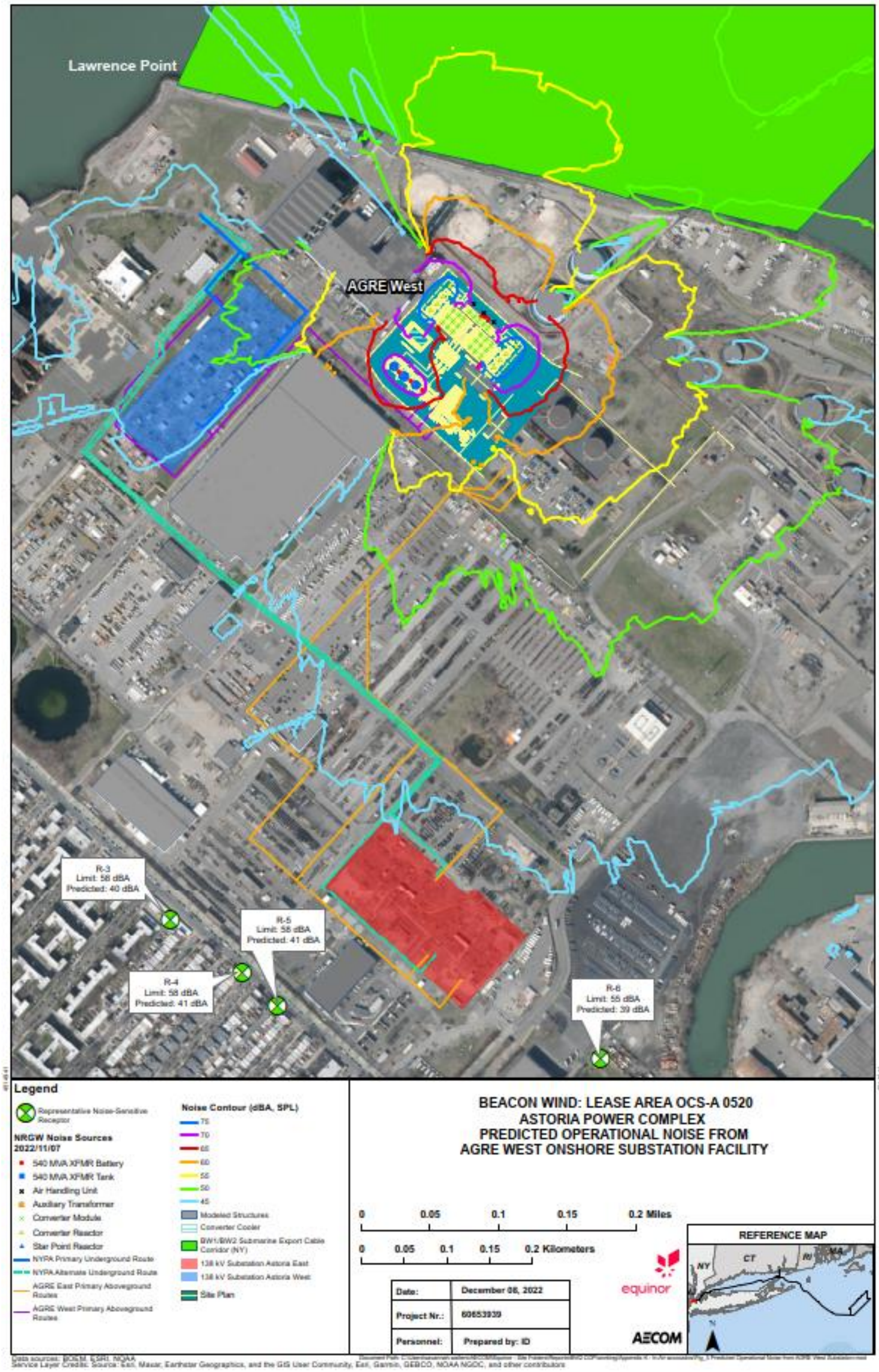


FIGURE 4.4-12. PREDICTED NOISE CONTOURS FOR THE NYPA ONSHORE SUBSTATION FACILITY

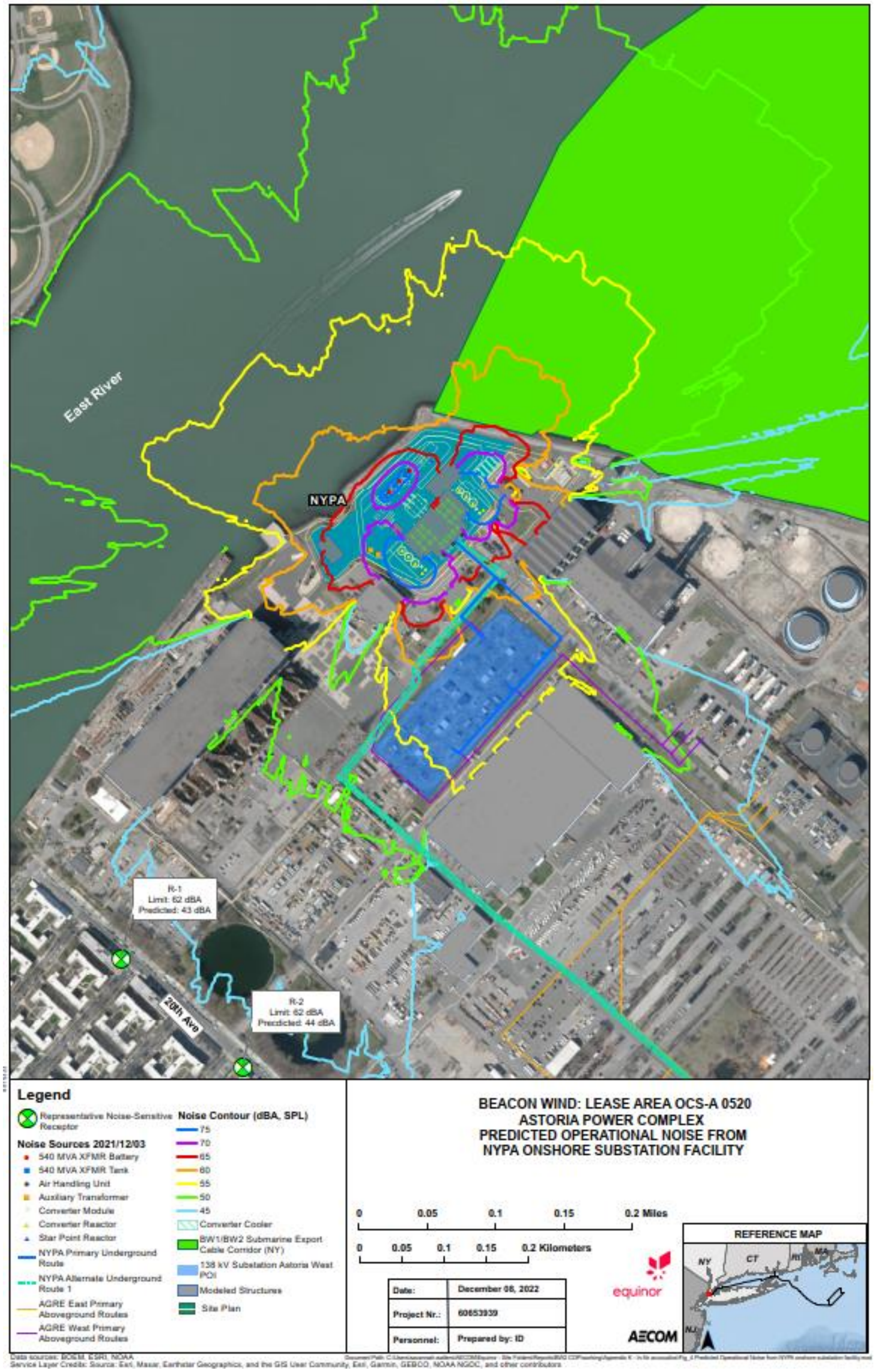


FIGURE 4.4-13. PREDICTED NOISE CONTOURS FOR BOTH AGRE WEST AND AGRE EAST ONSHORE SUBSTATION FACILITIES

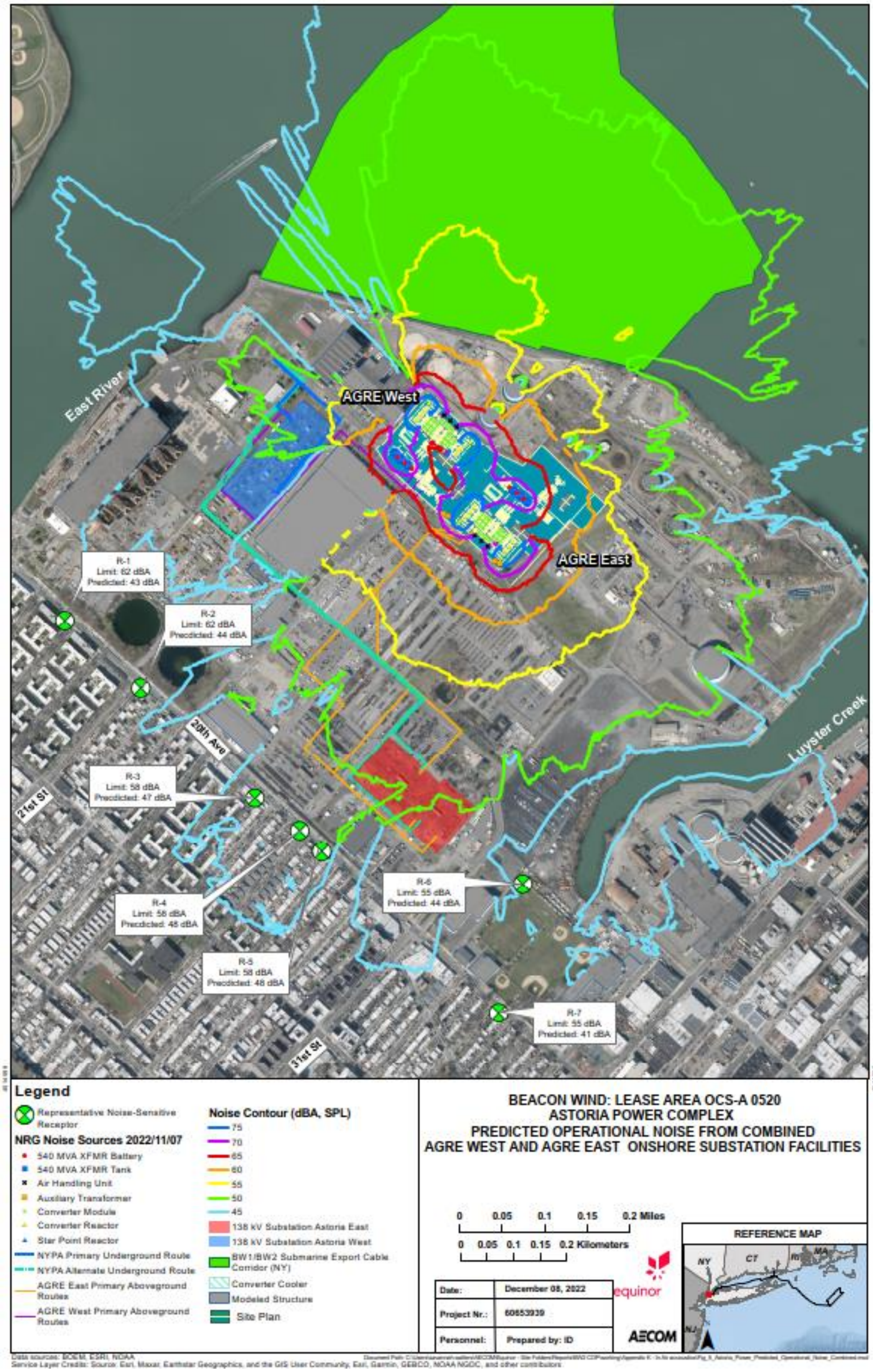


Figure 4.4-14. Predicted Noise Contours for Both NYPA and AGRE East Onshore Substation Facilities

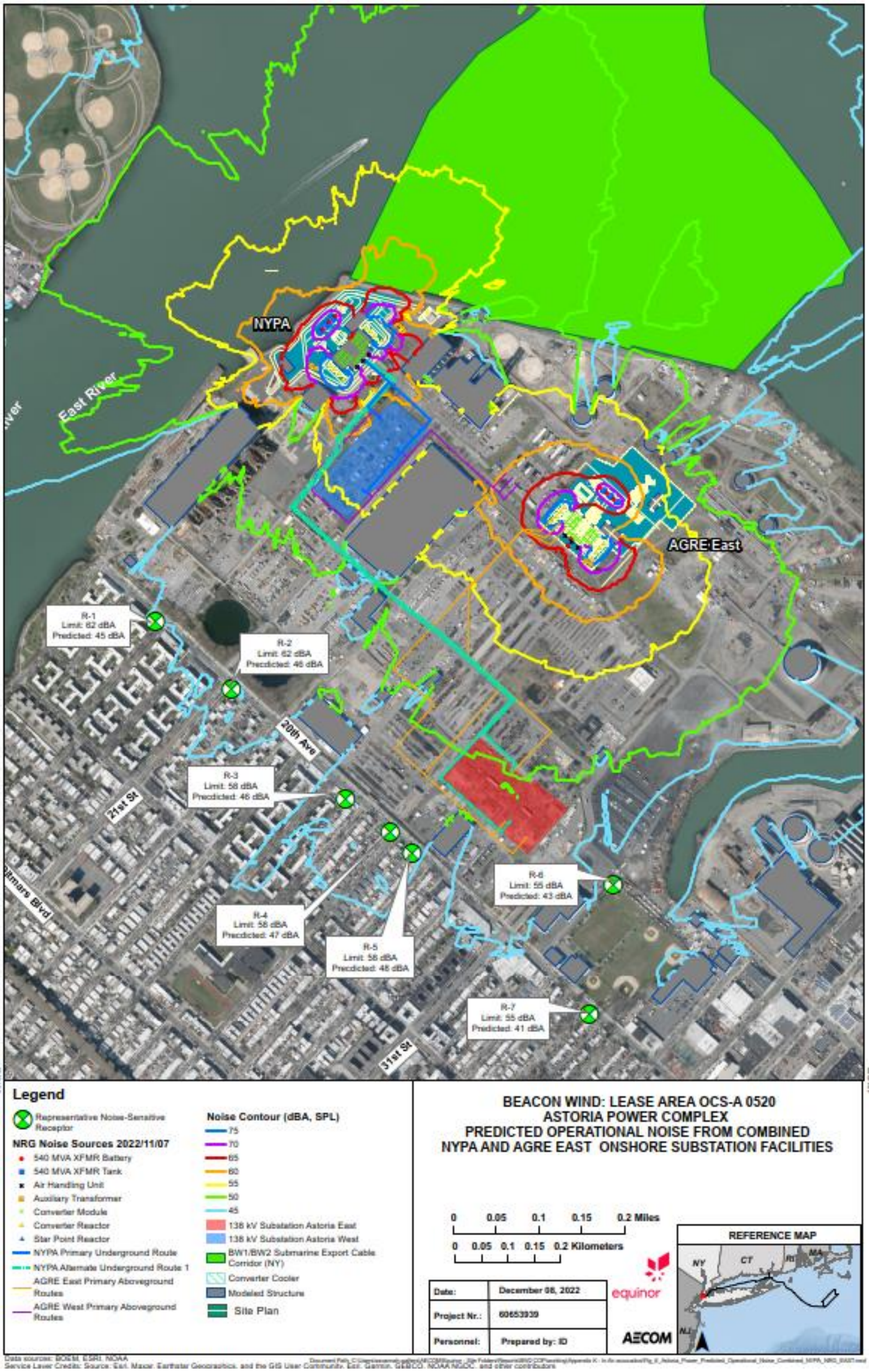
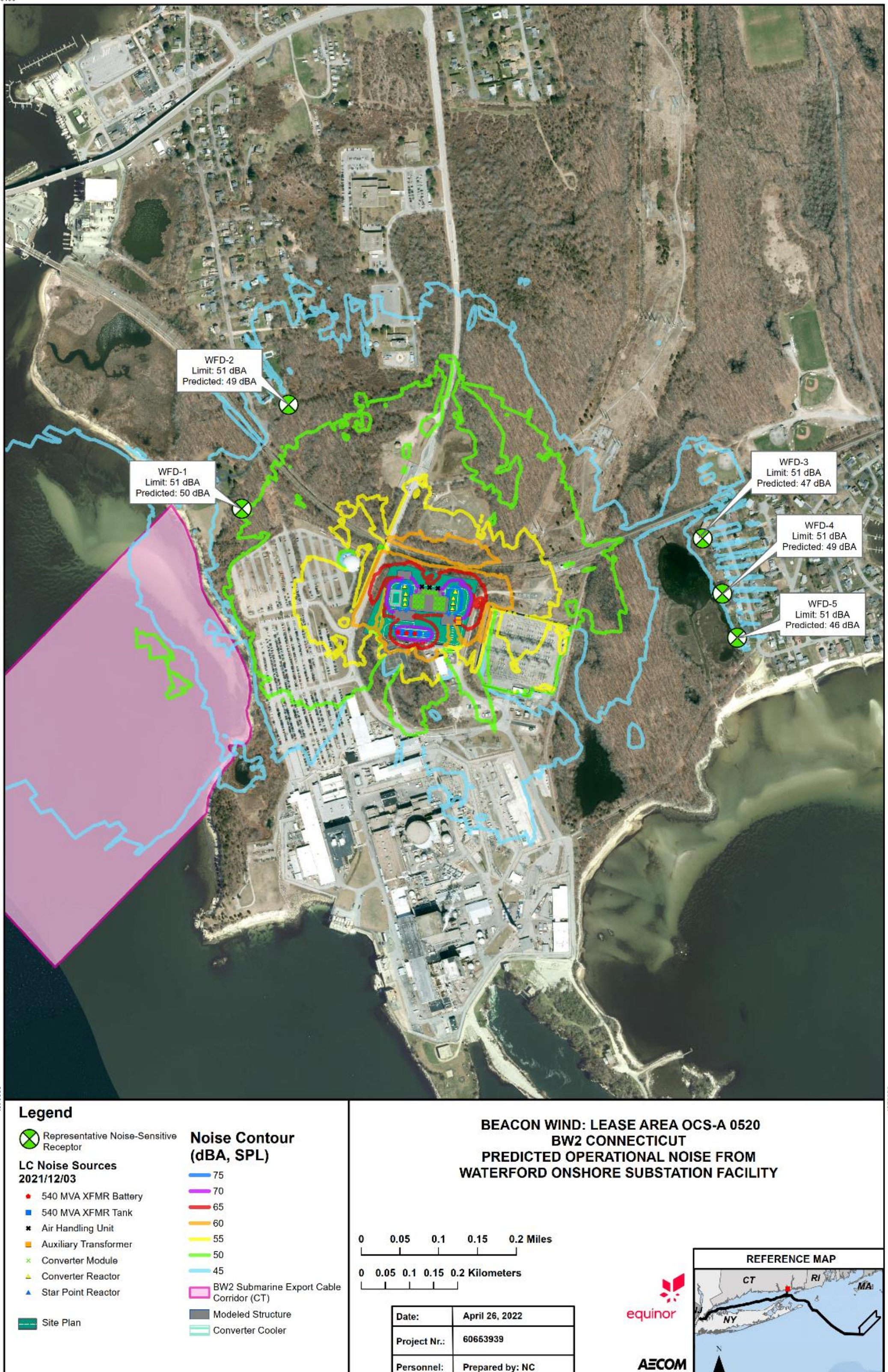


FIGURE 4.4-15. PREDICTED NOISE CONTOURS FOR THE WATERFORD ONSHORE SUBSTATION FACILITY



Data sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

4.4.1.2.3 Decommissioning

During decommissioning, the potential impact-producing factors for in-air acoustics are expected to be similar to those experienced during construction, as described in **Section 4.4.1.2.1**. A full decommissioning plan will be approved by BOEM prior to any decommissioning activities, and potential impacts will be re-evaluated at that time.

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**, Beacon Wind is proposing to implement the following avoidance, minimization, and mitigation measures.

4.4.1.3.1 *Construction*

During construction, Beacon Wind will commit to the following avoidance, minimization, and mitigation measures to mitigate the in-air acoustic impacts described in **Section 4.4.1.2.1**:

- The vessels used for nearshore work and vessels transiting between Project ports and the Lease Area will comply with relevant noise standards;
- 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;
- Where feasible, newer models will be used to provide the quietest performance;
- Construction equipment will be turned off when not in use and idling times will be minimized;
- Quieter-type adjustable backup alarms for vehicles will be used as feasible;
- Noisy equipment will be located as far as possible from noise-sensitive areas;
- Where noise levels may be excessive, temporary barriers will be strategically placed between dominant stationary equipment and noise-sensitive receptors where practicable and safe;
- Hours of construction operations will be minimized to the extent practical, especially if nighttime operations are necessary;
- HDD construction activities will occur during daytime periods unless otherwise deemed acceptable by the appropriate regulatory authority;
- In the case of night operations, only the HDD drill rig and power unit will be used, unless deemed acceptable by the appropriate regulatory authority; and
- A noise compliance hotline will be made available to help actively address noise-related issues.

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

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

4.4.1.3.2 *Operations and Maintenance*

In the Project Area and its onshore components, the only known operational Project-related noise sources anticipated to generate airborne acoustical impacts to noise-sensitive receptors are associated with the onshore substation facilities and offshore operation vessel use. Modeling of the onshore substation facilities in Queens New York determined that the NYPA and NRG sites would exceed New York City's octave band Noise Code limits. Modeling of the Waterford, Connecticut onshore substation facility location determined that the onshore substation facility would not result in the exceedance of the applicable noise level limit. The following bullets detail the measures required to mitigate impacts associated with the Queens New York onshore substation facilities to bring operation in line with the required limits. During operations, Beacon Wind 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;
- Onshore substation facility equipment will be maintained and, where appropriate, mufflers will be installed;
- 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; and
- Noise mitigation measures may be required for either (or both) of the Queens, New York onshore substation facility sites to bring Project operations within the octave-band center frequency limits. To avoid potential non-compliance with New York City's octave band noise level limits, final equipment selection for the converter reactors and the 540-MVA main transformers will be reviewed and vetted by a noise control engineer to ensure that installed equipment will meet the applicable criteria. The final design and noise mitigation strategies will be presented to federal and state agencies through the permitting process and necessary documentation, such as the New York State required Environmental Management and Construction Plan (EM&CP).

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 4.4-13. 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

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4.4.2 Underwater Acoustic Environment

This section describes the regulatory framework for Project-related underwater noise 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 Beacon Wind are also described, which are intended to avoid, minimize, and/or mitigate potential impacts related to underwater noise.

Other resources and assessments detailed within this COP that are related to underwater 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 K**); and
- Underwater Acoustic Assessment (**Appendix L**).

Under the MMPA, with certain exceptions, the "take" of marine mammals is prohibited. The MMPA is regulated by both NOAA Fisheries and USFWS. Upon request, NOAA Fisheries may issue an Incidental Take Authorization (ITA) under the MMPA, allowing for the 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 specific geographical region. Section 3 (16 U.S.C. § 1362 [13]) of the MMPA defines the term "take" as follows: "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". The term "harassment" has two levels: Level A is harassment that "has the potential to injure a marine mammal or marine mammal stock in the wild"; Level B "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." For underwater noise, NOAA Fisheries defines the threshold level for Level B harassment at a SPL of 160 dB referenced at 1 micropascal (re 1 μPa) for impulsive sound (e.g., air guns, impact pile driving), averaged over the duration of the sound signal, and at 120 dB re 1 μPa for non-impulsive sound (e.g., tactical sonar, vibratory pile driving with no relevant acceptable distance specified.

Sound in water and sound in air are both waves that move similarly and can be characterized the same way, however how their amplitude is reported differs greatly. The reference level used in air (20µPa @ 1m) is used to match human hearing sensitivity. A different reference level is used for underwater sound (1µPa @ 1m); and because of these differences in reference standards, noise levels cited in air do not equal underwater levels (NOAA 2022a). To compare noise levels in water to noise levels in air, 26 dB must be subtracted from the noise level referenced in water (NOAA 2022a).

In 2018, NOAA Fisheries revised the 2016 technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NOAA Fisheries 2018a). The guidance identifies the received levels, or thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources; these levels may be used when seeking to determine whether and how their activities are expected to result in potential impacts to marine mammal hearing via acoustic exposure. The guidance includes a protocol for estimating permanent threshold shifts

(PTS) for impulsive and non-impulsive sound sources; the formation of marine mammal hearing groups (low-frequency [LF], mid-frequency [MF], and high-frequency [HF] cetaceans), and otariid (OW) and phocid (PW) pinnipeds; and the incorporation of marine mammal auditory weighting functions into the derivation of PTS and temporary threshold shifts (TTS) onset thresholds. The thresholds are presented using dual metrics of weighted cumulative sound exposure level (SEL_{CUM}) and peak sound level (PK) for impulsive sounds and weighted SEL_{CUM} for non-impulsive sounds. The guidance does not mandate requirements for specific mitigation but may inform decisions relating to mitigation and monitoring requirements.

In order to account for the fact that different species groups use and hear sounds differently, the guidance sub-divided marine mammals into five broad hearing groups and thresholds in the weighted SEL_{CUM} metric incorporate auditory weighting functions. The five groups 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 comprises most of the dolphins, toothed whales except for *Kogia* spp., and 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 of 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] because some species have best sensitivity at frequencies exceeding 100 kHz).
- **Phocids Underwater (PW) —** this group is made up of true seals with a generalized underwater hearing range from 50Hz to 86 kHz (this group is 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 (this group is called 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]). Note that otariid pinnipeds do not occur in the Study Area.

These hearing ranges are generalized, and the ability to hear sounds varies with frequency as demonstrated by examining audiograms of hearing sensitivity (NOAA Fisheries 2018a; Southall et al. 2019). In order to reflect higher noise sensitivities at particular frequencies, auditory weighting functions were developed for each functional hearing group, which reflect 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 2018a). These weighting functions are applied to individual sound levels to reflect the susceptibility of each hearing group to noise-induced threshold shifts, which is different from the range of best hearing (**Figure 4.4-16**).

NOAA Fisheries (2018a) defined acoustic threshold levels at which PTS and temporary threshold shift (TTS) are predicted to occur for each hearing group for both impulsive and non-impulsive signals (**Table 4.4-14)**, which are presented as both sound energy level (SEL) and L_{PK}. The TTS threshold is defined as 20 dB less than the PTS threshold.

FIGURE 4.4-16. AUDITORY WEIGHTING FUNCTIONS FOR CETACEANS (LF, MF, AND HF SPECIES) AND PINNIPEDS IN WATER (PW) FROM NOAA FISHERIES (2018A)

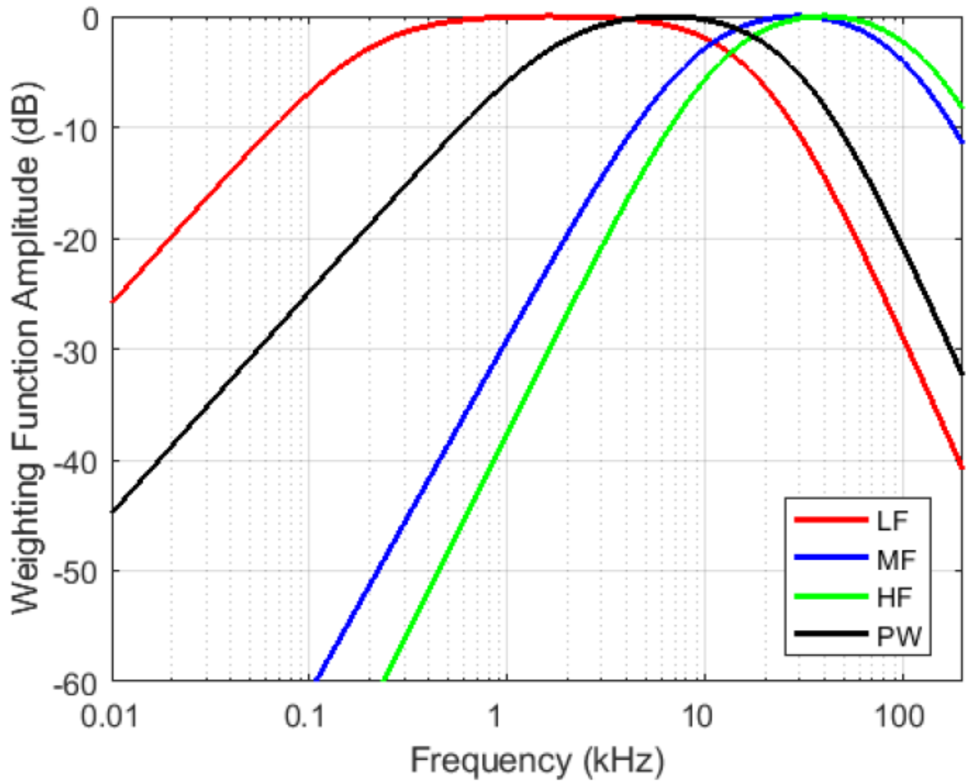


TABLE 4.4-14. RELEVANT ONSET ACOUSTIC THRESHOLD LEVELS FOR MARINE MAMMAL HEARING GROUPS

	Impulsive Signals		Non-Impulsive Signals	
Faunal Group	**PTS a/ Onset**	**TTS b/ Onset**	**PTS Onset**	**TTS Onset**
Low-frequency cetaceans (LF)	219 dB (L_{PK}) c/ 183 dB SEL d/	213 dB (L_{PK}) 168 dB SEL	199 dB SEL	179 dB SEL
Mid-frequency cetaceans (MF)	230 dB (L_{PK}) 185 dB SEL	224 dB (L_{PK}) 170 dB SEL	198 dB SEL	178 dB
High-frequency cetaceans (HF)	202 dB (L_{PK}) 155 dB SEL	196 dB (L_{PK}) 140 dB SEL	173 dB SEL	153 dB
Phocid pinnipeds underwater (PW)	218 dB (L_{PK}) 185 dB SEL	212 dB (L_{PK}) 170 dB SEL	201 dB SEL	181 dB

Notes:
a/ PTS = permanent threshold shift
b/ TTS = temporary threshold shift
c/ L_{PK} = peak sound pressure (dB re 1 µPa)
d/ SEL = sound exposure level (dB re 1 µPa^{2}s)
Source: NOAA Fisheries 2018a

NOAA Fisheries has considered injury onset for sea turtles beginning at SPL RMS 204 dB re 1 µPa in order to prevent mortalities, injuries, and most auditory impacts and behavioral response from impulsive sound sources such as impact pile driving at SPL RMS 166 dB re 1 µPa, which has elicited avoidance behavior of sea turtles **(Table 4.4-15**) (Blackstock et al. 2018). Though there is limited information available on the effects of noise on sea turtles, and the hearing capabilities of sea turtles are still poorly understood, NOAA Fisheries recently updated the prescribed behavioral response threshold for sea turtles to SPL RMS 175 dB re 1 µPa.

TABLE 4.4-15. ACOUSTIC THRESHOLD LEVELS FOR FISHES AND SEA TURTLES FOR INJURY AND BEHAVIOR

Hearing Group	Injury	Behavior
Fishes	206 dB (L_{PK}) a/ 187 dB SEL b/	150 dB SPL RMS
Sea turtles	232 dB (L_{PK}) a// 204 dB SEL b/	166 dB SPL RMS 175 dB SPL RMS (NOAA)

Notes:
a/ L_{PK} = peak sound pressure (dB re 1 µPa)
b/ SEL = sound pressure exposure (dB re 1 µPa^2·s)
c/ SPL RMS = root mean square sound pressure (dB re 1 µPa)
Source: Stadler and Woodbury 2009; NOAA Fisheries GARFO 2019; Blackstock et al. 2018

Interim criteria were developed cooperatively between federal and state agencies to assess the potential for injury to fishes and sea turtles exposed to pile driving sounds. The Fisheries Hydroacoustic Working Group (FHWG), assembled by NOAA Fisheries, established noise injury thresholds that were subsequently adopted by NOAA Fisheries. The NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) has updated these standards (NOAA Fisheries GARFO 2019) and applied them in assessing the potential effects on ESA-listed fish species and sea turtles exposed to elevated levels of underwater sound produced during pile driving. These noise thresholds are based on sound levels that have the potential to produce injury or illicit a behavioral response from fishes (**Table 4.4-15**).

Sound exposure guidelines for fish and sea turtles were also developed by a Working Group organized under the ANSI-Accredited Standards Committee S3 Subcommittee 1, Animal Bioacoustics (**Table 4.4-16**) (Popper et al 2014). The Working Group categorized the following three fish types depending on how they might be affected by underwater sound: fish with no swim bladder or other gas chamber (e.g., dab and other flatfishes); fish with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., salmonids); and fish with a swim bladder that is involved in hearing (e.g., channel catfish).

TABLE 4.4-16. ACOUSTIC THRESHOLD LEVELS FOR FISHES AND SEA TURTLES FOR ONSET OF MORTALITY, POTENTIAL MORTAL INJURY, RECOVERY INJURY, AND TTS

	Impulsive Sounds			Non-Impulsive Sounds	
Hearing Group	Mortality and Potential Mortal Injury	Recoverable Injury	TTS a/	Recoverable Injury	TTS
Fishes without swim bladders	Greater than 213 dB (L_{PK}) /b Greater than 219 dB SEL_{CUM} c/	Less than 213 dB (L_{PK}) Less than 216 dB SEL_{CUM}	Much greater than 186 dB SEL_{CUM}	—	—
Fishes with swim bladders 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 bladders 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 d/	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 e/ (I) Low f/ (F) Low g/	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	—	—

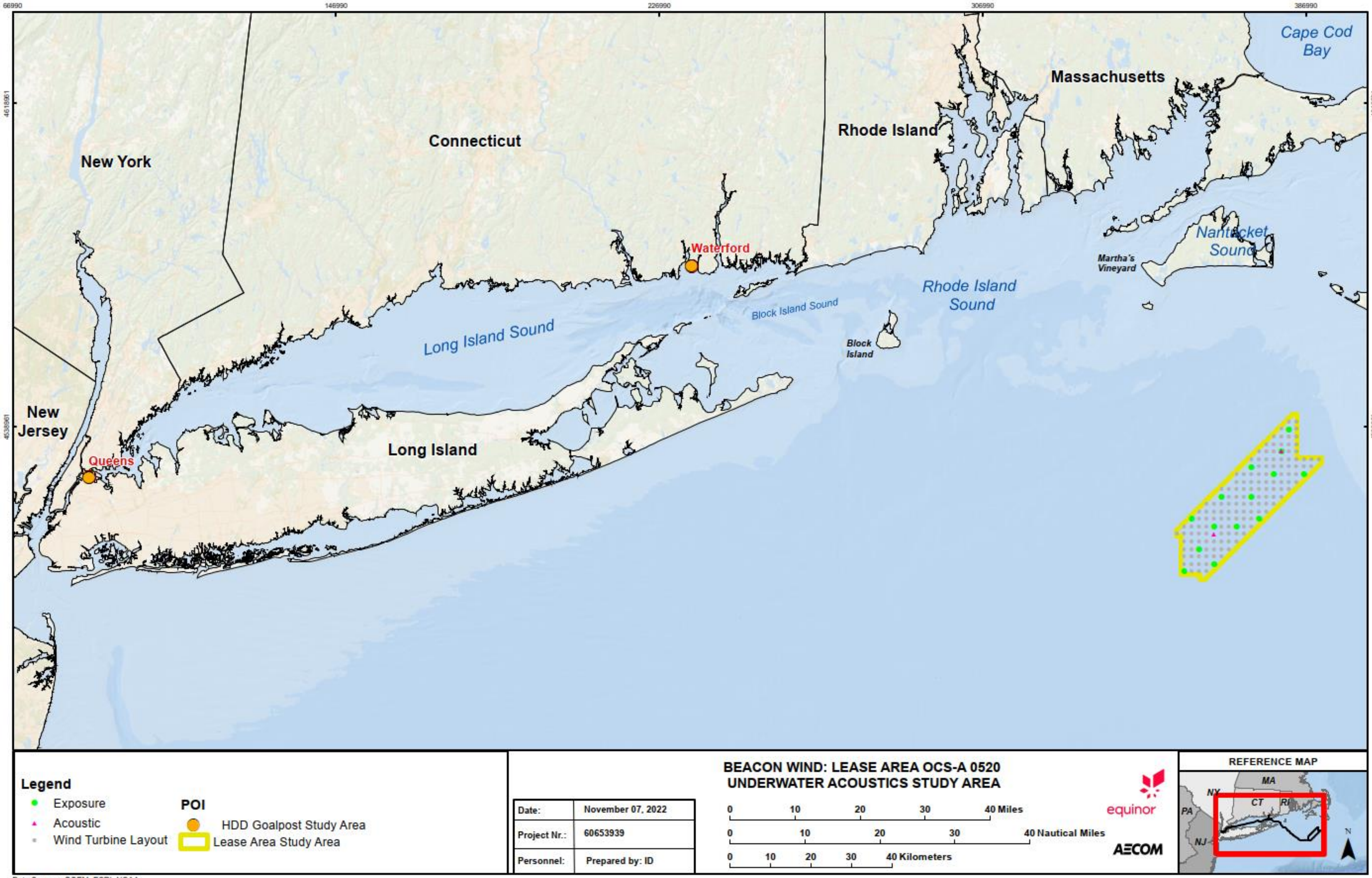
Notes:
a/ TTS = temporary threshold shift
b/ L_{PK} = peak sound pressure (dB re 1 μPa)
c/ SEL = sound exposure level (dB re 1 μPa2 ·s)
d/ RMS SPL = root mean square sound pressure (dB re 1 μPa)
e/ N = near (tens of meters)
f/ I = intermediate (hundreds of meters)
g/ F = far (thousands of meters)
— = not applicable
Source: NOAA Fisheries GARFO 2019; Popper et al. 2014

Data Relied Upon and Studies Completed

For the purposes of this section, the Study Area includes the offshore and coastal waters associated with and in the vicinity of the Lease Area and BW1 and BW2 submarine export cable landfalls (**Figure 4.4-17**).

In support of this COP, underwater sound propagation modeling to predict the level of underwater noise expected during Project-related construction activities is being undertaken. **Appendix L Underwater Acoustic Assessment** provides a description of underwater noise modeling methodology, inputs, and preliminary results.

FIGURE 4.4-17. UNDERWATER ACOUSTIC STUDY AREA



Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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 and are not addressed within this COP. Beacon Wind expects these improvements will support the broader offshore wind industry and will be governed by applicable environmental standards. Beacon Wind will comply with these standards when using the facilities.

Physical and biological processes generate natural noise in the ocean. Tectonic seismic activity, wind, and waves are examples of physical noise sources; the vocalizations of marine mammals and fish are examples of biological noise sources. Biological sound sources can vary from minute-to-minute, hour-to-hour, and seasonally. The ambient noise for frequencies above 1 kHz is due largely to waves, wind, or heavy precipitation (Simmonds et al. 2004). Breaking waves with spray and surface wave interaction are also significant sources of noise. Wind-induced bubble oscillations and cavitation are other near-surface noise sources. Surf noise will be prominent in the frequencies ranging up to a few hundred Hz at areas within 4 to 5 mi (8 to 10 km) of the shoreline (Richardson et al. 2013).

Aquatic animals generate sounds for communication, echolocation, prey detection, and as by-products of other activities such as feeding and may contribute considerably to the amount of background noise in an area. Biological sound production usually follows seasonal and diurnal patterns, which are dictated by variations in the activities and abundance of the vocal animals. Underwater biological sounds range in frequency from less than 10 Hz to greater than 150 kHz. Source levels show a substantial variation ranging from less than 50 dB to more than 230 dB SPL RMS re 1 μPa at 3.1 ft (1 m). There is also significant variation in other source characteristics such as the duration, temporal amplitude, frequency patterns, and the rate at which sounds are repeated (Wahlberg 2008). Wenz (1962) shows classic curves for the frequency dependency in relation to different noise sources typical of underwater noise levels.

Anthropogenic underwater noise can originate from sources such as industrial development, offshore oil and gas development activities, naval or other military operations, and marine research. Commercial vessels and recreational watercraft are also contributors to underwater noise. Cavitation from ships' propellers create sound that dominates coastal waters while main engines, gearboxes, and generators contribute sounds that are secondary to those of the propulsion systems. The use of sonar and depth sounders, which occur at generally high frequencies and attenuate rapidly, are also secondary sources. The typical shipping vessel produces sound at frequencies below 1 kHz while smaller fishing, recreational, and leisure craft typically generate sound at somewhat higher frequencies (Simmonds et al. 2004).

The Project is located in a continental shelf environment characterized by predominantly sandy seabed sediments, with some thin clay layering. Water depths in the Lease Area vary between approximately 128-203 ft (39-62 m). From April to October, increased solar radiation warms the upper 82-164 ft (25-50 m) of the water column. A warmer surface layer results in a downward refracting propagation environment where propagated sound energy tends to interact with the seafloor more than in a well-mixed environment. In November, the temperature structure begins to change as solar radiation decreases and wind mixing increases near the surface. This trend intensifies and continues from December to March, resulting in a sound speed that is more uniform with depth. In shallow water environments where there is increased interaction with the seafloor, the properties of the substrate have a large influence over the sound propagation.

In order to understand the existing environment and current level of activity within the Lease Area contributing to the ambient noise levels, Beacon Wind completed assessments across several commercial and recreational uses such as, commercial and recreation fishing and vessel traffic.

As detailed within **Appendix BB Navigation Safety Risk Assessment** a NVIC-01-19 compliant survey providing a breakdown of vessel traffic was completed in 2019 for the Project. This assessment documented, throughout the 2019 survey period, an average of approximately 10 unique vessels per day within the Lease Area Study Area. The busiest month in 2019 was June, with an average of approximately 34 unique vessels per day, while the busiest day was July 17, 2019 with 57 unique vessels recorded. Vessel traffic was observed to be highest during the summer months, which is reflected in the high numbers of fishing vessels recorded in the data and which exhibited seasonal variation with higher vessel numbers between May and September.

Section 8.8 Commercial and Recreational Fishing details the level of fishing activities occurring within the Lease Area and currently contributing to the ambient underwater acoustic environment. Specific to commercial fishery activities within the Lease Area, NOAA Fisheries uses a vessel monitoring system to keep track of fisheries under its jurisdiction (50 CFR § 660.14) and many types of commercial fishing vessels are monitored with installed equipment that provides position and activity information while operating. Within the Lease Area, recreational fishing is concentrated near areas of structured habitat, such as “The Star” located in the northeastern portion of the Lease Area, or “The Dump,” a former disposal area located west of the Lease Area. Recreational fishing boats may also transit through the Lease Area to reach a site, but their exact transit routes are not represented on commonly used, publicly available datasets. Commercial fishermen from New York, Connecticut, Rhode Island, Massachusetts, New Jersey, and other locations fish in or transit the grounds in and around the Project Area while targeting several different fisheries. Commercial fishing transits are not concentrated in the Lease Area as supported by insight on commercial fishing activities within the Project Area obtained from the automatic identification system, vessel monitoring systems, vessel trip reports, landings data, and outreach activities.

NOAA’s Cape Cod exclusive economic zone soundmap covers the Project Area and provides a modeled prediction of wide-ranging contributions from “chronic” anthropogenic sources for underwater noise from commercial and passenger vessels (e.g., cruise ships and cruise ferries). Predicted received levels within the model are expressed as equivalent, unweighted sound pressure level (L_{zeq}), which is a time-average of sound levels across a specified duration, represented in specific 1-Hz frequency bands, which for the Cape Cod sound map is at a frequency of 50 hz at 16 ft (5m). The annual average ambient noise for both global shipping and passenger vessels in the Project Area was depicted as a range of 85-65 db (NOAA 2022b).

4.4.2.2 *Impacts Analysis for Construction, Operations, and Decommissioning*

The potential impacts resulting from the construction, operation, and decommissioning of the Project are based on the maximum design scenario from the PDE (see **Section 3 Project Description**). The maximum design scenario for assessments associated with the full build-out of the Lease Area of BW1 and BW2 incorporates a total of up to 157 structures within the Lease Area (i.e., 155 wind turbines and two offshore substation facilities) (**Table 4.4-17**). Calculations supporting the maximum design scenario are shown in **Table 4.4-17**.

TABLE 4.4-17. SUMMARY OF MAXIMUM DESIGN SCENARIO PARAMETERS FOR UNDERWATER NOISE

Parameter	Maximum Design Scenario	Rationale
Construction		
Offshore structures	Based on full build-out of the Project (BW1 and BW2) (155 turbines, two offshore substation facilities).	Representative of the maximum number of structures for BW1 and BW2.
Wind turbine foundation	Monopile, Piled Jacket	Representative of foundation options that have the installation method that would result in the greatest amount of underwater noise.
Wind turbine foundation installation method	Pile driving	Representative of the installation method that would result in the greatest amount of underwater noise.
Duration offshore installation	Based on full build-out of the Project (BW1 and BW2) which corresponds to the maximum number of structures (155 wind turbines and two offshore substation facilities), 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 has the potential to impact resources in the Project Area.
Pile driving – single monopile	Pile diameter: 43 ft (13 m) Max penetration: 180 ft (55 m) Max hammer energy: 6,600 kJ[6] Total max pile driving duration per foundation: 4.8 hours Total duration for 155 wind turbines: BW1 and BW2: 744 hours	Representative of the maximum parameters associated with impact pile driving of monopile foundations which would equate to the greatest potential impacts

[6] Total rated energy shown; actual effective energy level will not exceed 6,208 kJ.

Parameter	Maximum Design Scenario	Rationale
Pile driving – piled jacket	Pile diameter: 14.7 ft (4.5 m) Max penetration: 229.6 ft (70 m) Number of piles per foundation: 4 Max hammer energy: 2,300 kJ[7] Total max pile driving duration per foundation: 24 hours (6.1 hours per pile) Total duration for 155 wind turbines: BW1 and BW2: 3,100	Representative of the maximum parameters associated with impact pile driving of piled jacket foundations which would equate to the greatest potential impacts
Pile driving – piled offshore substation facilities (BW1 and BW2)	Pile diameter: 9.8 ft (3 m) Max penetration: 328 ft (100 m) Max number of corner legs piled: 4 Max hammer energy: 2,850 kJ[8] Total max pile driving duration per pile: 8.3 hours Total number of piles for: BW1: 3 BW2: 6 Total number of piles per leg for: BW1: 12 BW2: 24 Total duration for two offshore substation facilities: BW1 and BW2: 470 hours	Representative of the maximum parameters associated with impact pile driving of piled jacket foundations which would equate to the greatest potential impacts 470 hours is considered the maximum amount of time required to drive pile driven jackets for two offshore substation facilities (active pile driving).
Casing Pipe and Goalposts installation method	Impact pile driving Based on full build-out of the Project : • BW1 to Queens, New York (HDD casing pipe and goalposts in a 60 x 7 ft [18 x 2 m] area offshore). • BW2 to Queens, New York (HDD casing pipe and goalposts in a 60 x 7 ft [18 x 2 m] area offshore) or • BW2 to Waterford, Connecticut (HDD casing pipe and goalposts in a 60 x 7 ft (18 x 2 m] area offshore).	Representative of the installation method that would generate underwater noise in the nearshore environment
Operations and Maintenance		
Wind turbines	Based on a full build-out of the Lease Area of 155 wind turbines.	Representative of the maximum underwater noise generated by operational wind turbines.

[7] Total rated energy shown; actual effective energy level will not exceed 2,168 kJ.
[8] Total rated energy shown; actual effective energy level will not exceed 2,168 kJ.

Parameter	Maximum Design Scenario	Rationale
Project-related vessels underwater noise	Based on full build-out of the Project (155 wind turbines, two offshore substation facilities, submarine export cables, and associated interarray cables). Based on maximum number of vessels and movements for servicing and inspections.	Representative of the maximum predicted level of Project-related vessels for underwater noise.

4.4.2.2.1 *Construction*

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

- Installation of offshore components including foundations, offshore substation facilities, submarine export and interarray cables, and casing pipe and goalposts.

With the following potential consequential impacts:

- Short-term increase in underwater noise levels due to monopile and jacket impact pile driving activities associated with the installation of wind turbine and offshore substation facility foundations;
- Short-term increase in underwater noise levels due to impact pile driving activities associated with casing pipe and goalposts installation;
- Short-term increase in underwater noise levels associated with the installation of submarine export and interarray cables;
- Short-term increase in underwater noise levels associated with Project-related vessels; and
- Short-term increase in underwater noise levels associated with drilling and vibratory driving that may be required for installation of wind turbine and offshore substation foundations.

Increase in underwater noise levels associated with monopile and jacket pile impact pile driving activities required for the installation of wind turbines and offshore substation foundations: In support of this COP, underwater sound propagation modeling was completed in order to predict the level of underwater noise expected during Project-related construction activities in the Project area. Piles deform when driven with impact hammers, creating a bulge that travels down the pile and radiates sound into the surrounding air, water, and seabed. This sound may be received as a direct transmission from the sound source to biological receivers (such as marine mammals and sea turtles) through the water or as the result of reflected paths from the surface or re-radiated into the water from the seabed. Sound transmission depends on many environmental parameters, such as the sound speeds in water and substrates. It also depends on the sound production parameters of the pile and how it is driven, including the pile material, size (length, diameter, and thickness) and the make and energy of the hammer. Sound fields produced during impact pile driving for installation of monopile and jacket foundations were estimated by modeling the vibration of the pile when struck with a hammer, determining a far-field representation of the pile as a sound source, and then propagating the sound from the apparent source into the environment.

Acoustic propagation modeling used JASCO's physical model of pile vibration and near-field sound radiation (MacGillivray 2014) in conjunction with the GRLWEAP 2010 wave equation model (Pile Dynamics 2010) to predict source levels associated with impact pile driving activities. The lower frequency bands were modeled using Full Wave Range Dependent Acoustic Model (FWRAM), which is based on the parabolic equation method of acoustic propagation modeling. For higher frequencies, additional losses resulting from absorption were added to the propagation loss model.

For the quantitative acoustic analysis, the potential underwater acoustic impacts resulting from the installation of tapered monopile foundations and piled jacket foundations were modeled for the maximum parameter foundation diameters and embedment depths. **Appendix L Underwater Acoustic Assessment** provides a full description of the underwater noise modeling methodology, inputs, and results.

The analysis and results detailed in **Appendix L Underwater Acoustic Assessment,** will be used to inform development of 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 fishes from underwater noise and will establish appropriate and practicable mitigation and monitoring measures through discussions with regulatory agencies. **Appendix L Underwater Acoustic Assessment** details the source modeling results, acoustic propagation modeling results, and exposure modeling results for marine mammals, sea turtles, and fishes.

Increase in underwater noise levels associated with submarine export cables installation and landfalls: Installation techniques for the submarine export cable landfalls may include trenchless (e.g., HDD, jack and bore, or micro-tunnel) and trenched (open cut trench) methods. Under a base case for HDD landfalls, pneumatic pipe ramming will be used to install casing pipe and goalposts in support of the submarine export cables HDD exit at either Queens, New York and/or Waterford, Connecticut. The installation of a casing pipe using pneumatic pipe ramming would also necessitate the temporary installation of cylindrical steel goalpost piles via impact pile driving. Vibratory driving, pneumatic pipe ramming and impact pile driving produce underwater sounds that have the potential to impact marine mammals, sea turtles and fishes. The isopleth distances to thresholds corresponding to potential injury and behavioral disruption of marine mammals, sea turtles and fishes were computed by propagating measured source levels at potential cable landfall construction areas and then comparing the resulting sound fields to regulatory thresholds. Exposure estimates were then calculated based on expected construction scenarios for casing pipe installation and goal post pile driving, incorporating animal density estimates in the Project area where available. **Appendix L Underwater Acoustic Assessment** details the results of acoustic and exposure modeling for goal posts and casing pipe.

Increase in underwater noise levels associated with the installation of submarine export and interarray cables: Vessels specifically designed for laying and burying cables on the seabed will be used during construction to install the submarine export and interarray cables. The installation is proposed to be completed through the use of a jet plow or underwater plow (for a complete description of the equipment proposed to install and bury the submarine export and interarray cables, see **Section 3.4.2.4 Submarine Export Cable**). The cable-laying vessel will employ the use of DP thrusters to maintain the predetermined track using a Global Positioning System (GPS) to control the thrusters. The underwater noise produced will depend on the equipment used and the nature of the seabed sediments but will be predominantly generated by vessel thruster use.

Dynamic positioning (DP) thruster noise is a continuous noise source and has sound propagation properties similar to vessel noise. Although noise from DP thrusters is within marine mammal functional hearing ranges, DP thruster use does not elicit a behavioral response by marine mammals based on previous reporting, and therefore DP thruster use is not expected to result in harassment of marine mammals or other protected species (NOAA Fisheries 2018b, GeoQuip 2022).

Increase in underwater noise levels associated with Project-related vessels: It is anticipated that additional vessel traffic from construction-related vessels will slightly increase underwater noise from the current baseline (Blair et al. 2016). Based on the maximum design scenario presented in the PDE, there will be an insignificant increase in vessel traffic associated with the construction of the Project. The increase in Project-related vessel activity will be sporadic, both within the 24-hour work day as well as the season and will not occur all at once. It is unlikely that the noise impact of vessel traffic due to Project construction will create a significant increase in underwater noise compared to baseline conditions.

Increase in underwater noise levels associated with drilling or vibratory piling of the wind turbine and offshore substation facilities: While not anticipated, if resistance occurs during impact pile driving due to the presence of rock or hard soil, the drive and drill method may be used to complete the installation of the pile to the target penetration depth. The potential for drive and drill is considered to be a contingency and is not expected to occur. In the event of refusal, the soil would be drilled out below the pile tip . The piling would then be re-established and driven to its final position.

Vibratory piling may be used as part of the piling process to set the piles before the hydraulic impact hammer is used. The use of vibratory piling is highly dependent on the soil conditions and feasibility has not been concluded yet. It is believed that the use of vibratory piling will reduce noise as it will reduce the use of the hydraulic hammer.

4.4.2.2.2 *Operations and Maintenance*

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

- Operations and maintenance activities associated with the offshore components of the Project including wind turbines and offshore substations.

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: The main source of underwater noise during operation of the Project will come from the working of the gears in the nacelle at the top of the turbine (Nedwell and Howell 2004). The noise/vibration from the gears is predominantly transmitted into the water as low-frequency noise by the structure of the turbine itself but may also be transmitted via the tower and the seabed, and through the air and air/water interface (Nedwell and Howell 2004). Source levels from operation of 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 and Howell 2004). While wind turbine noise will increase with increasing wind speed, the noise level relative to ambient noise (i.e., from wave action and entrained bubbles) remained relatively constant due to the increase to the background noise as well (Nedwell and Howell 2004). Furthermore, studies have shown the main impacts of noise and vibrations occur during the construction phases. Per Nedwell et al. (2007), after weighing the received spectra for different species, the sound level increase from operational noise at four different offshore wind farms, beyond the ambient levels, remained within the natural variability present within an underwater environment. This study therefore concluded that the operation of offshore wind farms cannot be expected to invoke changes in the behavior of marine mammals and fishes (Nedwell et al. 2007). An additional study by Stoeber and Thomsen (2021), looked at published underwater sound levels from operational wind farms, where sound increased in correlation with wind turbine output and assessed impact ranges for behavioral response of marine mammals and the potential effect of the transition from gear to direct drive technology. The review showed a generally increasing trend of noise for increasing nominal power, extrapolating the trend of 10 MW yielded a source level of 177 dB re 1 μPa and a more than tenfold larger impact area for behavioral disruption (NOAA Level B criterion) compared to a 5 MW wind turbine (Stober and Thomsen 2021). The study estimated the reduction associated with the technology transition from geared wind turbines to direct drive turbines to be about 10 dB, which reduced the impact range for behavioral disruption from 4 to 0.9 mi (6.3 to 1.4 km) at 10 MW nominal power. The study ultimately indicated their findings point in the direction that operational noise of offshore wind farms of larger size, as planned to be installed in the future, might only have limited impacts related to behavioral response in marine mammals and fishes (Stober and Thomsen 2021). Impacts from operational underwater sound due to Project operations are expected to be negligible.

Another type of offshore structure associated with the Beacon Wind Project is an offshore converter station, located within the offshore substation facilities, that will utilize up to 10 mgd of once-through non-contact cooling water. This operational activity is not expected to contribute to a discernible increase to the underwater acoustic environment, and impacts from underwater sound due to operation of the offshore substation facilities are expected to be negligible.

Increase in underwater noise levels associated with Project-related vessels: Because vessel traffic during operations is expected to have an insignificant increase above existing baseline conditions, underwater noise from Project-related operations and support vessel traffic is not expected to be greater than the ambient noise levels in the Study Area. During operations, additional traffic will consist mainly of supply and maintenance crew vessels. Due to baseline vessel traffic in the area (**Section 8.7.1.1**), the noise associated with supply and maintenance crew vessels transiting to the offshore facilities will have a negligible contribution to total ambient underwater sound levels. Nearshore vessel activity will generally be concentrated in established shipping channels and near industrial port areas and will be consistent with the existing ambient noise in those areas. Therefore, impacts from and underwater sound due to Project-related vessel activity during operations are not expected to be significantly greater than baseline conditions (Tougaard J., Hermannsen L. and P. Madsen 2020).

4.4.2.2.3 *Decommissioning*

Impacts during decommissioning are expected to be 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 and technologies are anticipated to occur throughout the 35 year operations phase of the Project and are anticipated to lessen the impacts of decommissioning. A full decommissioning plan will be submitted and 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 are currently anticipated to be needed for the Project, please see **Section 3.7 Decommissioning Activities**.

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.

4.4.2.4 *References*

TABLE 4.4-18. 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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